Bristol Water

Revised Draft Water Resources Management Plan 2024

October 2024

Foreword

I'm pleased to be able to share our draft Water Resources Management Plan

Our aim in publishing this draft plan is to set how we will evolve our water resources so that future generations can depend on them. Our plan will:

- Protect people, homes and businesses from the impacts of climate change and increasingly hot and dry summers
- Protect rivers and reservoirs, and the wildlife that depends on healthy water levels
- Support the long-term economic health of the region
- Maximise the value of water as a precious resource

The role of responsible business is one of stewardship for sustainable living, and what we do and how we do it is driven by our purpose – supporting the lives of people and the places they love for generations to come. We take in rainfall, store it to treat it to make it safe for all, and distribute to customers and businesses across the region. And along the way we ensure that water continues to provide healthy habitats for wildlife, and recreational spaces for communities.

Managing this precious resource is essential for hygiene, health and recreation.

We operate across a unique region. Water is vital to the environment, be it coasts, rivers, reservoirs or lakes. Bristol Water's reservoirs are important to residents and visitors (both human and wildlife!) for health and recreation.

But our region is changing. The South West is particularly vulnerable to climate change. By 2050, summers in the South West will be on average 2-3 degrees warmer than today, with at least 20 days a year of extreme heat. The drought of 2022 has been devastating for river flows, groundwater levels and reservoir stocks, yet by 2050 the chance of summers as hot as 2022 will increase to 50%. At the same time, population growth means a further 230,000 people will be living and working in the Bristol Water area, increasing the need for water.

From this, one thing is clear - whether you are a customer, a business, a farmer, or a water company - water resources will become stretched, with competing priorities. There is a clear need to act in our water resources plans.

We are determined to make the South West resilient to the increased risks of drought, to support sustainable economic and tourism growth, and to protect our environment, whilst reducing our carbon footprint.

Our work sets out the need to transform the way we all use water, as we adopt new ways of working, focus on sustainable operations and decarbonisation, think innovatively, and empower customers to make informed decisions around water use.

This means investing in new reservoirs, and for the first time ever - working with other water companies to share resources. A second reservoir will be developed at Cheddar in 2035 that will be used to increase resilience of water resources across the entire region. And with increased interconnections and reduced leakage, we can make sure that we share this water around the region, with customers and businesses protected from changing weather patterns and growth. This will provide flexibility to supply high-quality water outside of drought periods to the Bristol Water area and reduce treatment and pumping costs associated with water supplied from the Gloucester & Sharpness Canal. In addition, in the Mendip Hills there are quarries and pits that are well suited to be used for raw water storage and one quarry will be developed as a reservoir in 2042 to further increase the resilience of water resources across the region.

There are other supply options in the long run that could see us invest in water recycling. Today, most of the water we all use, along with rainwater that lands our roofs and driveways, all ends up going down the drain and into the sea. We could introduce recycling schemes that will retain and recycle this water that would otherwise flow into the sea.

We will do our bit to make homes fit for the challenge, to support government targets to reduce leakage by 50% and reduce consumption by a quarter by 2050. Homes need to be able to recycle water, using more water butts and rainwater harvesting systems. Smart meters for all will help homes to manage water use and will identify the leakage on customer properties -which currently accounts for over one third of all leaks. This will ensure homes are smarter and healthier in the future. Our draft plan focuses on reducing water demand with the preferred plan comprising demand side options only with no need for supply side options. We are however engaged with the regional water resources planning effort, West Country Water Resources (WCWR), which has selected preferred strategic regional supply options: a second reservoir at Cheddar and a further reservoir within the Mendip Hills. These supply options while providing no dry year benefit to Bristol Water customers will be constructed within Bristol Water's supply area in order to serve the wider water resources resilience needs of the wider West country region. The regional plan is due to be published in early 2025.

We believe that this water resources plan delivers for everyone, and it is one that future generations can be proud of.

Susan Davy
Chief Executive Officer

Executive Summary

Bristol Water provides 275 million litres of excellent quality drinking water every day to our 1.18 million domestic customers and 30,900 business across our supply area of approximately 2,400 square kilometres (1,000 square miles) which covers Bristol City, North Somerset and areas of Bath, North East Somerset and South Gloucestershire.

Our water comes from a combination of sources including from our Mendip Hill reservoirs, groundwater within our supply zone and nearly half our supply is taken from the River Severn via the Gloucester and Sharpness Canal. Our entire supply area acts as one integrated zone, with the ability to share resources across the whole area.

In June 2021, Bristol Water was acquired by the Pennon Group, joining South West Water and Bournemouth Water. We are delighted by this opportunity to learn and share knowledge and resources across the group, whilst retaining the Bristol Water brand and local connection with our communities.

This is Bristol Water's Water Resources Management Plan (WRMP24) for the period 2025 to 2080. The plan proposes the best overall balance of affordability and long-term value to ensure that we can provide a reliable and resilient supply of water to our customers, even in the face of severe drought. In developing our plan, we have engaged with our customers and stakeholders to understand their preferences.

The baseline position

We face several challenges in our region over the next 25 years. Climate change is predicted to reduce available water supply at a time when there will be an increased demand for water from an additional 230,000 people living in our area. There is also the need to protect some of our most environmentally sensitive supplies through reduced abstraction.

We have used best practice techniques in water resource planning to estimate changes to both supply and demand over the long-term. Our plan considers the new principle of an "Environmental Destination" for reduction in abstraction, and we have worked closely with Environment Agency teams to explore this. Initial assessments for Bristol Water suggest the likely impact of this is very small, with less than 1% of the total water available to the company likely to be affected. We have set out a proposed programme of work and investigations to support our understanding of the likely environmental destination requirements in the future and we will develop this over the next five years. In discussion with the EA following the consultation period we have agreed to take a precautionary approach and include a scenario of an additional 4.1Ml/d reduction in abstraction across AMP8 and AMP9 in our baseline. This reduction is not confirmed; it reflects the amount that is currently under WINEP investigations that have not yet concluded.

Our baseline supply balance shows that population growth, combined with the move to a 1 in 500 level of drought resilience, creates a deficit of supply against demand in around 2040. This assumes that we hold leakage at 2025 target levels and per capita consumption (PCC) at broadly current levels.

Our best value plan

We have created a best value plan to ensure an environmentally sustainable water supply is provided in the Bristol Water area both for the immediate future and the long term. This plan is predicated on activity required to meet government policy target glidepaths of:

- **Leakage:** 20%, 30%, 37% and 50% reduction by 2027, 2032, 2038 and 2050, respectively.
- **PCC:** 122 litres per person per day by 2038 and 110 litres per person per day by 2050
- **NHH Water Use:** 9% and 15% reduction by 2038 and 2050 respectively
- **Distribution Input:** 9%, 14% and 20% reduction per head by 2027, 2032 and 2038, respectively.– We have identified that in the face of current water demand there are no technical options available that can deliver the 9% reduction target by 2027. In light of the need to keep our plan affordable, we have decided not to frontload our preferred plan and therefore do not expect to achieve a 14% reduction in DI by 2032. Neither of these will lead to any compromise in the resilience or sustainability of water supply.

Bristol Water is already at the forefront of leakage management in the UK water industry, and we plan to take an "intelligent pathway" to deliver an incremental reduction in leakage across the planning period, balancing deliverability, affordability, and intergeneration fairness.

Our current low level of leakage means that increased mains replacement, beyond our long-term maintenance needs, will be required.

We propose to take the same intelligent pathway approach on PCC and we have assumed a fifteen-year programme of universal smart metering between 2025 and 2040. Whilst we cannot currently compel customers to pay based on this metered consumption, the data we receive will both help identify leaks on customers' supply pipes and provide customers with the information they need to reduce demand.

Our plan recognises that there has been a significant increase in per capita household water consumption because of COVID-19, as more people work at home more often. This makes the government PCC target glidepath to 110 l/h/d by 2050 even more challenging and will require policy changes such as mandatory water efficiency labelling of white goods and the ability to meter on a compulsory basis in our region.

This demand management strategy creates a supply surplus across the planning period and therefore on this basis, no further investment in supply schemes is required. We recognise that our demand management plan is highly ambitious, with pioneering levels of demand reductions being dependent on rapid innovation and the action of others (including changes in legislation such as new planning requirements for improved water efficiency in new homes). We also recognise that these reductions are likely to become even more challenging in the face of climate change. We also recognise the efforts being made at national level and will continue to explore innovative options and look to adopt best practices from across the industry when they emerge and have proven delivery of appropriate cost benefits.

We have been working with our neighbouring water companies to develop a regional plan due to be published in early 2025 for water supply, to ensure the most efficient solution for customers overall. This has resulted in the following regional preferred options being selected:

- A second reservoir at Cheddar, a new reservoir in our region, benefitting South West Water with 20Ml/d during the summer months (6 month period) from 2035. The option will be constructed within Bristol Water's supply area and primarily serve the wider needs of the west country region, however it would also provide flexibility to supply high-quality water outside of drought periods to the Bristol Water area, reducing treatment and pumping costs associated with water supplied from the Gloucester & Sharpness Canal, if the need were to arise.
- Mendip quarries, a new reservoir in our region, benefitting both South West Water (Bournemouth Water) and Wessex Water with 46Ml/d on average and 106Ml/d on peak split across the two companies with opportunities to expand and provide resources to other areas. The option will be constructed within Bristol Water's supply area and primarily serve the wider needs of the west country region.

We have continued to assess the ongoing resilience of existing sources. One of our key sources, the Gloucester and Sharpness Canal, receives water from the lower reaches of the River Severn. We recognise the importance of this source in the resilience of our plan, and we have therefore carried out significant investment in the physical resilience of the canal, working with the canal operator (the Canal & River Trust) on emergency management, assessment of the likely impacts of drought on the Severn, and long-term contractual agreements stretching beyond the timeline of the statutory planning period. We will continue to work with the Trust and EA to ensure we have the best possible understanding and management of the resilience of this important water source.

Comparison with our previous WRMP

We last published a Water Resources Management Plan in 2019, and this WRMP24 differs from this plan in the following ways:

- The principle of planning for regional water management rather than just in our company area has been a driving principle for the plan, and we have worked closely with other partners in the West Country region to build our plan.
- WRMP24 now plans to deliver resilience to an extreme (worst in 500 years) drought rather than the 1 in 200 year drought; to reduce the risk our customers face in the event of an exceptionally severe drought. Our plan delivers resilience against this kind of severe drought from 2025.
- We now assess our "actual" levels of service (for instance how often we might implement temporary use bans) as well as our "planned" levels of service - this indicates that our actual performance is even better than our planned level of service. For instance, with temporary use bans, while we have developed and tested a plan that allows for this kind of usage restriction to be implemented once ever fifteen years, our actual performance is that our customers are likely to see this once every fifty years.
- The Plan now extends further into the future than WRMP19: our previous plan extended to 2045 and this new plan extends to 2080 rather than being limited to the statutory planning period of 25 years.
- Our approach on climate change has used the most up-to-date information available and is based on a range of different scenarios to develop a plan that is resilient to a severe level of climate impact, if necessary, but which does not assume this worst-case scenario as a baseline and thus drive unnecessary expense for customers.

Development of our plan

Development of the plan has followed the structured guidance issued by the Environment Agency (EA), and formal pre-consultation meetings have been held with EA and other key stakeholders to test the development of the plan and ensure that it takes a proportionate and evidence-based approach to the management of water resources. The plan aligns with the new regional planning approach on water resource management, developed in collaboration with other water companies and key water users in the West Country region, and delivers government expectations on demand reduction (leakage, PCC and non-household water demand). The regional plan is due to be published in early 2025.

The Pennon Board has full ownership of this plan, which has been developed under a formal process of external assurance and review. The plan was published for consultation with the public, our stakeholders and our regulators, and we have refined and developed our WRMP in response to the feedback we received. The programme of water resource management actions identified in this draft of the WRMP24 are fully aligned with our PR24 business plan.

The revised draft (rdWRMP) version of our plan was submitted to support the Statement of Response, enabling our regulators to understand how our plan evolved in response to consultation responses, regulatory queries and customer feedback.

There are two areas where the WRMP24 has been improved since the Statement of Response was published to ensure deliverability within wider business plan proposals, these impact the following areas:

- The leakage reduction profile now reaches a 50% reduction from the 2017/18 baseline by 2050 rather than 2045 due to the board assurance process in relation to ensuring fair costs to customers.
- New population forecasts have been reviewed but it has been determined that the differences between the existing data used and the new data are too small to warrant revising our assessment.

Public Value Principles

Table 1-1 How our plan follows Ofwat's public value principles.

#	Description	How do we contribute?
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.	Principle 1 aligns to the sub-metrics in Table 14-1 that are a reflection our long-term vision of being a company *"…that our communities trust and are proud of"* whilst meeting the current and future needs of our customers, stakeholders, and the environment, fulfilling a role well beyond the basic provision of water. For more information, see https://www.bristolwater.co.uk/about-us/our-plans/our-long-term-ambition/

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.	Principles 2 & 3 are core to the comprehensive customer engagement and results processing undertaken during pre-consultation and consultation for the WRMP. Throughout the process we have worked with our customers, stakeholders, and regulators to identify and act on their views and feedback. We have drawn upon our both customer research and the Bristol Water Challenge Panel, an independent group of interested and expert stakeholders whose role is to ensure that customer voices remain at the heart of Bristol Water's decision making. It is also the case that a monitoring plan has been proposed for the environmental effects of the preferred plan as part of the SEA process (Environmental report, Appendix E Section 9.3) as well as on the success of our demand management and leakage reduction activities.
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 help identify opportunities for delivering additional social and environmental value.	
Principle 4	Delivery of social and environmental value outcomes should not come at greater cost to customers without customer support.	Principle 4 has been considered through our Willingness to Pay research which underlies the option characterisation in determining AISC.
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.	Principle 5 is demonstrated by our proposals to work with neighbouring companies, for example in providing a transfer to Wessex water and in developing the Regional Plan that actively works with other sectors.
Principle 6	Companies should take account of their capability, performance and circumstances in considering the scope for delivering greater social and environmental value.	Principle 6 has been a core principle in that environmental assessment has been fundamental to the development of the our Best Value Plan.

Board Assurance Statement

1. Our approach to assurance

Our approach to governance is an integral part of our culture, guiding how we do business and create value for our stakeholders.

We publish information which ensures we not only meet our statutory, licence and regulatory obligations but also provide information to customers on the Company's activities, how the Company is performing and most importantly, how customers can get help when they need it. Underpinning this information, we publish our risk and assurance processes. These processes have been embedded into the management of the Company and are designed to ensure risks are promptly identified, updated on a regular basis, and appropriate mitigation is in place to suit the level of risk.

We have a mature integrated risk management framework which is fully embedded into our governance structures and embodies our values of being 'trusted' and 'responsible' in the way we carry out our business. Details of this integrated assurance approach are published each year in our assurance plan.

Our integrated assurance approach includes our three lines of defence:

- **Management:** review, quality control and sign off
- **Policy setting and compliance checking:** adequate policies, internal audit and business management systems
- **External scrutiny:** external audit and other assurance providers.

First line of defence

Our WRMP24 has been led by an experienced team, with staff who have carried out this activity in previous planning periods, have worked in regulatory roles on resource planning, and have relevant experience across the water sector. Team members are also fully engaged with the Regional Planning process and represent the Company on the West Country Water Resources Group (Steering Group and Board) and on the Strategic Regional Options assessment process with the Regulators' Alliance for Progressing Infrastructure Development (RAPID).

Extensive technical support has been provided by industry experts, including leading our best value modelling. The work packages delivered by consultancies have been commissioned through a structured procurement framework, with formal assessment of the expertise of all consultancies commissioned.

Second line of defence
Engagement with the plan across the business has been regular and detailed.

For the draft WRMP24 (dWRMP24), Pennon's Internal Audit Team undertook a review of the assurance underpinning the plan The scope of Group Internal Audit's work was to provide independent assurance that there was sufficient underlying evidence to support the various Board Assurance Statements submitted as part of the draft Water Resources Management Plan.

For the revised draft WRMP24 (rdWRMP24), the working group for the WRMP, attended by both technical staff and senior staff from Bristol Water and South West Water, has provided critical review and steer of the ongoing process to update the dWRMP in the context of both the Statement of Response, ongoing discussions with regulators and Periodic Review 2024.

For the final WRMP24, Pennon's Internal Audit Team and technical staff undertook a final review of the changes made to the rdWRMP24 to prepare for publication.

Third line of defence
For the dWRMP24, the Company employed the services of independent third-party assurance partners Turner & Townsend to assure the technical quality and the accuracy of the plan. Copies of assurance reports were appended to the company's dWRMP24.

For the rdWRMP24, Turner and Townsend reviewed the work undertaken to update the dWRMP in light of changes identified in the Statement of Response. They provided an updated version of the Assurance Report included as Appendix A2 of the rdWRMP24 and final WRMP24 (WRMP24).

2. Company engagement

Throughout the development of the Regional Plan and our WRMP we have undertaken regular engagement with the Environment Agency and Ofwat to discuss our methodology and plans; wider stakeholder engagement has been completed with Natural England, Local Councils, Historic England, Rivers Trust and SW Rivers association, to build a shared understanding of the challenges and possible solutions.

We have engaged with customers and discussed with the Bristol Water Challenge Panel.

3. Alignment with the Regional Plan

The WRMP24 is aligned with the Regional Plan which is due to be published in early 2025.

Planning tables from our revised draft WRMP will be used in the final Regional Plan, and data will be validated by a third party, with a formal statement of alignment made within the Regional Plan.

The strategic regional options which have been selected within the regional plan associated with Bristol Water directly are:

- a second reservoir at Cheddar, a new reservoir in our region, benefitting South West Water with 20Ml/d during the summer months (6 month period) from 2035. The option will be constructed within Bristol Water's supply area and primarily serve the wider needs of the west country region, however it would also provide flexibility to supply high-quality water outside of drought periods to the Bristol Water area, reducing treatment and pumping costs associated with water supplied from the Gloucester & Sharpness Canal, if the need were to arise.
- Mendip quarries, a new reservoir in our region, benefitting both South West Water (Bournemouth Water) and Wessex Water with 46Ml/d on average and 106Ml/d on peak split across the two companies with opportunities to expand and provide resources to other areas. The option will be constructed within Bristol Water's supply area and primarily serve the wider needs of the west country region.

There is an additional strategic regional option in the plan which is not associated with Bristol water directly:

- Poole effluent recycling benefitting both South West Water (Bournemouth Water) and Wessex Water with 20Ml/d during the summer months (6 month period) from 2035.

4. Further refinement of our plans

Our plan includes some challenging demand management targets which require the support of both customers, other stakeholders and us to deliver. For example, legislation changes are required for tougher water efficiency standards for new homes and mandatory labelling of white goods.

Our final plan also considers interdependencies with other programmes such as our PR24 business plan and long-term delivery strategy

5. Assurance activities in respect of the draft, revised draft and final WRMP

Assurance activities in respect of the draft Water Resources Management Plan (dWRMP) followed our integrated assurance approach with three lines of defence.

Internally there was a robust review process and sign off of the underlying assumptions and inputs to the draft WRMP.

Our external assurance provider performed a set of reviews, mutually agreed between Bristol Water and the provider, reflective of risks in establishing the WRMP. These focused on:

- Ensuring we have developed our plan (where possible at the draft stage) in accordance with the National Framework and relevant guidance
- Reviewing evidence of engagement with third parties, driving collaboration within the plan.

The external assurance provider's procedures were the agreed-upon reviews as reported to the Board which confirmed that there were no issues identified that would present concerns creating material risk of the draft WRMP being established outside of the guidance and framework.

Our Board provided an assurance statement at the draft WRMP stage. The Board were satisfied that this was a well-evidenced, fully assured plan, that was best value for our customers and stakeholders given the prescribed National Framework. It reflected that due to it being a draft plan, there remained some uncertainty. For the rdWRMP and this final WRMP we have made updates to resolve these uncertainties.

For the revised draft, we commissioned consultant Turner & Townsend to provide external technical assurance to the company in terms of the methodologies and approach and data used to develop and support the draft and the rdWRMP.

For our final plan, the minor changes made were reviewed internally to ensure that the final report and associated planning tables were ready for publication.

6. Board Statement

For the draft WRMP, the Bristol Water Board considered that the process Bristol Water went through in developing the plan was sufficient to ensure that, in all material aspects, the draft WRMP was in line with the guidance and frameworks set out to establish consistent plans.

Due to the oversight and assurance processes applied during the development of the draft WRMP, the Bristol Water Board were satisfied that:

- The National Framework and relevant guidance were being followed and applied
- There were clear links and processes in place to ensure the appropriate interventions, including Regional Plan and partnership schemes.

At the draft stage, our plans represented an investment programme based on modelled interventions and established costing processes which represented our best value plan for customers and the environment, given the best available assumptions at the time.

For the rdWRMP24, Turner and Townsend reviewed work undertaken to update the dWRMP in light of changes identified in the Statement of Response. They provided an Assurance Note (Appendix A2) which is in addition to the dWRMP Assurance Report included as Appendix A.

The underlying principles and drivers of the WRMP were previously signed off by the Board at draft stage. The revised draft was an amended version following the consultation process. As such the Board were given sight of key changes between the draft and the revised draft plan and the assurance process undertaken on these aspects. The Board were satisfied that the changes from the draft to the revised draft were robust and compliant with associated frameworks and guidance.

The Board understands that the primary driver of the Bristol Water WRMP is the Government targets determining the focus on demand management. Sustainability reductions and Environmental Destination are less significant drivers of change in the supply demand balance. Costs for the proposed WRMP options are considered in the context of the wider PR24 business plan and are considered affordable and deliverable by the Board.

Contents

A set of Appendices are published alongside this plan, see **Section 1.4**. This is supported by a range of technical documents which are available by request.

1 Introduction

1.1 Background

Bristol Water is now part of the Pennon Group following its acquisition in June 2021 and clearance by the Competition & Markets Authority in March 2022. Bristol Water's licence transferred to South West Water on 1 February 2023 and South West Water is now the water supplier to the area formerly covered by Bristol Water. The draft Water Resource Management Plan was published ahead of this licence transfer and the revised draft plan has kept this separate identity for WRMP24, reflecting that Bristol Water is a separate water supply area, not contiguous with the South West Water or Bournemouth Water areas. This document therefore continues to use the term "Bristol Water" to refer to the definitions which applied when the draft WRMP was written. We anticipate that future Water Resource Management Plans will integrate the former Bristol Water area into the wider Pennon planning process, as a named water resource zone.

This is Bristol Water's final Water Resources Management Plan 2024 (WRMP24). It sets out how, with the active participation of our customers, we propose to ensure that there is a sufficient supply of water to meet the demand forecast from all our customer over the next 55 years from 2025 to 2080 whilst also protecting and enhancing the environment. It is one of the core business planning tools that we use to drive our business, and links directly to our Business Plan, our Drought Plan, and our annual operations planning. It reflects our strategies set out in 'Our routemap to Net Zero Carbon by 2030'[1] and 'Bristol Water…Clearly'[2] that sets out our long-term ambition looking ahead to 2050.

Bristol Water's ambition is that by 2030 we will not cause any increase in greenhouse gas emissions to Earth's atmosphere through our activities to supply water to customers. We have proposed a mix of methods to achieve carbon neutrality by 2030. It is also consistent with the strategy for the West Country Region, as set out in the final West Country Water Resource Group (WCWRG) Regional Plan due to be published in early 2025.

This plan describes in detail the technical assessments we have carried out to determine the water that will be available for supply over the planning period to 2080; the anticipated customer demand for water over this time; and the supply demand balance. This is a technical document and presents all the analysis required by our regulators and Government to support our proposed strategy for maintaining an affordable and resilient supply of water to our customers. It sets out how we will maintain the balance of supply and customer demand, and the options we have considered in determining our preferred plan, including demand reduction measures, optimising the use of our existing water resources, water transfers from outside our supply area and/or developing new water resources within our supply area.

All water companies in England and Wales must produce a WRMP and update it every five years (see **Section 1.2** for detail of the regulatory framework). We last published a WRMP[3] in August 2019 and are now reviewing and updating the plan to publish a final version in 2024. As part of the development of this

[1] Our routemap to Net Zero Carbon by 2030 (Bristol Water, 2021)
[2] Bristol Water…Clearly (Bristol Water, 2018)
[3] Final Water Resources Management Plan 2019 (Bristol Water, 2019)

WRMP24 we have drawn on engagement with customers to understand their preferences and priorities (**Section 2**). This engagement completed during the formal consultation process tested the plan and is informing the development of our final plan, as detailed in **Section 2**.

Each WRMP builds on the previous one by updating and reviewing the assessments to reflect the latest information, technology, regulatory guidance and the views of customers and stakeholders. This means that although any options identified for implementation over the first five years of the planning period from 2025-2030 (during AMP8) are very likely to be put in place and planned through the Price Review process, any options identified for later years may be subject to change in terms of timing and/or options solution, as further detailed investigations are carried out to inform reviews and updates of our WRMP. This adaptive planning approach enables water companies to respond and adapt to the ever-evolving water resources position in terms of environment, demographics, climate change and regulatory processes.

Bristol Water is committed to evolving our water resources so that that future generations can depend on them. The aim of our plan is to protect people, homes and businesses as well as the rivers and reservoirs in our area and the wildlife that depends on them. The role of responsible business is one of stewardship for sustainable living, and what we do and how we do it is driven by our purpose – supporting the lives of people and the places they love for generations to come.

1.1.1 Changes and Improvements Since WRMP19

There has been a step change in the water resource planning requirements since we published our 2019 WRMP (see table 1-1) and since we published our draft WRMP24. We have taken on board all these changes and worked closely with our colleagues in the West Country Water Resources Group (WCWRG) to develop our WRMP24 to reflect the latest requirements set out in the Defra, Environment Agency and Ofwat water resource planning guidance, and to align our WRMP with the WCWRG regional strategy as set out in the final WCWRG Regional Plan due to be published in early 2025.

In March 2020, the Environment Agency published a National Framework for Water Resources[4] (referred to as 'the National Framework'), setting out a strategic direction for the work being carried out by the regional water resources groups, building on previous work from Water UK[5] and the National Infrastructure Commission[6]. This work identified that investment is required to reduce demand and increase supplies to increase drought resilience and make sure that the nation's water supplies, and environment can cope with an uncertain future in the face of climate change and population growth. The National Framework set out proposals for water companies to plan to reduce both leakage and demand to target levels by 2050 and increase drought resilience to a 1-in-500 year drought (0.2% annual chance) so that level 4 drought restrictions (emergency drought orders/standpipes) are implemented no more often that once in 500 years on average.

The National Framework also introduced the concept of 'Environmental Destination' setting out expectations for actively enhancing the environment, considering where abstraction recovery may be required, how the greatest environmental benefits can be released through better abstraction management and resource opportunities.

The Water Resources Management Plan (England) Direction 2022[7] and associated government expectations document sets out the policy assumptions water companies should use in developing their WRMP24 for demand (leakage, per capita consumption levels and non-household demand), drought resilience and environmental destination, reflecting the strategy set out in the National Framework.

The Environment Act 2021 provides a legal framework for environmental governance and established specific expectations on environmental improvement, including measures on air, water, biodiversity, and resource efficiency and waste reduction. Whilst legally binding long-term environmental targets have not yet been approved, in 2022 the government consulted on a number of these measures. Their proposals included reducing water demand by 20% by 2037 and halting the decline of and increasing species abundance by at least 10% by 2042. The proposals were also aimed at addressing nutrient pollution by reducing nitrogen, phosphorus, and sediment pollution from agriculture to the water environment by at least 40% by 2037 and by reducing phosphorus loadings from treated wastewater by 80% by 2037.

The key changes to the WRMP24 compared to our 2019 WRMP are detailed in **Table 1-1**.

[4] Meeting our future water needs: a national framework for water resources (Environment Agency, 2020)
[5] Water Resources Long Term Planning Framework (2015-2065) (Water UK, 2016)
[6] Preparing for a drier future, England's Water Infrastructure Need (National Infrastructure Commission, 2018)
[7] Environment Agency, 2022. Water Resources Management Plan (England) Direction

Table 1-1: Changes to our WRMP since WRMP19

Item	Change from WRMP19 to WRMP24	Approximate impact of change on supply demand balance
Deployable output	We are now planning to be resilient to a 1-in-500 year drought event from 2025 rather than 1 in 200 year drought event. This approach reflects the latest EA guidance and government expectations.	There is a reduction in supply availability (deployable output) of 4.4Ml/d between the 1 in 200 and 1 in 500 years baseline stochastic DO assessment that have been undertaken for this WRMP. Due to improvements in the underpinning Aquator model, this represents nearly 5Ml/d increase in DO, compared to the 1 in 200-year assessment figure for WRMP19..
Climate Change	Climate change assessment updated to reflect the UKCP18 climate change scenarios in line with EA guidance. This indicates a more significant impact of climate change on our resource profile than in WRMP19 under all climate change scenarios.	Under the medium climate change scenario (PB6.0) there would be an additional reduction in supply availability (deployable output) of between 8Ml/d and 15Ml/d compared to the climate change effects assessed in the WRMP19.
Environmental Destination	In addition to any assumptions relating to agreed sustainability reductions we are now required to include any additional supply side reductions associated with delivering our Environmental Destination requirements by 2050.	Initial assessments for the Rural Bristol Avon catchment suggest that we will need to reduce abstraction by 3.28 Ml/d by 2050 to maintain sustainable abstraction in the context of climate change. We shall reduce supply availability (deployable output) by 3.28Ml/d from 2030.
Unconfirmed sustainability reductions	In addition to confirmed sustainability reductions and Environmental Destination requirements, the Environment Agency has requested that we include a scenario of 4.1Ml/d supply reduction in our baseline plan for WRMP24.	We shall reduce supply availability in AMP 8 and 9 by a total of 4.1Ml/d to demonstrate the impact of such a change, if it were to be confirmed.
Leakage	Leakage reduction increased to reflect the policy target glidepath to 50% reduction by 2050 against the 2017/18 outturn leakage. The glidepath includes 20%, 30%, 37% reduction by 2027, 2032 and 2038 respectively against the 2017/18 levels. For Bristol Water the 2050 target translates as a reduction in leakage of 22Ml/d from the 2017/18 baseline by 2050 (~9Ml/d by 2027; ~13Ml/d by 2030/31; ~16Ml/d by 2037).	An increase in water available by 9.89Ml/d in 2050 compared to the baseline leakage value of 31.85Ml/d (end of AMP7 target).
Household demand	Per capita consumption reduced to reflect the policy target glidepath to 110 l/h/d by 2050. The glidepath includes 122 litres per person per day by 2038 and 110 litres per person per day by 2050. For Bristol Water the 2050 target translates as a reduction in PCC of 45 l/h/d from the 2021/22 outturn value of 155 l/h/d (and 22l/h/d by 2029/30 and 33l/h/d by 2038/39 for interim targets).	An increase in water availability of approximately 40Ml/d by 2050 compared to the baseline PCC forecast.

Item	Change from WRMP19 to WRMP24	Approximate impact of change on supply demand balance
	In WRMP19, the anticipated PCC in 2021/22 was 143Ml/d. Whilst a small difference between the forecast and outturn values are to be expected, the primary reason that the PCC target was not met is due to the impact of changing working patterns during the Covid-19 pandemic. We are committed to continuing to reduce PCC and have a post-COVID PCC strategy being implemented over the remaining years of AMP7 and 8 (see Section 3.3.)	
Non-household demand	Non-household demand reduced to reflect the policy target of 9% reduction by 2037/38 and 15% reduction by 2050 from 2019/20 levels. For Bristol Water, this translates as a reduction of 5.3Ml/d by 2037/38 and of 8.8Ml/d by 2050, compared to the total non-household consumption of 58.7Ml/d in 2019/20.	An increase in water availability of approximately 50Ml/d by 2050 compared to the baseline non-household consumption forecast.
Distribution input per head	Distribution input per head reduced to reflect the policy target glidepath to 20% reduction by 2038 against the 2019/20 outturn. The glidepath includes 9%, 14% and 20% reduction per head by 2027, 2032 and 2038, respectively. For Bristol Water, this translates to reaching a distribution input of 200.2 l/d per head, 189.2 l/d per head and 176 l/d per head, respectively.	An increase in potable water supply of approximately 3.1 Ml/d for the total resource zone population by 2038.

1.2 Regulatory Framework

WRMPs are produced as part of a statutory process. Under Section 37 of the Water Industry Act 1991 (WIA), water companies are required to provide domestic and non-domestic customers with a reliable supply of water for domestic and business purposes. The Water Act 2003 amended the WIA 1991 by introducing a statutory requirement for water companies to produce WRMPs at least every five years, setting out how they ensure that they can meet the demand for water that they expect will arise in the future (WIA 1991 Section 37A, as amended). This legislation also requires us to consult with customers and stakeholders on our dWRMP (WIA 1991 Section 37B, as amended).

When producing this WRMP, reference has been made to the following guidance and legislation.

- Water Industry Act 1991, sections 37A – 37D, as amended by the Water Act 2003
- Water Resources Act 1991
- Environment Act 1995
- Environment Act 2021
- Water Resource Management Plan Regulations 2007
- Water Resource Management Plan (England) Direction 2022
- Meeting our future water needs: a national framework for water resources (Environment Agency March 2020).

- Water Resources Planning Guideline: Version 10 updated December 2021 and Version 12 updated March 2023.
- Government expectations for water resources planning (Defra April 2021)
- Environmental Assessment of Plans and Programmes Regulations 2004
- Conservation of Habitats and Species Regulations 2017
- Water Environment (Water Framework Directive) (England and Wales) Regulation 2017 (WFD regulations)
- The Water Supply (Water Quality) Regulations 2016
- Eels (England and Wales) Regulations 2009
- Wildlife and Countryside Act 1981
- Countryside and Rights of Way Act 2000
- Natural Environment and Rural Communities Act 2006
- Invasive Alien Species (Enforcement and Permitting) Order 2019
- Strategic Environmental Assessment Directive (2001/42/EC)
- Habitats and Wild Birds Directives (92/42/EEC and 2009/147/EA)
- Water Industry Strategic Environmental Requirements (WISER), Environment Agency and Natural England, October 2017
- February 2022: The government's strategic priorities for Ofwat, (updated March 2022)
- Environmental Improvement Plan 2023

Additional detailed technical guidance and methodologies on specific aspects of the WRMP are referenced in the relevant sections throughout this document and are included in the Reference list.

The WRMP must be kept up to date and is therefore a live document that Bristol Water keeps under review. We are required to send the Secretary of State a statement of conclusions following each annual review of the published WRMP. The WRMP annual review process is a review of the current understanding of the components of the supply demand balance, based on the annual outturn data, and an assessment of how this compares to the final published WRMP. Any material changes to the WRMP identified because of the annual review could trigger the need for the development of, and consultation on, a revised/updated WRMP.

1.3 Compliance with Government Direction

Our WRMP must comply with the Water Resources Management Plan (England) Direction 2022, which came into force on the 28th April 2022 and directs all water undertakers wholly or mainly in England on the contents of our WRMPs. **Table 1-2** lists the requirements set out in the Directions, and where we have addressed these within this WRMP.

Table 1-2: Requirements of the Water Resource Management Plan (England) Direction 2022 and where they have been addressed in the WRMP

Direction 2022 Reference	Contents of WRMP required by the WRMP (England) Direction 2022	WRMP Reference
2. (1)	…a water undertaker must prepare a water resources management plan for a period of at least 25 years commencing 1st April 2025.	Section 3.4

Direction 2022 Reference	Contents of WRMP required by the WRMP (England) Direction 2022	WRMP Reference
3.(1) (a)	The appraisal methodologies which it used in choosing the measures which it has identified in accordance with section 37A(3)(b) and its reasons for choosing those measures.	Section 12, 13 & 14
3. (1) (b)	For the first 25 years of the planning period, its estimate of the average annual risk, expressed as a percentage, that it may need to impose prohibitions or restrictions on its customers in relation to the use of water under each of the following – (i) Section 76(b); (ii) Section 74(2)(b) of the Water Resources Act 1991(c); and (iii) Section 75 of the Water Resources Act 1991, and how it expects the annual risk that it may need to impose prohibitions or restrictions on its customers under each of those provisions to change over the course of the planning period as a result of the measures which it has identified in accordance with section 37A(3)(b).	Sections 3.7.1 & 15.2.1 and WRP table 2f
3. (1)(c)	The assumptions it has made to determine the estimates of risks under sub-paragraph (b) including but not limited to drought severity.	Section 15.2.1
3. (1)(d)	In respect of greenhouse gas emissions – (i) The emissions of greenhouse gases which are likely to arise as a result of each measure which it had identified in accordance with section 37A(3)(b), unless that information has been reported and published elsewhere and the water resources management plan states where that information is available; (ii) How those greenhouse gas emissions will contribute individually and collectively to its greenhouse gas emissions overall; (iii) Any steps it intends to take to reduce those greenhouse gas emissions. (iv) How these steps will support the delivery of any net zero greenhouse gas emissions commitment made by it; and (v) How these steps will support delivery of the UK government's new zero greenhouse gas emissions targets and commitments.	Sections 13.8 & 15.2.3
3. (1)(e)	The assumptions it has made as part of the supply and demand forecasts contained in the water resources management plan in respect of – (i) The implications of climate change, including in relation to the impact on supply and demand of each measure which it has identified in accordance with section 37A(3)(b); (ii) Household demand in its area, including in relation to population and housing numbers, except where it does not supply, and will continue not to supply, water to domestic premises; and (iii) Non-household demand in its area, except where it does not supply, and will continue not to supply, water to non-domestic premises or to an acquiring licensee;	Section 9 Section 6.9
3. (1)(f)	Its intended programme for the implementation of domestic metering including – (i) The proportion of smart meters to other meters; (ii) If it does not intend to install smart meters, the reason for this;	Section 15.1.3 Table 15-7 Table 15-8

Direction 2022 Reference	Contents of WRMP required by the WRMP (England) Direction 2022	WRMP Reference
	(iii) Its estimate of the cost of that programme, including the costs of installation and operation of meters;	
3. (1)(g)	Its estimate of the total number of meters installed to record water supplied to domestic premises at the commencement of the relevant planning period and including a breakdown of – (i) The number of smart meters; (ii) The number of meters that are not charged by reference to volume; (iii) The number of meters that are charged by reference to volume including – (aa) optant metering; (bb) change of occupier metering (cc) new build metering; (dd) compulsory metering; and (ee) selective metering;	Section 15.1.3 Table 15-7 Table 15-8 WRP table 2c
3. (1)(h)	Its estimate of the total number of domestic premises which will become subject to domestic metering during the planning period and including a breakdown of – (i) The number of domestic premises with smart meters; (ii) The number of domestic premises with meters that will not be charged by reference to volume; (iii) The number of domestic premises with meters that will be charged by reference to volume including (aa) optant metering; (bb) change of occupier metering (cc) new build metering; (dd) compulsory metering; and (ee) selective metering;	Section 15.1.3 Table 15-7 Table 15-8 WRP table 2c
3. (1)(i)	Its estimate of the impact on demand for water in its area of any increase in the number of premises subject to domestic metering.	Section 12.7.2
3. (1)(j)	Its assessment of the cost-effectiveness of domestic metering as a mechanism for reducing demand for water by comparison with other measures which it might take to meet its obligations under Part III of the Act;	Section 14, 15.1.2 & 15.1.3
3 (1)(k)	Its intended programme to manage and reduce leakage, including anticipated leakage levels and how those levels have been determined;	Section 15.1.3 & 12.7.1
3 (1)(l)	If leakage levels are expected to increase at any time during the planning period, why any increase is expected and if so, the proposed plan of works that will be undertaken to mitigate this;	Not applicable. We are not planning to allow leakage to increase over the planning period.
3 (1)(m)	How its intended programme to manage and reduce leakage will contribute to- (i) A reduction in leakage by 50% from 2017/18 levels by 2050; and (ii) Any leakage reduction commitment it has made in respect of its appointment area;	Section 12.7.1 & 15.1.3
3 (1)(n)	In respect of any relevant regional water resources plan –	Section 2.1.4, 3.6.3, 7.1, 7.3.2 & 12.7.1

Direction 2022 Reference	Contents of WRMP required by the WRMP (England) Direction 2022	WRMP Reference
	(i) How this plan has been considered and reflected in its water resources management plan; or (ii) Where the plan has not been considered and reflected in its water resources management plan, the reasons for this.	

1.4 Water Resource Management Plan Structure

This WRMP technical report takes the reader through the process we have implemented to develop our WRMP. We start with a general introduction to the company's supply area, and then set out each of the technical assessment areas used to determine the forecasts of supply (water available for potable use) and demand (the forecasted demand from customers) over the planning period. These assessments are then combined to derive the baseline supply demand balance that identifies whether there may be a risk of a supply deficit in the future. Any future deficit is addressed via the appraisal of options available to reduce or eliminate the deficit. The preferred plan is then set out showing how we propose to maintain customer security of supply and levels of service over the planning period to 2080.

This WRMP is structured as follows:

- Executive Summary
- Section 1: Introduction
- Section 2: Engagement with customers, stakeholders, and regulators
- Section 3: Background Information
- Section 4: Problem Characterisation
- Section 5: Water Supply
- Section 6: Water Demand Forecast
- Section 7: Baseline metering, leakage control and water efficiency
- Section 8: Sustainable Abstraction
- Section 9: Climate Change
- Section 10: Target Headroom
- Section 11: Baseline Supply-Demand Balance
- Section 12: Options Appraisal
- Section 13: Environmental Appraisal
- Section 14: Programme Appraisal
- Section 15: Final Water Resources and Demand Strategy
- Section 16: Testing the WRMP
- Section 17: Future Developments
- Section 18: National Security and Commercial Confidentiality
- Glossary of Terms and Abbreviations
- References

Appendices are presented separately from this report but include:

- Appendix A: Turner & Townsend Assurance Report on draft WRMP
    - Appendix A2: Turner & Townsend Assurance Report on revised draft WRMP
- Appendix B: Pre-Consultation List
- Appendix C: Problem Characterisation
- Appendix D: Habitats Regulation Assessment
- Appendix E: Strategic Environmental Assessment Report
- Appendix F: Water Framework Directive Assessment
- Appendix G: Natural Capital Assessment and Biodiversity Net Gain Assessment
- Appendix H: Invasive Non-Native Species Assessment
- Appendix I: WRMP Leakage Investment Strategy

Several supporting documents informed the development of this plan which are available by request.

1.5 Internal Review and Technical Audit

In the development of our WRMP we have implemented a rigorous process of internal challenge and review. This has been overseen via our internal WRMP Working Group which has met on a regular basis during the development of the WRMP to be updated on the latest project developments. At these meetings, each component required for developing the WRMP has been reviewed and challenged. We also commissioned consultant Turner & Townsend to provide external technical assurance to the company in terms of the methodologies and approach and data used to develop and support the draft and the rdWRMP. Assurance areas included:

- Compliance with the reporting requirements and general compliance with good practice as referred to in the EA Water Resources Planning Guideline (WRPG).
- Technical adequacy of the approach used and the modelling and analysis behind it.
- The quality assurance and input/output controls used by Bristol Water and, where appropriate, the consultants that were engaged to provide the relevant models and assessment work.

These audits for the rdWRMP built upon the audits undertaken by Turner & Townsend for the dWRMP. The Turner & Townsend external auditor's report on the dWRMP is in **Appendix A.** Turner & Townsend concluded that:

"*Overall, your team has worked hard to produce a dWRMP that is based on processes/approaches that appear materially aligned with the guideline (and its supporting guidance) an reflects your associated wider regional plan.*

You understand the plan may change between draft and final versions due to a number of factors (e.g. EA clarifications once it has reviewed all company plans; option consultation results; updated population data) but do not anticipate material impacts to arise from these."

Each area reviewed at the dWRMP was allocated an overall grade of A, B, C or D to reflect the extent to which the approach followed the guidance. This was also completed for the revised draft plan. No further changes were required for the publication of the final plan. Descriptions for each category are given in **Table 1-3**.

Table 1-3: Assurance Assessment Framework

Grade B – low /medium risk (the following statements are true) We have not identified any material deviations from the guidelines/directions for this component. We have not identified any material inconsistencies between the approach and the outputs. We have not identified any material issues with the population of the dWRMP tables.	**Grade A – low risk (the following statements are true)** We have not identified any deviations from the guidelines/directions for this component. We have not identified any inconsistencies between the approach and the outputs. We have not identified any issues with the population of the dWRMP tables.
Grade C – medium to high risk (one of the following statements are true) We have identified material deviations from the guidelines/directions for this component – or multiple minor deviations with a material effect. We identified material inconsistencies between the approach and the outputs – or multiple minor deviations with a material effect. We identified material issues with the population of the dWRMP tables – or multiple minor deviations with a material effect.	**Grade D – High risk (more than one of the following statements are true)** We have identified material deviations from the guidelines/directions for this component – or multiple minor deviations with a material effect. We identified material inconsistencies between the approach and the outputs – or multiple minor deviations with a material effect. We identified material issues with the population of the dWRMP tables – or multiple minor deviations with a material effect.

Table 1-4 summarises the findings of the Turner & Townsend assurance of the dWRMP24.

Table 1-4: Draft WRMP Assurance Outcomes

Technical component	Grade	Audit Summary	Summary of Agreed Actions
Problem Characterisation	A	We did not identify material deviations from the guidance in the team's approach, or in the application of the approach. The approach followed, and the resulting assessment, are consistent with WRMP19. The team considers the wider plan approaches that flow from the problem characterisation are consistent with at least the minimum guideline expectations and in some cases go beyond them.	• Confirm that the increasing complexity of SWW and WSX's WRMP problems does not materially impact BRL plan components through the implications of changes to the regional plan approach/outcomes.
Outage	B	We did not identify any material deviations from the guidelines and associated supporting material/requirements. We note there are some final updates still to make to the analysis (e.g.: to reflect WRMP24 DO figures) and we recommend the team explains some elements of its approach/outputs in its commentary for this component.	• Update outage analysis to take account of WRMP24 DO figures and of 1-in-500-year drought DO figures post 2040. • Consider how best to reflect Clevedon in outage figures given the site should be back online for the start of the planning period
Demand Forecast (household and non-household)	B	BRL collaborated at a regional level with other companies (WCWRG) to generate its forecasts. The aim of the joint project was to use a consistent method of forecasting across the region and to utilise the good practice of the WRMP19 assessments, including region specific micro-component data. We have not identified any material deviations in approach from the WRP guidelines.	• We recommend the team include a governance page at the front of the methodology document setting out document owner, reviewer, approver, date of current and next review • We recommend the team include a section within the methodology document setting out checks that are in place, when it is carried out, by whom and what the escalation process is if exceptions are identified. • Consider including a note in the submission as to why you consider the sources used for the micro component analysis are representative of BRL customers
Leakage	B	The approach to produce the leakage data appeared to align with guidelines and industry data where appropriate. The process needs to be fully documented once the process is completed.	• Finalise methodology report • We noted the cumulative PAL cost in year 10 was different between the 3 spreadsheets, i.e., cumulative sheets, output summary and input data sheets..

Technical component	Grade	Audit Summary	Summary of Agreed Actions
		During the data audit, we observed areas of the RPS model which were note yet finalised. For example, tailoring to Bristol Water; checks and controls over links within the model and to other datasets on the RPS SharePoint which result in mismatches of source inputs and outputs. The team were working to fix these issues before providing the model outputs to Bristol Water	• Recommend including a section in the report outlining the data checks and controls that are in place to ensure robustness and accuracy of data. • Also recommend that the team conducts checks that all data is being pulled through to the model summary tab. • Finalise model to tailor it to Bristol Water. For example, grand total heading is actually DMA grand total, and make clear that trunk main leakage is being dealt with separately and any other areas that require clarification. • The team noted that it is limited to using the industry standard PRV cost – so optimisation assumes all will cost the same to install regardless of other factors. The team said it has used costs from 3 companies that RPS work with. This should be noted in the commentary accompanying the submission.
Population forecast	B	We note that the team are content with the level of data provided and generated by Experian -and that the Bristol Water team is still working on finalising the dWRMP24 data in this area. We also note ONS/Census data is due to be published in 2023. The fWRMP is likely to reflect this data, and there is a limited possibility of driving non-trivial changes to the plan. We recommend this likely update is noted in the plan – and that between the draft and final plans, any significant changes are communicated to stakeholders in a timely manner (once they are sufficiently understood).	• We recommend the team include a governance page at the front of the methodology document setting out document owner, reviewer, approver, date of current and next review. • We recommend the team include a section within the methodology document setting out checks that are in place, when it is carried out, by whom and what the escalation process is if exceptions are identified.
Deployable Output (Historical and Stochastic)	B	We did not identify material issues during our sampling. We noted some areas where approach and assumptions could be set out in documentation for clarity, though we understand these have been agreed between Bristol Water, HR Wallingford, and	• Set out clearly the rationale for EVA which results in higher DO during droughts compared to IR including in

Technical component	Grade	Audit Summary	Summary of Agreed Actions
		Hydro-Logic. For example, explaining clearly the rationale for EVA which results in higher DO during droughts compared to IR and a potentially higher implied risk in the WRMP24	relation to the potentially higher implied risk in the WRMP24. • Key risks and assumptions and details of reviews to support justifications set out in documentation. A risk matrix format could be used to display these. • Check consistency of assumptions, datasets used with wider longer term planning such as PR24, drought plans and drainage plans
Climate Change	B	We identified no material compliance issues with the consultant team's approach to deriving climate change supply side impacts. We note that there are some limited choices and checks left for the BRL team to consider as part of integrating the consultant product into the dWRMP.	• Check consistency of assumptions, datasets used etc with wider long term planning e.g. PR24, drought plans, drainage plans • Check whether integration of climate change impacts into WRMP baseline leads to any double counting of risk in relation to the headroom assessment. • Check whether EA/ Ofwat provided feedback on the climate change impacts approach set out in the methodology document.
Drought Vulnerability	B	The team has a good understanding of the process and data for this WRMP component. However, we note the target headroom figure, which is an input to for this component, has been revised following a recent separate audit. The drought vulnerability model and analysis has not been re-run however this is considered immaterial.	• Consider including a checks and controls sections within the documentation setting out: risks; what checks are in place; for example internally as well as when data is sent/ received by each stakeholder; when checks are carried out, by whom and what the escalation process is if exceptions are identified. • We recommend assumptions and support justifications are set out in report/ documentation. Also the target headroom change must be flagged and any potential impacts.

Technical component	Grade	Audit Summary	Summary of Agreed Actions
			• The guidance asks to "consider how you can improve resilience to droughts through your plan"/ The team stated this can only be done through DO assessment. We recommend you state this in your commentary accompanying the submission for this component.
Headroom	B	The team has a good understanding of the process and the data. Atkins updated the original target headroom model it had created in WRMP19 to reflect the requirement for WRMP24 and to reflect the current uncertainty around the headroom components. The approach is consistent with WRMP19	• Recommended that a log of checks is carried out for the purpose of audit trails and to support the robustness of data. • Ensure that glidepaths are consistent between data tables and headroom models. • For D3: Climate change adjustment on demand, confirm approach and consider if any updates to made ahead of final WRMP24
Environmental Assessment	B	The Strategic Environmental Assessment (SEA) process is a qualitative one and the SEA matrices provide detail of the assumptions that have been made about different options. During the audit, we observed the process and reporting was not yet finalised, some assumptions are yet to be agreed with Bristol Water and checks and controls are required on completion. The team are working collaboratively with all parties, including Bristol Water, before formally providing the completed outputs.	• Capture the full end-to-end process in a reporting document. This should include specific roles and responsibilities of different members of the team and the process for feeding results into Bristol Water for consideration. • Finalise process for Bristol Water approval including the moderation exercise. • Ensure any changes/deviations/assumptions are incorporated into the reporting document.
Options Appraisal	B	The approach to options appraisal and costing appeared to align with guidelines and industry data where appropriate – this drives our assessment. We discussed some potential inconsistencies with the team, which it considers justified – e.g.: • Due to the nature of the Cheddar 2 option, there may be some inconsistency in how it is represented in the options appraisal process between Bristol Water and regional plans.	• Finalise methodology report • Finalise Options Appraisal spreadsheet for Bristol Water approval • Determine EA requirements regarding extent of information required for Tables 5 and 5A-C. If no clear

Technical component	Grade	Audit Summary	Summary of Agreed Actions
		• The use of historic, rather than current, carbon data from BEIS. During the audit, we observed that the options list was not yet finalised, some assumptions are yet to be agreed with Bristol Water and checks and controls are required on completion. The team are working collaboratively with all parties, including Bristol Water, before formally providing the completed outputs.	steer given by EA, ensure approach is agreed internally and signed off, and set out approach clearly in supporting submission narrative to reduce potential for queries from EA. • Ensure changes/deviations/assumptions/focus is incorporated into the methodology report. This includes use of industry data, use of historic BEIS data, focus on leakage and PCC etc., providing rationale for doing this. • Set out clearly the approach taken for Cheddar 2 in the dWRMP24 narrative, including highlighting rationale, and any perceived inconsistencies between Bristol Water and the regional plan
Decision Making	B	The approach to the decision making appeared to align with guidelines and industry data. The process needs to be fully documented once the process is completed. During the audit, we observed that the process had not yet been finalised, some figures and assumptions are yet to be agreed with Bristol Water and checks and controls are required on completion. The team are working collaboratively with all parties, including Arup, Ricardo and Bristol Water.	• Finalise methodology report. • Finalise Decision making spreadsheet for Bristol Water approval. • Ensure to re-define Mendip reservoir option prior to submission. • Ensure all assumptions and any potential deviations from the guidance are explained in the plan narrative and also incorporated into the methodology report. • Set out clearly the approach taken regarding adaptive planning, Cheddar 2, etc., in the dWRMP24 narrative, including highlighting rationale, and any perceived inconsistencies between Bristol Water and the regional plan.
WRP Tables audits (carried out after the completion of the component audits above)			
WRP Tables 1, 2, 3, 6 & 7 (excl 7c AP8FP and 7d)	B	The team has completed Tables 1, 2, 3, 6 & the majority of table 7. During our sample checks we identified a number of minor issues that the team plans to correct before plan submission.	

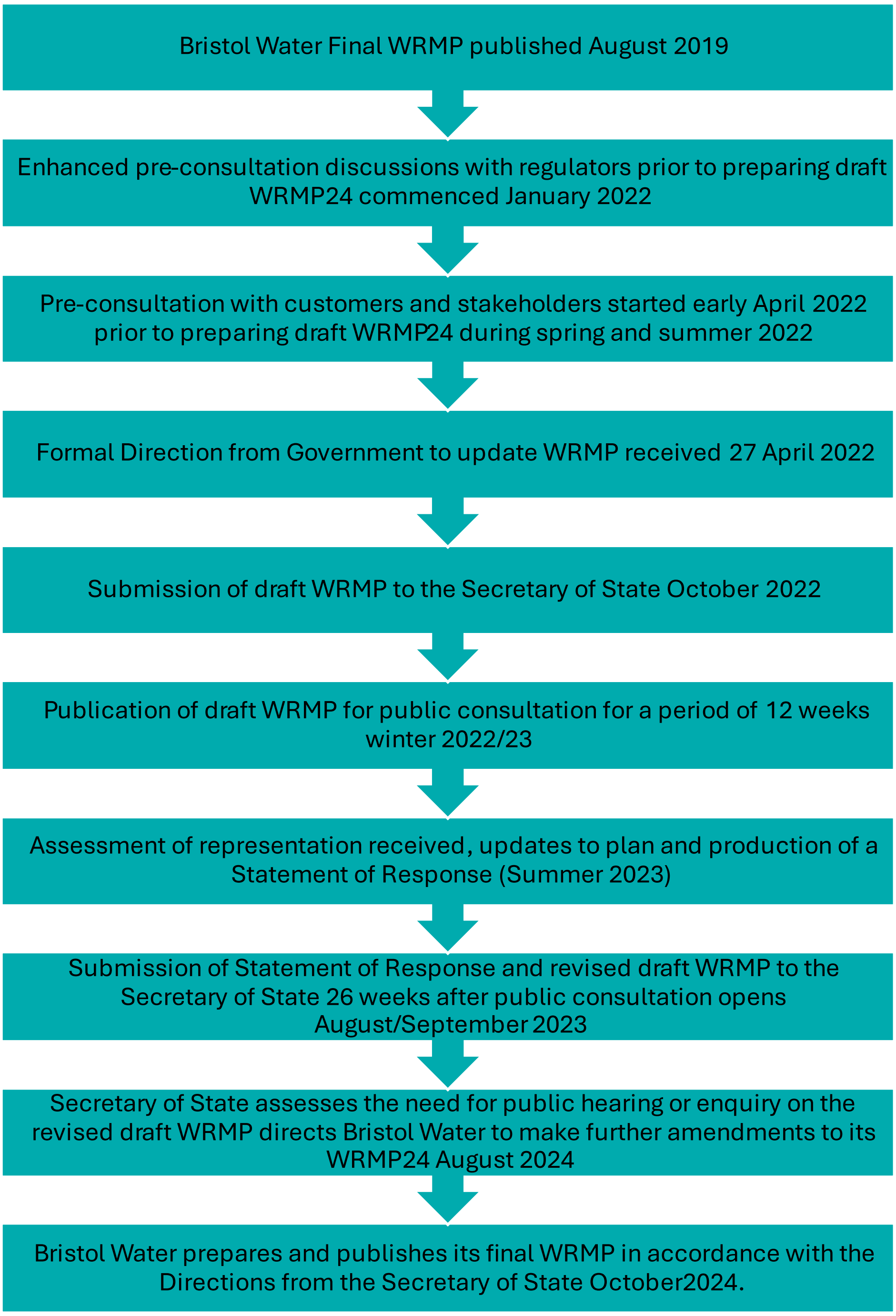
Technical component	Grade	Audit Summary	Summary of Agreed Actions
WRP Tables 4, 5, 5a–5c	B	The team has completed the majority of table 4 and tables 5 and 5a-5c. During our sample checks we identified some exceptions. For example, an incorrect formula (30 years instead of 25 years as the denominator) was being used for some data; and another instance where a cumulative annual total rather than daily average figure was being used. We note the team acted promptly to correct these exceptions.	

SoR/rdWRMP24 and WRP Tables audits (carried out after the completion of the rdWRMP24)		
SoR/rdWRMP24 consistency (offline review)	n/a	We observed that for the sample of three broad key WRMP24 changes you highlighted; we did not identify material inconsistency with how these were reflected in the sections of the rdWRMP24 main technical document you signposted us to (and your SoR where applicable).
WRP table data sampling (tick and tie sampling session via Teams)	B	We did not identify material inconsistency between the final rdWRMP24 tables and the immediate key datasets providing input to the tables during our sampling. We also saw evidence of an appropriate internal assurance and approval process from HR Wallingford prior to handing over the tables to Bristol Water. We note our sampling focused on tables/lines affected by changes in the following areas: DO modelling; resilience service level increase; climate change and sustainability reduction impacts; updated Government demand targets; and leakage, metering and water efficiency options. You identified these as the most material areas of change in relation to the tables in your rdWRMP24.

1.6 Timeline and Finalisation of the WRMP

The flow chart in **Figure 1-1** illustrates the regulatory process and timeline for the development of our WRMP24.

Figure 1-1: Regulatory process and timeline for developing WRMP24.



2 Engagement with customers, stakeholders, and regulators

2.1 Pre-consultation on the Draft WRMP

Throughout the development of the dWRMP we worked with our customers, stakeholders, and regulators to identify and act on their views and feedback. Our pre-consultation process ensured that interested parties had an opportunity to input and contribute to the development of the dWRMP.

The main elements of the pre-consultation process are set out in **Table 2-1**. The programme included enhanced pre-consultation with regulators and consultation with stakeholders, neighbouring water companies and customers. We worked closely with the Environment Agency, Ofwat and the Bristol Water Challenge Panel in developing our dWRMP explaining the framework, technical methodologies, assumptions, and decision-making processes to ensure all parties were suitably informed to allow directed challenge and debate.

Table 2-1: Bristol Water pre-consultation engagement activities to support dWRMP development.

Group	Organisation/Activity	Details of engagement process
Customers	Bristol Water Challenge Panel (BWCP) & BWCP Environmental sub-group.	Independent group of interested and expert stakeholders who ensure that the customer voice remains at the heart of Bristol Water decision-making. The Panel meets quarterly, and the Environmental sub-group also meets quarterly. We provided updates on progress with the development of the dWRMP to both groups.
	Customer Research	Online customer panel. Surveys every 3 months about Bristol Water and the things that matter to our customers. Programme of customer engagement workshops as part of joint WCWRG customer research. See Section 2.1.1.
	CCW	Updates on progress with developing the dWRMP provided at the CCW/Bristol Water Quarterly meetings.
Regulators	Environment Agency	A series of enhanced pre-consultation meeting held during January and early February 2022, with further updates provided in August 2022. Workshop also held in March to support the SEA scoping report consultation.
	Ofwat/RAPID	Enhanced pre-consultation meetings held in January and May 2022.
	Natural England	Updated on progress with the dWRMP via their representation on the BWCP and BWCP Environmental sub-group. Also attended the workshop held in March to support the SEA scoping report consultation.
	Historic England	Consulted as part of the formal pre-consultation process and as part of the SEA scoping report consultation process.
Water Suppliers	Water companies	Ongoing discussions with water companies both independently and as part of the WCWRG. Details are provided in Section 2.1.4.
	West Country Water Resources Group	WCWR Steering Group meets every 5 weeks, and we are working in close liaison with Wessex Water and South West Water to develop the Regional Plan, setting out the water resources strategy for the West Country region. There are several collaborative regional projects that have input into our dWRMP. Further details are provided in Section 2.1.4.

In April 2022 we carried out a formal pre-consultation process, writing to around 100 organisations and individuals, setting out the process we were implementing to update the dWRMP and asking for any recommendations or considerations to be submitted to us in writing so we could take them into account during our review process. A list of the organisations we contacted is provided in **Appendix B**. We received six formal responses to this consultation process from the Environment Agency, Bristol Water Challenge Panel, Historic England, North Somerset Council, Country Land and Business Association (CLA), and Everflow Water. **Table 2-2** summarises the comments received and where we addressed them in the dWRMP.

Table 2-2: Comments from organisations responding to our formal pre-consultation process.

Organisation	Summary of comments	Comments addressed in section:
Bristol Water Challenge Panel	• Expect to see the four strategic aims that the WCWRG have adopted being developed further in the WRMP • Explanation of how the 9 conclusions from the WCWRG's plan will contribute to the WRMP and their effect on domestic customers • Explanation of how the Government's expected rise in regional housing stock and thus water demand will be catered for. • Would welcome a discussion on phase 2 and 3 of the WCWRG plan, particularly the need for new reservoirs. • Explanation of what BW expect in the way of Government assistance to achieve leakage reduction • Improve metering installation performance now that BW can access more domestic properties • Involving customers in the choices to be made to provide their water supply, in particular the panel being involved with the methodology and results that are used to develop the plan.	Section 2.1.4, 3.6.3, Section 6 & 15 Section 12.7.4 Section 15.1.3 Section 15.1.3 Section 2.1.1 Section 2.3 Section 7.2.1 7.3.2 & 7.4.1

CLA	• Security of supply for agriculture
	  ○ Any reduction in abstraction quantities for agriculture must be compensated or replaced with resilient supply
	  ○ In a drought situation, animal welfare for livestock needs to be a key priority
	  ○ Key water availability issues are communicated to businesses
	• Demand side solutions: support for on-farm water efficiency
	  ○ Should be prioritised regardless of whether a deficit is shown locally
	  ○ Should include metering and public awareness campaigns
	  ○ Support for the retrofit of homes and buildings (water efficient fixtures and fittings) including for private water supplies
	  ○ Appropriate support for farm water efficiency such as rainwater harvesting
		See Bristol Water Drought Plan 2022
		
		Section 12.7.2 & 15.2

Organisation	Summary of comments	Comments addressed in section:

	• Supply side solutions: engage locally
	  ○ Local engagement with landowners where the infrastructure projects may impact and all plans should make best use of existing assets before looking for new / additional sources of supply
	• Multiple benefits and consistency of ambition
	  ○ Embodied carbon must be assessed, especially where large scale infrastructure is considered.
	  ○ Supportive of Nature-based Solutions (NBS) due to the many benefits
	  ○ Unclear what impact the 1-in-500-year drought resilience ambition for the public water supply would have on agriculture and whether support for the sector would be needed
		Section 12.7.4
		
		Section 13.8

Environment Agency	• Include a suite of demand management options that are different from those implemented before and can provide assurance and evidence on their effectiveness. • Improve rates of metering uptake to achieve WRMP19 forecast and be ambitious for WRMP24. • Demonstrate actions that will be taken to ensure achieving the PCC target of 110 l/h/d by 2050 whilst taking into account the long-term impacts of COVID-19. • Assessment in WRMP24 should be resilient to a 1-in-500-year drought • Establish the implications on deployable output if the River Severn drought order is implemented. • Use the environmental destination approach from the Regional Plan to take a longer-term view. Costs of environmental destination scenarios need to be presented in a transparent manner. • Risks must not be double counted in headroom and adaptive pathways. The plan should provide clear triggers and thresholds for each pathway. • All abstractions are sustainable, now and in the long term and will not lead to deterioration • Clearly specify which year is used as the base year. • Let the EA see and provide comments, prior to submission of the draft plan on the report on inflow and stochastics.	Section 12 Section 15.1.3 Section 15.1.3 Section 5.1 & 5.2.7 Section 17.2 Section 5.3.3 & 8.4 Section 10 & 14.4 Section 8 Section 3.4 Provided in June 2022
Everflow Water	• Prioritise demand reduction and would like to see data on the anticipated split between leakage and water efficiency work. • Considering the needs of NHH customers whose businesses are connected to the local environment. • Smart Metering: ○ A commitment to no longer fitting dumb meters	Section 15.1.3 Section 15.1.3

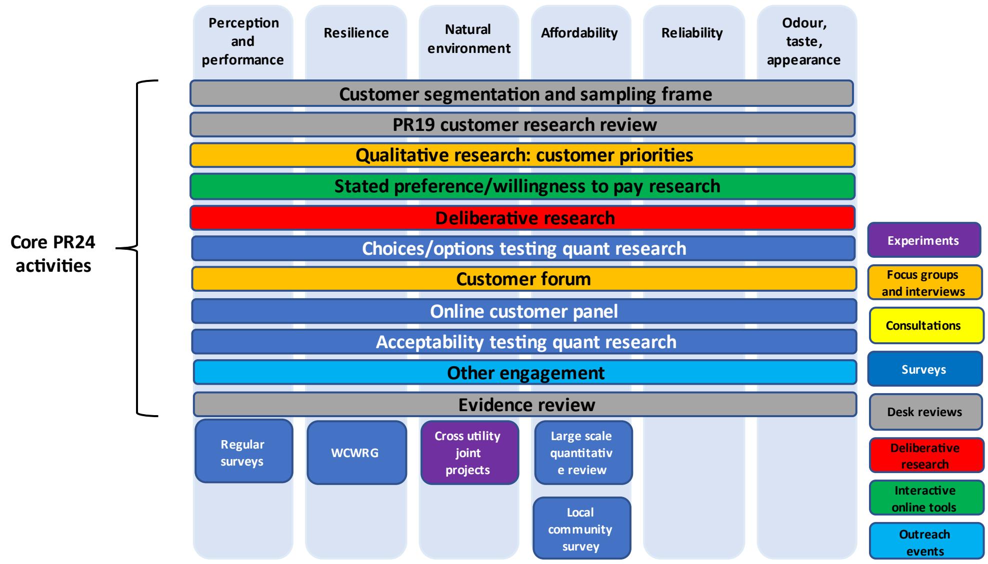
Organisation	Summary of comments	Comments addressed in section:
	○ Collaborative work between wholesalers and retailers to support installs ○ Proactive use of loggers and high flow alerts provided through retailers ○ Implementation of grant funding or credit available to retailers to support the install of enhanced technology ○ If smart metering will not be delivered to NHH customers in full until 2030, we would like to see an interim solution for high priority customers. ○ Providing a sterner 'police' type function when customers don't respond to retailers about potential leaks and over consumption • Data Availability: ○ Wholesaler commitment to pool their NHH benchmarking data to share with retailers, enabling strategic decision making ○ Making existing smart meter/logger data available to retailers • Collaborative Approach: ○ Work collaboratively with wholesalers to support demand reduction initiatives for NHH customers (customer side leakage and water efficiency). ○ More detail around all wholesalers plans to deliver water efficiency to the NHH market, as this has considerable impacts on our own strategies.	Section 15.2
Historic England	• Would like to ensure that the conservation, enhancement and enjoyment of the historic environment (cultural heritage) is taken into account – especially with regard to avoiding the need for a new reservoir and other initiatives that may affect the significance of the historic environment. • Historic England have not been consulted on the West Country Water Resource Regional Plan – and they would welcome early discussions, especially on supply-side options • Conserve and enhance the historic environment where relevant to works undertaken by Bristol Water.	Section 13 Actioned and underway Section 13
North Somerset Council	• As the WRMP period extends beyond the Local Plan 2038 we would be interested to understand how growth beyond the local plan period will be calculated and fed into the overall demand calculation. • It is essential that any abstraction proposals do not have an adverse impact on the water supply to the rhynes, the SSSIs and areas of peat. • If there is a need for future reservoirs or reservoir expansion, this should be highlighted at an early stage to ensure they are considered for the long-term planning of nature recovery networks and future North Somerset Nature Parks and fit with their Green Infrastructure Strategy.	Section 6.3, 6.4 & 6.5 Section 13 Section 12.7.4

Organisation	Summary of comments	Comments addressed in section:
	• See more innovation and a greater use of Integrated Water Management to create a more sustainable supply of water to our residents, working closely with Wessex Water to achieve this	Section 15.1

2.1.1 Customers – Customer Research

We engage and consult with customers on an ongoing basis and have developed an extensive evidence base on customers' views and how these have changed over time. As part of the PR24 business planning process, and to support the development of our WRMP, we have developed a customer engagement framework (see **Figure 2-1** below). This engagement framework sets out a schedule for mixed-methods research and engagement to enable us to understand customer views and to bring the voice of the customer into the centre of our decision-making processes.

Figure 2-1: Customer Engagement Framework



The customer engagement framework is our guide on what topics and priorities we should be engaging customers on and how. This includes quantitative customer surveys, qualitative customer research (such as focus groups, interviews, and deliberative engagement), ongoing customer forums and panels, acceptability testing, choices, stated preference and willingness to pay research.

In simple terms, customers still value a safe and reliable supply of water as their top priority for us to focus on. They are consistently highly satisfied with water quality and how reliable their service is, a finding that has remained consistent from WRMP 2019. Customers are, however, also content with the current level of service that they receive and therefore favour investment in the environment as a priority for the future. They often identify actions that could support Bristol Water's environmental credentials, such as more water meters and involvement in wider environmental protection initiatives. Overall, Customers' views on our role in protecting and enhancing the environment have strengthened over the past five years. Protecting river flows, enhancing biodiversity, and reducing our carbon impact are seen to be an important part of our role by most customers.

Customers consistently place resilience and leakage as a high priority, but perceptions of our performance in this area have historically not been as favourable as we would like. Our more recent research, however, shows this to be improving. Furthermore, more targeted customer research into leakages specifically has strengthened our understanding of views in more recent years. We know that minimising leakage is an important priority for customers, not only from the perspective of responsible resource management but also in relation to metering, where leaks could negatively impact bills. Similarly, in general customers find bill affordability an extremely high priority and are mostly satisfied with value for money. However, there are concerns for some customers about being able to afford their bill, particularly during Covid-19 and now in the cost-of-living crisis. Our research also shows that affordable bills are particularly important to customers in lower socio-economic groups. The importance of affordability has remained consistent over the last five years, although views on value for money are more favourable now. Our more recent research has prioritised targeted engagement with financially vulnerable customers, which will help us develop a much clearer picture of the challenges this group face.

Between June 2021 and March 2022, we used a combination of qualitative (deliberative groups and quantitative research (online survey) to develop our understanding of customer views in relation to the regional plan. The deliberative groups consisted of 66 household customers across eight groups meeting over two sessions. The online survey was with a regionally representative sample of 1,504 household and 304 non household customers. The WCWRG companies have already engaged with customers and stakeholders – through PR19 - and as part of their business-as-usual activities. This study builds on this existing insight to further develop customer and stakeholder evidence to inform the development of the regional water resource plan. The overall purpose is to support WCWRG in formulating the best value regional plan for the South West. The research is also pertinent to the development of our WRMP. Key findings were as follows:

- **Drought resilience**. Customers were aware of the future water supply challenges in the South West, although had limited understanding about the impacts of extreme drought. Severe water use restrictions like rota cuts were perceived as difficult to cope with and generally unacceptable.

- **Environmental ambition**. Customers see water in the environment as a precious resource and there was a strong preference for the plan to go beyond the minimum requirements for environmental protection to provide even greater benefit for nature and wildlife.

Trade-offs. Most customers supported higher frequency of less severe restrictions such as hosepipe bans and the potential inconvenience it would cause if this would contribute to keeping more water in the environment and protecting sensitive habitats. However, this research was completed before the dry weather experienced in summer 2022.

Thanks to our active management and a resilient system, Bristol Water customers did not experience any supply restrictions in the hot dry period of 2022 and we were able to continue a resilient "business as usual" supply of water throughout this period. Feedback from customers and other stakeholders on this performance was very positive and we were able to take the opportunity of public interest in hot dry weather to carry out a significant media campaign on the importance of water-saving, without having to manage some of the more challenging responses that can occur where supply restrictions or other drought measures are necessary.

We did determine during this period, via feedback from other areas where restrictions were imposed, that supply restrictions are less palatable for customers in reality than when the question is posed on a theoretical basis, but due to the resilient supply provided to Bristol Water customers in 2022 we have not determined a specific change in customer preference around supply restrictions.

- **Timing of investment**. Customers favoured earlier investment in new supply options, even if this had increased risk that they may not be needed, or they could be wrong size. For customers, the benefits or acting early and being prepared outweighed the potential benefit of waiting for more certainty in the future before acting.

- **Option types.** No supply and demand options for the plan were unacceptable to customers. However, supply options were seen as more reliable, because of the uncertainties associated with demand reductions and the reliance on sustained behaviour change by customers. Support was highest for reducing leakage, closely followed by new or extended reservoirs.

- **Transfers.** Customers were supportive of sharing water at both national and regional levels, particularly if this helped to better protect the environment in water scarce areas. However, the support was conditional – with maintaining aesthetic quality of water for "donors" along with leakage and water saving levels in "recipient" areas being critical considerations.

2.1.2 Customers – Bristol Water Challenge Panel

The predecessor group to the Bristol Water Challenge Panel, known as the Local Engagement Forum, was first established in 2012 to support development of the WRMP14 and the Periodic Review 2014 (PR14) Business Planning process. In 2016 the group was re-named and refreshed as the Bristol Water Challenge Panel to support the PR19 process and the WRMP19. It has continued to act on behalf of Bristol Water's customers across four key objectives:

1. It ensures the company builds its business plan around customer priorities and preferences.
2. It receives and scrutinises the report of the external assurer to assure itself of the accuracy of data collected and used by Bristol Water.
3. It scrutinises the implementation of Bristol Water's five-year business plan
4. It monitors the design and implementation of the company's environmental and community Social Contract.

The Bristol Water Challenge Panel is an independent group of interested and expert stakeholders whose role is to ensure that customer voices remain at the heart of Bristol Water's decision making. One of the roles of the Challenge Panel is to help us develop Business Plan proposals that reflect the views of customers as well as the interests of other stakeholders and the environment. This includes the development of the WRMP and how this informs the business planning process.

Peaches Golding OBE is the independent Chair of the Challenge Panel, and the following organisations are currently members of the Panel:

- Natural England
- Consumer Council for Water (CCW)
- The Story Group
- University of the West of England
- South Bristol Advice Centre
- Environment Agency
- Mendip Council
- North Somerset Council.

The Panel meets quarterly, and the minutes of the meetings are available on our website[8].

Throughout the development of the dWRMP we provided regular progress updates to the Challenge Panel at their meetings. This direct engagement focused on explaining the assumptions and results of the assessments supporting the dWRMP as the work progressed, so the Panel members had a clear understanding of the overall process and opportunity to comment on and influence the process as it developed. With the integration of Bristol Water into South West Water we are now able to benefit from broader engagement with a wider community across the West Country peninsula and our Challenge Panel will in future be integrated into this larger engagement programme as part of the future plans and engagement process for the area we serve.

2.1.3 Government and Regulators

Environment Agency:
We implemented a programme of enhanced pre-consultation on the draft WRMP24 with the Environment Agency in November 2021. An outline of the meetings held, and the technical areas covered at each meeting is set out in **Table 2-3.** The purpose of the enhanced pre-consultation discussions was to outline the methods and approaches we have implemented in developing our draft WRMP24 to reduce the need for changes later in the process and ensure that close liaison between Bristol Water and the Environment Agency was maintained. As part of this pre-consultation process, we also issued method statements to the Environment Agency for discussion and comment, describing the methods and approached we used in developing specific technical areas of the WRMP.

[8] Our Customers (bristolwater.co.uk) (Bristol Water, 2022)

Table 2-3: Programme of Environment Agency WRMP24 enhanced pre-consultation meetings

Technical area covered	Date(s) of meeting(s)
1-in-500 drought assessment methodology	18th Nov 2021
Inflows and water resource model development	5th Jan 2022
Problem Characterisation	18th Jan 2022
Demand Forecast	24th Jan 2022
Headroom Assessment	24th Jan 2022
Outage Assessment	25th Jan 2022
Environmental Assessment	2nd Feb 2022
EBSD & Decision Making	2nd Feb 2022
Options Appraisal	2nd Feb 2022 Feasible options list provided 11th July 2022.
Supply assessments (Deployable output, climate change and drought vulnerability assessment)	Technical note/method statement issued 11th July 2022
Pre-consultation overview meeting	17th Aug 2022

In addition to the enhanced pre-consultation process, the Environment Agency is also represented on both the BWCP and the BWCP Environmental Sub-Group. We presented regular updates on the development and progress of our dWRMP to these groups, providing another forum via which any issues or gaps in our approach could be identified by the Environment Agency. As part of the integration of Bristol Water into South West Water, our sub-groups are now managed through the broader South West Water engagement process, and membership of the sub-groups will be amalgamated into this wider approach.

As part of the preparation for our Strategic Environmental Assessment (SEA) and Habitats Regulation Assessment (HRA) the Environment Agency was consulted on the scope and approach of the SEA and HRA methodologies. Further details of this process are set out in the SEA Environmental Report and HRA report accompanying our dWRMP in **Appendix D** and **E**.

Natural England

Natural England is represented on both our BWCP and the BWCP Environmental Sub-Group as outlined in **Section 2.1.2**. As a statutory consultee, Natural England was consulted on the scope and approach for the SEA and HRA methodologies and attended the workshop held on 31st March as part of this consultation process. Further details of this process are set out in **Appendix D** and **E**.

Historic England

As a statutory consultee, Historic England was consulted on the scope and approach we have used for the SEA and HRA methodologies. Further details of this process are set out in **Appendix D** and **E**.

Ofwat

In November 2021, Ofwat wrote to all water companies setting out their expectations and approach to pre-consultation meetings for WRMP24. In response to this we held a pre-consultation meeting with Ofwat on the 17th January 2022. During this meeting we set out our water strategy and approach to WRMP24. We covered an overview of the methodologies and assessment we were implementing for the dWRMP24. Ofwat provided a formal written response to support this meeting setting out their expectations based on the information provided.

A second pre-consultation meeting was held on the 19th May 2022 to provide Ofwat with an update on the work we had completed to this point and an early view of the likely options we would need to implement to address any forecast deficit over the planning period to 2080. Again, Ofwat provided a formal written response to support this meeting setting out their expectations. We collated all the comments received from Ofwat and tracked how we took them into account in the development of our dWRMP24.

2.1.4 Stakeholders

Engagement with all stakeholders is extremely important to Bristol Water. The way in which we engage depends upon the audience. That may be direct contact with existing customers, engagement with farmers and landowners through our existing catchment management programme or other partnerships. We may engage with other organisations in our industry and beyond as part of the West Country Water Resource Group. We have recently engaged with organisations in the Bristol Avon Catchment Partnership and West of England Nature Partnership to develop our environmental programme (WINEP) for AMP8 and have some exciting partnership projects in development.

Water companies

We have carried out formal pre-consultation discussions with our neighbouring water companies and organisations who may have an interest in the water resources that we use, such as the River Severn. With the establishment of the Regional Water Resources Groups and the development of Regional Plans, some of this engagement has been done at the Regional Group level looking at the utilisation of strategic resource options (SROs) across England and Wales and discussing utilisation via the regional planning 'reconciliation' process. From the Bristol Water perspective this has largely focused on whether the West Country region is likely to want to utilise any water from the Severn Thames Transfer scheme, and how the Cheddar Two Source and Transfer strategic scheme might be utilised between companies.

The consultation process with other water companies is ongoing and integrated with the development of the Regional Plans.

We provided formal responses to the pre-consultation notifications received from both Dŵr Cymru Welsh Water (DCWW) and Severn Trent Water, highlighting the shared interest in resources along the River Severn corridor.

West Country Water Resources Group

The West Country Water Resources Group was established in 2017 to allow improved collaboration in water resources management in the West Country Region. The objective of the group is to support a coordinated approach to water resources planning in the West Country that transcends water company boundaries. In addition to the four core members, the group has several associate members who contribute to its work in several ways.

The four core members of the WCWRG are:

- Bristol Water (as part of South West Water)
- Environment Agency
- South West Water Limited
- Wessex Water Limited

The associate members are:

- Canal and River Trust
- Consumer Council for Water
- Drinking Water Inspectorate
- National Farmers Union
- Natural England
- Ofwat
- Southern Water Services Limited
- Water Resources East
- Water Resources South East
- Water Resources West.

As a core member we have been working with the WCWRG to build on our WRMP19s to develop a strategic regional plan that can be reflected across the individual WRMP24s produced by each of the water companies within the region. Our WRMP24 therefore is consistent with the final WCWRG Regional Plan due to be published in early 2025, reflecting the overall strategy and the three outcomes identified: improving the environment, ensuring water supply resilience and delivering societal benefit.

Engagement with the core members of the WCWRG has been constant throughout the development of our WRMP and we have also implemented several joint projects to support the development of our plans and the consistency of methodologies and approaches used for water resource assessment across the West Country region. Areas we have worked together on include:

- Demand forecasts
- Population forecasts
- Climate change assessment
- 1-in-500 drought assessment approaches
- Environmental Destination
- Customer engagement/research

Full details of the work carried out by the WCWRG and the minutes of our meetings are available on our website[9].

River Severn Working Group

The River Severn Working Group was formed in May 2017 and was set up to coordinate assessment and evaluation of strategic planning matters related to the use of water from the River Severn, with particular focus on resource development options under consideration for WRMP19 and the development of a list of options available for future raw or treated water transfers/trades. Following the WRMP19 submissions, the group has continued to meet with work being dominated by the development of the Severn to Thames transfer strategic resource option (SRO). Bristol Water has continued to engage with this group because of our significant interest in the River Severn source via our abstraction from the Gloucester and Sharpness Canal. Current representation on the group includes Natural Resources Wales (NRW), Environment Agency, Natural England, United Utilities, Severn Trent Water, South Staffs Water, Bristol Water, Thames

[9] West Country Water Resources Group (wcwrg.org) (WCWRG, 2022)

Water, DCWW, and the Canal & River Trust. Minutes and meeting records are distributed to relevant parties.

Our social contract approach

Our social contract was launched in 2019. It provides a framework to hold ourselves to account for the delivery of our social purpose. Each year we publish a programme designed to deliver additional benefit to our communities through working with local stakeholders on agreed projects. These projects include those focused on reducing per capita consumption through education and awareness and through cross utility resource efficiency trials.

One of the key features of our approach is the development of stakeholder partnerships. Through these partnerships we are in regular dialogue with our stakeholders, and in addition we use an annual stakeholder survey to receive feedback on our contribution to local communities.

2.2 Compliance with Guidelines on Consultation

As set out in **Section 2.1** we implemented an extensive programme of pre-consultation to support the development of our dWRMP24. This meets the requirements for pre-consultation set out in Section 37A(8) of the Water Industry Act 1991 and the Environment Agency Water Resources Planning Guideline[10] v10 updated December 2021. The process we are implemented for the formal public consultation is set out in Section 2.3.

[10] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline

2.3 Consultation process

The statutory process set out in the Water Industry Act 1991 required us to publish our dWRMP for public consultation. This process provides customers and stakeholders with an opportunity to consider the proposals we have set out in the dWRMP in terms of managing the water resources and demand in our supply area, how this may affect them, and to provide us with any feedback and comments.

We value all the feedback we received and have taken time to review all the comments submitted, meet with our statutory regulators, and write a formal statement of response setting out how we have taken on board the comments received and used them to develop our rdWRMP. Our statement of response has been published and is available on our website. Our rdWRMP was not published and was only intended to inform our regulators of the changes that were made in response to the comments we received, as signposted within our statement of response. Our final WRMP24 will be published on our website.

3 Background Information

Bristol Water is now part of the Pennon Group following its acquisition in June 2021 and clearance by the Competition & Markets Authority in March 2022. Ofwat has finalised its consultation to terminate the Bristol Water licence and modify the South West licence to cover the Bristol Water area and Bristol Water became part of South West Water on 1 February 2023 . The draft Water Resource Management Plan and this final WRMP reflect the fact that the Bristol Water area is a separate non-contiguous water supply area to the South West Water or Bournemouth Water areas.

We have formally integrated our WRMP24 development, under Board direction, with our other national, regional and local planning processes including the West Country Water Resource Group (WCWRG) Regional Plan, PR24, our Drought Plan and our operational plans. This section provides basic information about how and where we operate, and how the water resource management planning process is one of the main drivers of our business planning and operations.

Our supply area covers c2400km^2, extending along the eastern flank of the Bristol Channel between Tetbury in the north and Glastonbury in the south. We currently supply approximately 1.24m people, from our Mendip Hills reservoirs and from groundwater within our supply zone, with nearly half our supply from a large abstraction from the Gloucester and Sharpness Canal transferring water from outside our supply zone. Our system for managing water is highly interconnected and for the purposes of water resources planning we operate one integrated Water Resource Zone (WRZ) as agreed with our regulator.

For WRMP24 we have carefully followed all relevant and up to date guidance issued by regulators, Government and the water industry, and have tested our plan against formal requirements such as the Strategic Environmental Assessment and Habitats Regulation Assessment requirements. We have developed our long-term strategy in line with Government expectations and planned to be resilient to a 1 in 500-year drought from 2025. We plan to maintain our current level of service for planned restrictions to supply. During the public consultation process, we asked our customers for their views on our current level of service, see section 2.1.1.

3.1 Supply Area and Water Resources Zone

Bristol Water is a water-only company (WoC) that provides water supply in an area of approximately 2,400 square kilometres (1,000 square miles) with a population of approximately 1.24 million people. Our supply area ranges from Thornbury and Tetbury in the north to Street and Glastonbury in the south and from Weston-Super-Mare in the west to Frome in the east.

Water resource planning is undertaken at water resource zone (WRZ) level. A WRZ is defined as the largest area in which all water resources (including external transfers) can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall and the same level of service for demand restrictions. Due to the integrated nature of our sources, we plan based on operating the company area as a single WRZ as agreed with the Environment Agency. This means that all water resources within the company area are capable of being shared within the zone. Bristol Water uses the same WRZ for operational management, Drought Planning and water resource planning. Our supply area and the key features of our WRZ are illustrated in the map in **Figure 3-1**.

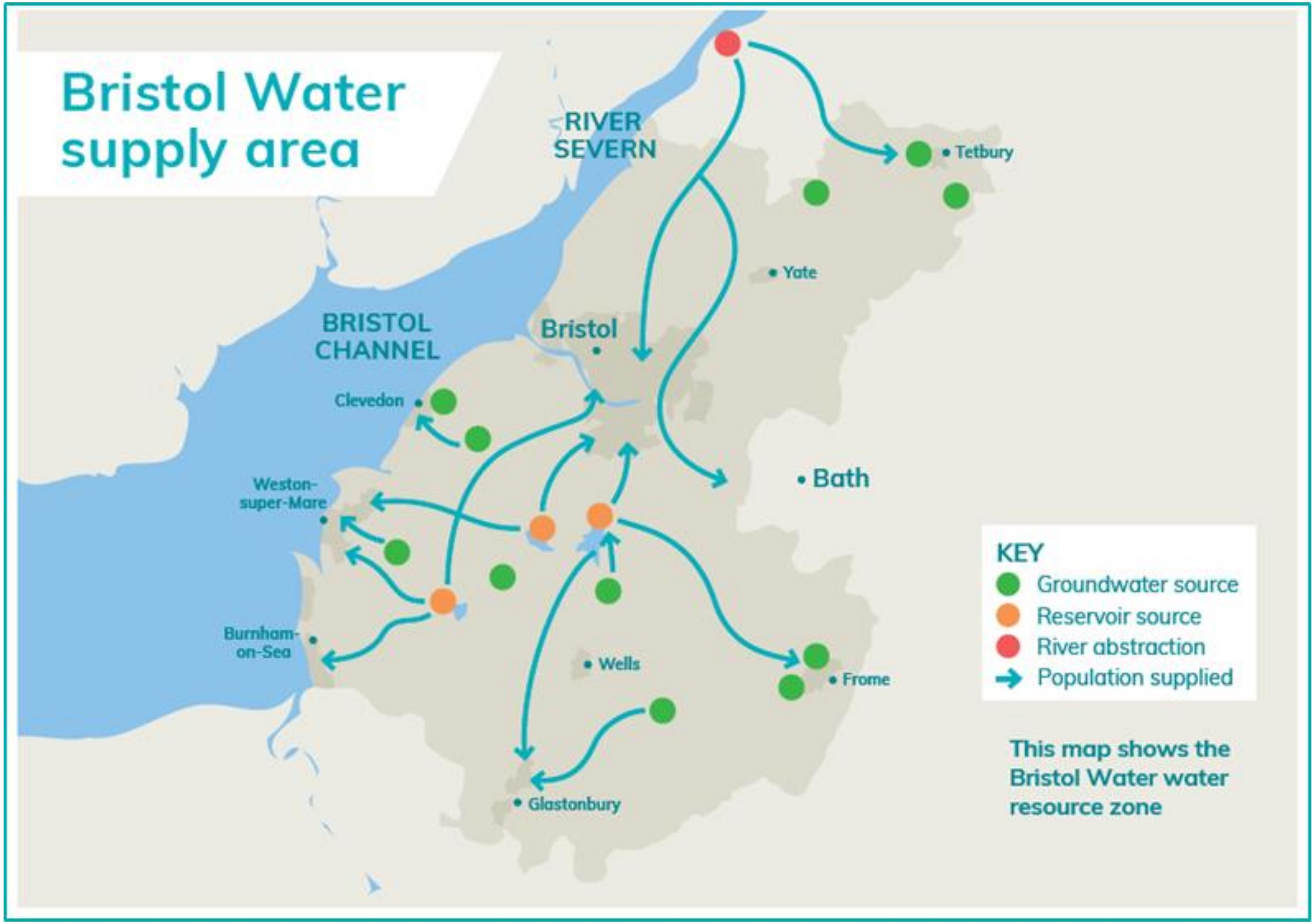
3.2 Sources of Supply

Only around half of the water supplied within the Bristol Water supply area is sourced from within it, with the rest being transferred into the zone from outside the area. This water is sourced from the Gloucester and Sharpness Canal to supply our largest northern treatment works and accounts for approximately 46% of our licensed resource. The Gloucester and Sharpness Canal is owned and operated by the Canal & River Trust and is supplied by the River Severn and other local rivers, the Cam and the Frome. In periods of dry weather, use of this source is maximised to conserve the water stored in our reservoirs.

The intrinsic water resources within the WRZ include our Mendip Reservoirs and associated surface water abstractions, which account for approximately 42% of our available licensed resource.

The remaining water sourced from within the water resource zone is derived from groundwater and accounts for approximately 12% of our available licensed resource. These sources are operated at their optimum output to meet the base-load demand for water.

Figure 3-1: Bristol Water, water resource zone and associated infrastructure



3.3 Progress with Implementing the Water Resources Management Plan 2019

We report on our progress with implementing our existing WRMP to the Secretary of State for Environment, Food and Rural Affairs via a formal WRMP annual review process. Our latest Annual Review was recently submitted in June 2023 and reported our progress with the leakage options we set out in WRMP19.

Despite the difficulties associated with the COVID-19 pandemic, the effects this had on customer household demand with increased home working and the restrictions put in place limited our access to customer properties for an extended period during 2020/21. We are still committed to delivering our end of AMP7 targets for leakage reduction and meter penetration. We have therefore included this assumption in our WRMP24 baseline supply demand forecast.

The shift in water consumption from non-household to household use due to increased working from home during the lockdown periods, and the ongoing preference for working from home now that restrictions have been lifted, has resulted in it being unlikely that we will be able to achieve our forecast level of Per Capita Consumption (PCC) (135.8l/h/d) by 2024/25 as set out in our WRMP19. Although we are committed to continuing to reduce PCC and have a post-COVID PCC strategy being implemented over the remaining years of AMP7 and into AMP8, we believe that the ongoing preference for working from home will result in a permanent impact in the relative water use between households and non-households. We estimate that this is equivalent to at least 4 l/h/d although our analysis is only based upon two full years of data at the time of writing and so there is considerable uncertainty associated with this value. Our WRMP24 forecast therefore reflects the PCC reductions we think we can realistically achieve from our current position. We are committed to delivering the policy targets of 122l/h/d PCC by 2038 and 110l/h/d PCC by 2050, and by ensuring that our WRMP24 reflects the realistic starting position for this strategy we are making sure that the options selected to deliver this target are appropriate.

In our WRMP19 we set out several commitments to review and update our supply side data and assessment. We have been working on this since 2019 and have reviewed and updated our water resource model as well as reviewing and updating the inflow data used within the model. We have also reassessed the yield of several of our groundwater sources. Full details of this work are set out in **Section 5**. The result of this work is that the deployable output of the water resource zone has changed slightly for both the 1-in-200 drought and the 1 in 500 year drought, noting that we have used the 1 in 500 drought only in this WRMP.

3.4 Planning Period and Base Year

The Environment Agency's Water Resources Planning Guideline[11] (WRPG) (v12 March 2023) states that WRMPs should take a long-term view, setting a planning period that is appropriate to the risks of the company and region, but which covers at least the statutory minimum period of 25 years. Bristol Water's Problem Characterisation process (**Section 4**) identified that the scale and complexity of our water supply planning problem is currently relatively low, therefore we could plan to the minimum 25-year period.

[11] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline

However, when viewed in the context of the West Country Region as a whole, it seemed more appropriate to plan out to 2080 (55 years), due to the potential resource position of the other companies within the region and to align with the assessments required for the strategic schemes being investigated within the West Country region. We have therefore planned against a period from 2025/26 to 2079/80.

The base year is the starting point for the forecasts and projections of future supplies and demands over the planning period. For the purposes of this WRMP the base year used for the supply/demand data is 2021/22. This is the most recent year for which we have out-turn data. It is also the most up to date indication we have relating to what demand for water is likely to be following the COVID-19 pandemic and the various lockdown restrictions implemented between March 2020 and March 2022. It should be noted that, as per the planning guidance, the base year for costs (and demand models) is 2020/21.

3.5 Planning Scenarios

Planning scenarios are based on a design 'dry year' condition, which is defined as a period of low rainfall but with unconstrained demand (i.e., no customer restrictions on demand such as Temporary Use Bans (TUBs)), since this is the scenario when the supply demand balance would be under the greatest stress.

The WRPG requires all water companies to base their WRMPs on the dry year annual average (DYAA)[12] scenario (for demand) and the 1-in-500 drought scenario (for supply). The Environment Agency's technical guidance and the Government expectations for water resources planning (April 2022) both state that this level of resilience should be achieved by 2040. However, as per the comments made on our dWRMP and following discussions with the Environment Agency, as we are able to adopt 1 in 500-year level of resilience from the start of the planning period we have agreed to implement this change by 2025 and are required to do so.

The dry year critical period planning scenario (DYCP)[13] corresponds to the period of peak water demand, which normally occurs during the summer months of June, July and August. The peak period of demand is usually defined in terms of the average day peak week (ADPW) demand. Operational experience shows that critical period scenarios such as those based on ADPW are not appropriate for the Bristol WRZ, as it is not significantly peak constrained from a water resources perspective. Due to the integrated nature of our supply network and the storage provided by our Mendip reservoirs peak demands can be managed across the supply network and do not present a constraining factor on customer supply. This has been tested in recent years during the heatwaves experienced in 2018, 2020 and 2022. The high demands experienced during these times did not present a constraint on our system.

We have used the DYAA scenario as the basis of our demand forecast for this WRMP, supported by an assessment of the deployable output and Water Available For Use for the 1-in-500 drought (from 2025) scenario to determine supply availability (see Section 5 for details). The approach was shared with the Environment Agency during pre-consultation discussions on our WRMP24.

[12] The annual average value of demand, deployable output or some other quantity over the course of a dry year
[13] The time in a dry year when demand is greatest, often taken to be the peak week. Commonly known as the Summer Peak Period

3.6 Links to Other Plans

3.6.1 National, regional and local planning – context and overview

Our WRMP24 is closely related to several other frameworks, plans and strategies. This now includes links with other tiers of water resources planning through the National Framework, Regional Plans and the development of the Strategic Resource Options via RAPID. This is a stepped change in the water resource planning process since the development of our WRMP19. We have embraced this change and worked hard with both our regulators, neighbouring water companies and stakeholders to develop our WRMP24 in the context of the evolving water resource planning process. How the WRMP is linked to other plans, from national down to local level, is set out in the following sections.

3.6.2 Government's 25 Year Environment Plan

The 25-year Environment Plan sets out the government's comprehensive and long-term approach to protecting and enhancing our natural environment (landscapes and habitats) in England for the next generation. Our WRMP24 reflects this ambition set out in the 25-year Environment Plan by setting our destination for environmental sustainability and resilience **(Section 8.4),** supporting nature recovery using natural capital in decision making (**Section 13.2.1** and **Section 14**), using a catchment approach (**Section 5.8.1**) and delivering net gain for the environment (**Section 13.2.3** and **Section 13.5**).

3.6.3 West Country Water Resource Group Regional Plan

As part of the requirements set out in the National Framework, water companies have been working to develop regional plans. We are a core member of the West Country Water Resource Group and have been working closely with the other companies in the group (South West Water and Wessex Water) to develop a strategic regional plan that can be reflected across the individual WRMP24s produced by each of the companies. Our WRMP24 is therefore guided by the principles followed in the WCWRG Regional Plan, reflecting the overall strategy and the three outcomes identified: improving environment, ensuring water supply resilience and delivering societal benefit. The final regional plan will be published in early 2025.

3.6.4 Bristol Water Business Plan

The Business Plan sets out how much we need to spend to maintain and improve our service over five years from 1 April 2025 to 31 March 2030 (this period is also referred to as AMP8), and the impact this will have on customer bills. The Business Plan therefore includes the first five years of the strategy set out in the WRMP, as well as any planning or investigations that may be required for schemes occurring in the longer term. This WRMP therefore also informs Bristol Water's Business Plan for the 2024 Periodic Review of Price Limits (PR24).

3.6.5 Bristol Water Drought Plan

Our Drought Plan is an operational plan identifying how we intend to manage a future drought, what trigger levels will be used to identify when action is required and what measures are available to support supplies at risk when customer levels of service may be compromised. The Drought Plan sets out how the effect of a drought and associated drought actions will be communicated to our customers and takes account of the need to undertake environmental monitoring at any sites which could potentially be affected by implementation of drought actions.

We updated our Drought Plan for submission to Defra in March 2021 and carried out a 5-week consultation during June and July 2021. We subsequently published a statement of response to this consultation on the 14th September 2021 and produced a draft Final Drought Plan to support this. We received permission from Defra to publish the final Drought Plan following minor additional considerations in March 2022 and we published on the 29th April 2022.

Our WRMP is consistent with the assumptions and measures set out in our 2022 Drought Plan. Links to the drought plan are documented in the Water Resource Planning Table '6. Drought Plan Links'. Details of the assumptions included in this table are included in **Sections 5.1** and **5.2**. Due to the supply demand surplus created by delivery of the policy targets on leakage and PCC we have not needed to include the deployable output benefits from the supply side measured set out in our drought plan within our final planning options. They were however assessed as part of the options appraisal process.

3.6.6 Environment Agency Drought Plans

The Environment Agency have two drought plans which are relevant to our supply area: the Wessex Drought Action Plan[14] and River Severn Drought Order Environmental Report[15]. Where relevant the potential linkages to these plans have been considered, for example in assessing the dry weather yield of the Gloucester and Sharpness Canal.

3.6.7 River Basin Management Plans (RBMPs)

Where new options have been identified an SEA, HRA and WFD assessment has been undertaken to determine any potential effects on the environment which would have implications on relevant RBMPs. The potential effects of flood risk has also been identified via the SEA. In addition, a Natural Capital Assessment has been undertaken to understand the potential impacts on ecosystem services that each supply option may have. Furthermore, a Biodiversity Net Gain assessment has been undertaken to understand the potential impacts and benefits of each option within the catchment.

The River Severn River Basin Management Plan (RBMP) and the South West RBMP[16] are relevant to our area of supply. These plans identify environmental enhancements currently undertaken by Bristol Water, for example our commitments under the Water Industry National Environment Programme (WINEP) as discussed further in **Section 9**. We are committed to continuing to work with local stakeholders to identify and resolve environmental issues.

[14] Environment Agency, May 2020. Wessex Drought Action Plan.
[15] Environment Agency, November 2020. River Severn Drought Order Environmental Report. Working Draft Version 8.
[16] Environment Agency/ Defra, October 2021. River basin management plans: 2015.

3.6.8 Drainage and wastewater management plans

As a water only company, we do not publish a Drainage and wastewater management plan (DWMP). Wessex Water covers the wastewater management in our supply area. In June 2022 Wessex Water published its draft DWMP for consultation, and the final DWMP was published in May 2023. We have ensured that alignment exists between Wessex Water's final DWMP and our final WRMP in terms of growth forecasts, climate change scenarios and the timetable for delivering solutions.

Growth forecasts

Wessex Water's Developer Services Planning Liaison team provide growth information to feed into both the WRMP and the DWMP. The same methodology is followed for the entire Wessex region, including Cheddar and Bristol. This is based on the Local Authorities' local plans and ONS forecasts consistent with the growth forecasts used within Bristol's plan.

More detail can be found in sections 7.4.1 and Annex F of Wessex Water's DWMP (here).

Climate change scenarios

Different aspects of climate change are relevant to the WRMP and DWMP, so they do not need to fully align; for example, the WRMP uses drought forecasts, whereas DWMP uses rainfall intensity increase forecasts. It is the first time that Wessex Water have produced a DWMP and did not consider sea level rise within this planning round.

The DWMP uses 20% increase in rainfall intensity by 2050 (as mentioned in the DWMP framework and other guidance). This is the central climate change forecast (RCP 6.0), consistent with the central climate change scenario used for the WRMP, to which some sensitivity testing in larger catchments was applied. Wessex Water used adaptive planning to move from the central future position to a more extreme climate change scenario (RCP 8.5). This increase in intensity creates increased flood risk and also requires larger solutions to address storm overflow discharges.

More detail can be found throughout the DWMP report (here) including relevant sections 7.4.3 and 11.2.

More details can also be found on the DWMP website (here), such as Drainage strategies and geospatial maps which show how climate change can increase flood risk in some catchments more than others.

3.6.9 Drinking water safety plans (DWSP)

Our drinking water safety plans are kept under continual review. Where appropriate the WRMP has taken account of these safety plans. We have considered if there are opportunities to mitigate any risks due to water quality which might impact our supply-demand balance or preferred options. There is an embedded DWSP approach and escalation of risk to asset and company risk registers. This has allowed for early conversations regarding our sources, risks and mitigations and additionally allowed us to provide a feed into long term Drinking Water Quality planning for PR24 and beyond.

3.6.10 Local Authority Plans

Local authority plans set out future development, such as housing. We have used the data and information from the local authority plans to inform the property and population forecasts used to develop our demand forecast. See **Section 6** for more details.

3.6.11 Local Nature Recovery Strategies

The Environment Act 2021 introduced Local Nature Recovery Strategies for areas in England. Public authorities will have duties in relation to these. The WRMP should support recovery and enhancement of biodiversity according to opportunities and priorities identified in strategy areas (the Nature Recovery Network). To this end we are submitting proposals to undertake investigations with an Environmental Destination driver under our PR24 WINEP. These would investigate the potential implications for our abstractions of future climate change scenarios considering environmental and ecological requirements. We will also continue to support landowners in delivering environmental land management under the future schemes which will replace Countryside Stewardship, through our catchment management programme.

3.7 Company Policies Including Levels of Resilience and Levels of Service

3.7.1 Planned Level of Service

Expectations about the frequency with which restrictions on water use are implemented during dry years are known as 'levels of service' and set out the standard of service customers can expect to receive from their water company. We are required by our regulators to both specify and report our levels of service, or frequency at which customers can expect to experience restrictions on water use and what types of restrictions these would be.

During extended periods of dry weather, it may be necessary to encourage increased customer water efficiency and to restrict customer demand, to ensure that adequate water supplies are maintained. Initial demand management actions therefore include encouraging customer restraint on water use through media campaigns.

As dry weather continues into drought conditions and the risk to water supply increases, more formal water use restrictions may be required such as TUBs. In extreme drought conditions, Drought Orders may be needed to further restrict water use for commercial purposes.

We do not plan for a level of service that would guarantee there would never be any customer demand restrictions because this would require significant investment in additional water resource assets infrequently used resulting in unacceptably-high water bills for customers. The planned levels of service for Bristol Water customers remain the same as they were in the 2019 WRMP, except for Emergency Drought Orders – partial supply, standpipes or rota cuts (Level 4 restrictions) which have been updated to reflect the requirements set out in the Water Resource Plan Government Expectations 2022 whereby the level of resilience of our system is increased to a 1-in-500 year drought. We have planned to be resilient to a 1-in-500 year drought from 2025 onwards. Details of the assessments carried out to support this work are set out in **Sections 15.2.1**. The updated planned levels of service are set out in **Table 3-1**. This is consistent with the planned levels of service reported in our Drought Plan 2022 except for the Emergency drought order – partial supply, standpipes or rota cuts, which reflect the move to a more resilient position after 2025.

Table 3-1: Bristol Water levels of service and frequency of restrictions

Drought Action	Level of service
Temporary Use Bans (TUBs)	1 in 15 years on average
Drought Order – Non-essential use ban	1 in 33 years on average
Emergency Drought Order - Partial supply or rota-cuts	1-in-500 years on average

Temporary use bans

TUBs relate to hosepipe bans which may be applied over a 5-month period during a period of drought. The low instance of drought in our supply area means that many customers have not experienced significant water resource drought. However, 2022 has been a very dry year, with a notable number of water companies implementing TUBs restrictions across England and Wales. Bristol Water did not need to implement TUBs restrictions during 2022. Our customers are generally content with our Levels of Service, see Section 2.1.1, there is not an indication that customers feel strongly that our Levels of Service should change.

Drought Order – Non-essential use ban

Non-essential use ban Drought Orders apply to non-household customers. As with TUBs, this level of restriction has not been implemented in the Bristol Water area and therefore has not been experienced by Bristol Water non-household customers.

Emergency Drought Order – Partial supply or rota-cuts

The *Government expectations for water resources planning*[17] require all water companies to plan to be resilient to a 1-in-500 year level of drought severity by 2040 without having to implement emergency drought orders (Level 4 restrictions). In our WRMP19 we planned to be resilient to a 1-in-200 year level of drought severity and maintain supplies without emergency drought orders. This WRMP24 therefore sets out how we will deliver the increased level of resilience to the 1-in-500 year drought.

Following discussion with the Environment Agency, as we are in a position to adopt 1 in 500 from the start of the planning period the EA has required us to implement this change by 2025. In our WRMP, there are no changes over the planning period to the frequency of use of the supply side drought permits (levels of service). Any benefits of the drought permits are aligned to the assumed drought severity and these benefits are not included in the baseline for final planning supply demand balance.

[17] Defra, April 2022. Government expectations for water resources planning.

4 Problem Characterisation

4.1 Overview

The UKWIR methodology *WRMP 2019 Methods – Decision Making Processes: Guidance*[18] sets out a process of 'Problem Characterisation' which is an assessment tool widely adopted by the industry for identifying a water company's vulnerability to various strategic issues, risks and uncertainties. This enables a company to identify a proportional response in terms of the effort and cost devoted to adopting the selected decision-making tools and methods used within the water resources planning process.

The problem characterisation process required the use of expert judgement from across Bristol Water to complete the scoring assessment. We therefore commissioned the support of consultants HR Wallingford to plan and facilitate a workshop to take us through the requirements of the problem characterisation process, help us identify the key issues affecting the development of our WRMP, support us in developing the draft score of the problem characterisation, and identify the evidence which is required to underpin the assessment. Representatives from across the business attended this workshop, including staff from our teams in Water Resources & Environment, Production Asset Planning, Network Asset Planning, and Strategic Planning.

There are two elements to the problem characterisation assessment:

- Strategic needs- a high-level assessment of the scale of need for new water resources and/or demand management strategies ("How Big is the Problem?") –; and
- Complexity factors– an assessment of the complexity of issues that affect investment in a particular water resource zone or area. ("How Difficult is it to Solve?").

The full report documenting the workshop and the evidence to support the assessment of the strategic need and the complexity factors is available in **Appendix C**. The overall scores agreed by the participants at the workshop for each part of the problem characterisation process are set out in **Table 4-1.**

[18] UKWIR, 2016. WRMP 2019 Methods – Decision Making Process: Guidance. UK Water Industry Research Ltd Report 16/WR/02/10.

Table 4-1: Summary of the scores from our problem characterisation assessment

	Bristol Water's WRZ Score
Strategic Needs	**2**
Complexity Factor (CF)	**8**
A - Supply CF	2
B – Demand CF	3
C – Investment Programme CF	3

The strategic need of Bristol Water was scored as 2, which equates to a 'small' scale problem in the terms of the UKWIR guidance. The overall Complexity Factor was 8, which equates to 'Medium'. The results from the problem characterisation assessment were then combined to understand the level of vulnerability faced by Bristol Water and the resulting complexity of decision-making tool ('modelling complexity') appropriate for our WRMP. This is illustrated by placing Bristol Water within the matrix in **Table 4-2** as set out in the UKWIR *Decision Making Processes: Guidance*.

Table 4-2: The completed problem characterisation assessment showing a low level of concern

		Strategic Needs Score ("How big is the problem")			
		0-1 (None)	**2-3 (Small)**	**4-5 (Medium)**	**6 (Large)**
Complexity Factors Score ("How difficult is it to solve")	Low (<7)				
	Medium (7-11)		**Bristol Water**		
	High (11+)				

This identified Bristol Water as a 'Low level of concern' and we concurred with this outcome. Under this category 'current' approaches as demonstrated via the Economics of Balancing Supply and Demand (EBSD) are considered adequate. If specific complexities are of a concern, then they can be examined at an individual level using 'extended' assessment methods as appropriate. The outcomes of this Problem Characterisation process were used to inform the assessment methods used throughout the development of our WRMP and are referenced where relevant throughout this report. In many cases, despite having a low level of concern we have followed more advanced assessment approaches to deliver a robust WRMP that is aligned to the methodologies being used across the WCWRG Region as part of the Regional Planning process.

5 Water Supply

5.1 Drought Risk Assessment and Drought Resilience

5.1.1 Drought Resilience and Design Event Return Periods

The Environment Agency's Water Resources Planning Guideline[19] (WRPG) requires water companies to be resilient to a drought with an annual probability of occurrence of 0.2%. This is commonly referred to as the 1-in-500 year level of resilience and water companies must plan to this level of resilience by 2039 at the latest. Prior to 2039, to allow some time in the planning process to adopt this position, a 1-in-200 year level of resilience should be considered as a minimum. As we are in a position to adopt 1 in 500 from the start of the planning period the EA has required us to do so. The WRPG states that the 1-in-500 level of resilience should not be derived from the historical record alone and that stochastic weather datasets should be used to create sequences from which the 1-in-500 year drought can be derived. The 1-in-500 level of resilience should be defined by a water supply system metric that can be "related to deployable output" as opposed to metrics associated with rainfall and/or river flows which might not reflect the risk experienced by customers. The deployable output of a 1-in-500 level of resilience should be considered as the level of system demand that could be sustained without the imposition of Level 4 drought interventions (standpipes and rota cuts).

The deployable output assessment should be undertaken without the use of demand savings and/or drought permits. The reported deployable output should therefore be an unrestricted demand. The benefits of any demand restrictions are reported separately in the WRMP planning table 6 (Drought Plan Links) and reflect the measures set out in the Bristol Water Drought Plan (2022). These demand restrictions have been reviewed as options in the options appraisal process.

5.1.2 Stochastic drought approaches

To assess 1-in-500 year levels of drought resilience, stochastics weather datasets have been used to underpin the deployable output assessment. The stochastic dataset contains long sequences of weather which include drought events that are used to test the water supply system resilience.

The stochastic climate dataset was created by Atkins, using a statistical weather generator[20], as part of a collaborative Regional Group project and provided to WCWRG. The weather generator uses statistical relationships to create sequences of monthly rainfall within the boundaries of wider climatological synoptic conditions as described by several climatological indices. The monthly rainfall is then disaggregated to daily data as a post-processing exercise. The boundary climatological indices are fixed for the period of 1950 to 1997 and therefore each stochastic replicate has these wider climate synoptic conditions "hard coded" into their sequence. This means that the combinations of dry, moderate and wet year drivers are unchanged and each stochastic replicate should be interpreted as a different version of the historic 1950 to 1997 period. Atkins used the weather generator to provide 400 stochastics replicates of the 1950 to 1997 period (48 years).

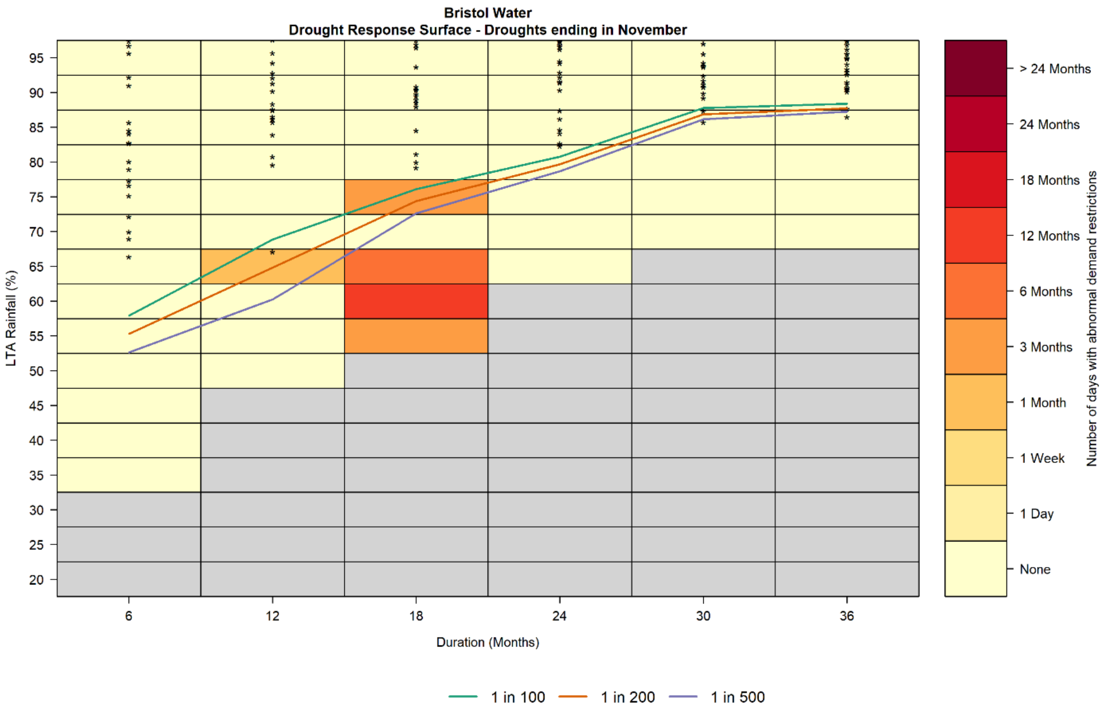
[19] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[20] Atkins, November 2021. Regional Climate Data Sets: WCWRG Baseline Stochastics Roll Out.

5.1.3 Drought Vulnerability Assessment

The Environment Agency guidance asks water companies to undertake an UKWIR Drought Vulnerability Framework (DVF)[21] assessment for each of their Water Resource Zones (WRZs). The DVF requires that a drought response surface (DRS) is created which demonstrates how the WRZ responds to increasingly severe drought events, defined by rainfall deficit and duration. For this analysis, a WRZ is tested using a specified demand reflective of current conditions such as Distribution Input, plus Target Headroom. For each drought event that is tested the number of days with "abnormal demand" should be recorded. For Bristol Water this represents the number of days with Level 4 drought restrictions in place. The DRS should be produced for two month ends which cover the period of most system stress (e.g., end of summer to start of winter when reservoir storage is lowest).

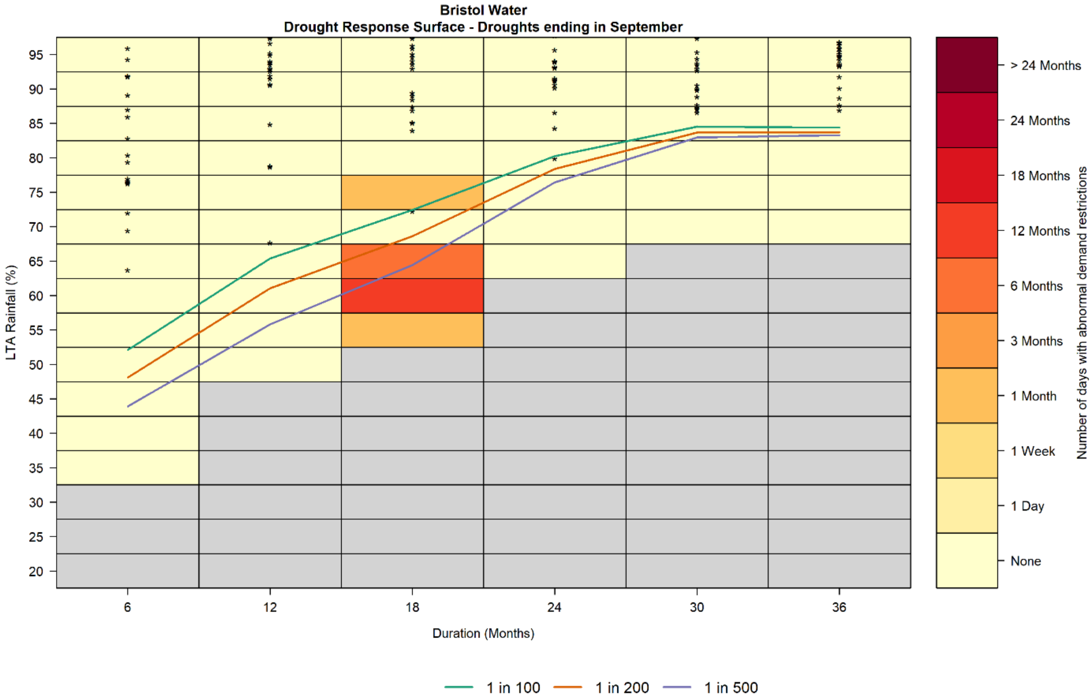
For WRMP24 the DVA has been undertaken using the stochastic dataset to ensure consistency between the DVA and the DO assessment. The DRS has been produced for a September end period and a November end period and is shown in **Figure 5-1** and **Figure 5-2**Error! Reference source not found. respectively. The DVA demonstrates that the Bristol WRZ is generally resilient to single season events (i.e., 6 - 12 months) but if a drought continues over the winter recovery period impacts can occur the following summer (i.e., 18 months duration, ending in September-November).

Figure 5-1 September ending DRS for Bristol Water WRZ



[21] UKWIR, 2017. Drought Vulnerability Framework. UK Water Industry Research Ltd Report 17/WR/02/12.

Figure 5-2 November ending DRS for Bristol Water WRZ



5.2 Deployable Output

5.2.1 Background

As part of developing the supply demand balance, we are required to estimate the yield of our resource zone in terms of deployable output (DO). DO is the output of a commissioned source or group of sources for the design drought that a water resource zone is assessed against, 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

In line with the commitments set out in our WRMP19 we have made significant improvements to our supply side data and modelling tools to inform the development of our WRMP24. This has included the following work:

- Review and update of our historical hydrological data, incorporating an assessment of the hydrology of the Gloucester and Sharpness Canal, as well as the Mendip Reservoir sources. This work was carried out by consultants Atkins, who developed rainfall runoff models of all the relevant catchments using the GR6J model[22].

- Development of stochastic hydrology data sets to inform the assessment of the 1 in 500 drought resilience.
- Water Resource Modelling development, including the review and update of our water resource model. Transferring the model from Miser to Aquator, enabling our water resource zone to be modelled as one conjunctive use zone.
- Groundwater yield assessment, progressing a programme of groundwater yield assessment to verify the deployable output of our groundwater sources. Although assessments are complete for the major sources and show that baseline values, impacts, and seasonal impacts are small, they highlighted the need to improve baseline data and knowledge of potential influence of climate change. As a result, the yield of these sources has not been updated.

We have a programme of work in place to review our reservoir control curves in the context of the updated inflow information however, this work will not be complete for this WRMP.

All the data and information improvements since WRMP19 have improved our understanding of how our conjunctive use water resource system responds to different hydrological events, and how resilient it is to future extremes due to climate change. Since the draft plan, we have made further improvements to the representation of our assets within our Aquator model. As a result, we have re-analysed our baseline stochastic and climate change DO using this new version of our model. The same methods and underpinning data have been used.

5.2.2 Bristol Water Resource Zone Deployable Output Assessment

As a result of the transfer of our water resource model to Aquator, we are now able to model our water resource zone as a fully conjunctive use system. There are three key components of this system that contribute to the overall deployable output:

- Gloucester and Sharpness Canal (supplied by the River Severn, Cam and Frome);
- Groundwater sources in the Jurassic Limestone and Triassic Mercia Mudstone Group; and,
- Reservoir system yield (Mendip Reservoirs).

The details of the data sources for each of these components is set out in the following sections, followed by an overview of the water resource modelling approaches used to assess our conjunctive use deployable output.

[22] Atkins, 2022, Hydrology Inflows Review Phase 1 and Phase 2 Reports.

5.2.3 Data Sources

Hydrological modelling of Inflows

Since WRMP19, Bristol Water have reviewed and updated their hydrological modelling and subsequent inflows for their water resources modelling[23][24]. Five new GR6J hydrological models have been created for relevant catchments across the Bristol Water area using rainfall inputs from the Met Office's HadUK dataset and potential evaporation (PET) from the Environment Agency's new national dataset. These are used to provide historical simulation of river flows for the period of 1901-2018 and are used for the historical deployable output assessment.

As outlined in **Section 5.1.2**, 1-in-500 drought resilience is assessed using the WCWRG stochastics dataset. This data was produced by Atkins, who in turn used the datasets to provide stochastic flow simulations for the five GR6J models. Each GR6J model has 400 stochastic sequences of 48 years, representing a period of 1950-1997.

The GR6J simulated flows are combined with transposition factors to provide appropriate inflows at locations of relevance to Bristol Water's Aquator water resources model. This includes the catchments that feed the Mendip Reservoirs, as well as the catchments that feed the Gloucester and Sharpness Canal. We have provided all the data associated with the Gloucester and Sharpness Canal catchments to the Canal & River Trust (CRT) to inform their Aquator modelling assessment of the source. Following our recent discussion (11th May 2023) with CRT we now understand that it will not be possible to include their work on the Gloucester & Sharpness Canal into WRMP24 however, we shall continue to work closely with CRT to ensure the resilience of this source and that the latest information informs our planning cycles at both the company and regional level in the future.

Groundwater

The groundwater source-yield assessments were undertaken by Bristol Water and in the future, may be incorporated into the Aquator model described in **Section 5.2.4**.

Bristol Water's Groundwater supply accounts for 12% of the total available annual licence. There are a total of 9 pumped borehole sources and 11 spring fed near surface sources.

Since WRMP19 we have been completing groundwater yield tests and have updated the Groundwater Yield Assessments to include operational data from 1996 to present day. The source-yield assessment for WRMP24 have been completed following guidance in the Reliable Yield approach from UKWIR *A methodology for the Determination of Outputs for Groundwater Sources*[25] and the further recommendations in Part C of UKWIR *Handbook of source yield methodologies*[26].

Operational telemetry data on water level and pumping rates has been used alongside yield/drawdown curves from pumping tests, historic data from key dry years in 1976 and 1995 and site metadata, to

[23] Atkins, November 2021. Regional Climate Data Sets: WCWRG Baseline Stochastics Roll Out.
[24] Atkins, 2022, Hydrology Inflows Review Phase 1 and Phase 2 Reports.
[25] UKWIR, 1995b. A Methodology for the Determination of Outputs for Groundwater Sources. UK Water Industry Research Ltd Report 95/WR/01/2.
[26] UKWIR, 2014. Handbook of source yield methodologies. UK Water Industry Research Ltd Report 14/WR/27/7.

construct source reliable output diagrams for each source. The drought bounding curve is then used to assess the uncertainty of source operation in drought conditions and a worst-case scenario for source-yield is derived. This result is input into the Aquator model groundwater components as a varying monthly profile, or source yield curve based on the lowest pumping water level (PWL) for each month from the historic record, limiting the maximum output from the site.

For the dWRMP24 Bristol Water completed groundwater source yield assessments for 3 major groundwater sources; Chelvey; Oldford Boreholes; and Clevedon Well. The remaining borehole and spring sources have updated groundwater yield assessments. However, these have not been input into the Aquator model for the final WRMP24 modelling runs because of the uncertainty that remains in the underpinning data. However, since the distribution network is highly interconnected and groundwater supply is a minor component of our total available licence, these remaining groundwater source-yield assessments are unlikely to materially affect the value for the WRZ conjunctive use deployable output.

5.2.4 Water resources modelling

Aquator Model

Bristol Water has developed a new Aquator water resources model of our WRZ for WRMP24. This represents a step forward in our ability to understand the water resource position and associated source resilience across the WRZ. The new water resource model was developed using the component steps described in UKWIR *Handbook of source yield methodologies*, ensuring that an updated understanding of the licences, infrastructure links and constrains, yield constraints and system context was included in the upgrade from the MISER model used in WRMP19. A benchmarking process was completed on the Aquator model using WRMP19 water resource model inputs to ensure a similar English and Welsh DO assessment result was obtained in comparison to the MISER model outputs.

The completed and benchmarked Aquator model was provided to HR Wallingford and Hydrologic to use for the WRMP24 DO assessment.

Deployable output assumptions

For WRMP24 the DO assessment is undertaken for an unconstrained demand with no demand restrictions or drought permits included within the model. The constraint on DO is the point at which Level 4 drought management interventions would be required. Therefore, the DO is defined as the maximum that can be supplied from the water supply system without the requirement for Level 4 interventions. For Bristol Water's WRMP24 the Level 4 restrictions would be implemented at the point that the aggregate reservoir storage reaches the emergency storage level, or if any single reservoir reached its dead storage. The latter is unlikely to be a constraint because the reservoirs are typically drawn down evenly within Aquator.

In order to assess the DO of the system the Scottish Method (SM) DO methodology was implemented in line with the Environment Agency WRPG[27]. This approach increases demand from a low value to a high value at fixed increments in order to systematically increase the stress on the water supply system. At each demand increment the Level 4 trigger is monitored to determine the level of demand which causes

[27] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline

this trigger to be breached in any given event. Importantly the demand increments do not stop once the Level 4 triggers are reached and continue to increase whilst monitoring these "failures".

5.2.5 Historical deployable output assessment

The historical period of 1901-2018 was used to undertake a SM DO assessment for consistency and comparison with the stochastic DO assessment. In this form of SM DO assessment the aim is determine the DO associated with each historical year which can be defined as the maximum demand that can be achieved without the reservoir group's emergency storage being breached in that year.

The DO of the 5 worst historical events is listed in **Table 5-1.** The worst historical DO is 360 Ml/d reported for 1921. In WRMP19 1933/34 was the worst historical event. 1934 is the third worst event in the WRMP24 historical assessment with a DO of 367.5Ml/d which is 7.5Ml/d higher than 1921. This change from WRMP19 is a result of two factors, firstly the new hydrological assessment which provides updated inflows for WRMP24 and secondly the improvements made in the new water resources model in Aquator. The years 1959 and 1938 are the next lowest historical DO figures of 377.5 Ml/d and 382.5 Ml/d, respectively.

Table 5-1: Historical DO Assessment

Year	Deployable Output (Ml/d)
1921	360.00
1922	362.50
1934	367.50
1959	377.50
1938	382.50

5.2.6 Stochastics deployable output assessment

The WCWRG stochastics datasets was used with Bristol Water's GR6J models to provide inflow sequences to Aquator as outlined in **Section 5.2.3**. This provides 400 48 years sequences of inflows to simulate in Aquator using a SM DO approach. Updates were made to Bristol Water's Aquator model to treat each 48-year sequence as an individual replicate. In order to efficiently simulate these sequences in Aquator XM (eXecution manager), they were grouped into eight batches of 50 sequences. The SM DO assessment used a range of DO from 300 Ml/d to 400 Ml/d with a demand step of 2.5 Ml/d. The Level 4 failure metric outlined in **Section 5.2.4** (Deployable Output Assumptions) is again applied here.

In order to derive a 1-in-200 and 1-in-500 return period DO, two separate approaches to estimating return periods of supply system impacts were implemented for comparison. These were an inverse ranking approach and a statistical extreme value analysis approach, details of each are provided below.

Inverse ranking

The inverse ranking (IR) approach treats the stochastic sequences as a continuous record of 19,200 years and implicitly assumes that this recreates the expected natural variability of the frequency of droughts over this period. The 1-in-500 DO is determined by ranking the data in terms of severity and taking the 38th-39th lowest value (i.e. 19,200 / 500 = 38.4). Similarly, a 1-in-200 DO is the 96th worst event. This approach to determine stochastic DO was widely used by water companies that used stochastics for their WRMP19 DO assessments. However, the methodology that underpins how the WRMP24 stochastics have been created may not support the assumptions that are required to use this approach.

The stochastics sequences are generated as monthly rainfall totals from a statistical model which uses the wider climate synoptic conditions as part of its explanatory variables. These wider climate synoptic conditions are not created as part of the weather generator and are instead observed sequences for the period of 1950-1997. This means that the weather generator creates 400 versions of a 48-year sequence, each with the same climatic boundary conditions which has the effect of causing droughts in the same years as the historical record (e.g. 1976). Whilst for example each stochastic 1976 year has different rainfall characteristics, the wider synoptic conditions means that the year is highly likely to be a drought year in the stochastics. The IR approach treats the sequences as a continuous record of 19,200 years and therefore a 1976 type event occurs every 48 years, once per sequence.

Extreme Value Analysis

An alternative approach to IR is to use the 400 sequences with each treated as an individual and separate replicate and representing the period from 1950 to 1997. In this approach the dataset is not assumed to be 19,200 years in length but instead 400 separate 48 years records. Extreme Value Analysis (EVA) is undertaken on each of the sequences independently to estimate the design return periods of 1-in-200 year and 1-in-500 year. With only 48 years of record in each stochastic sequence these return periods require extrapolation beyond the period of record. There is significant uncertainty based on these extrapolations, however by repeating the process 400 times the uncertainty in any one sequence is mitigated to some degree.

The EVA is undertaken on an annualised DO figure where the DO of each year represents the maximum demand that could be achieved that year without the Level 4 metric being breached. For each stochastic sequences this provides 48 values of DO. The EVA uses a peak-under-threshold (POT) sample to fit a generalised pareto distribution (GPD) to each stochastic sequence. From this it is possible to extrapolate to a 1-in-200 and 1-in-500 return period DO for each stochastic sequence.

Stochastic deployable output results

An overview of the stochastic deployable output results is shown in **Figure 5-3** and the WRZ DO is shown in **Table 5-1**. The results reported for the EVA analysis of the stochastics is a median value calculated from all 400 stochastics individual EVA.

The IR and EVA approaches to the stochastic DO assessment both provide a DO at a 1 in 100 return period of 355Ml/d. However, as the return period increases and events become more severe the differences become larger, a 1-in-500 year return period has IR of 337.5Ml/d and EVA of 347 Ml/d.

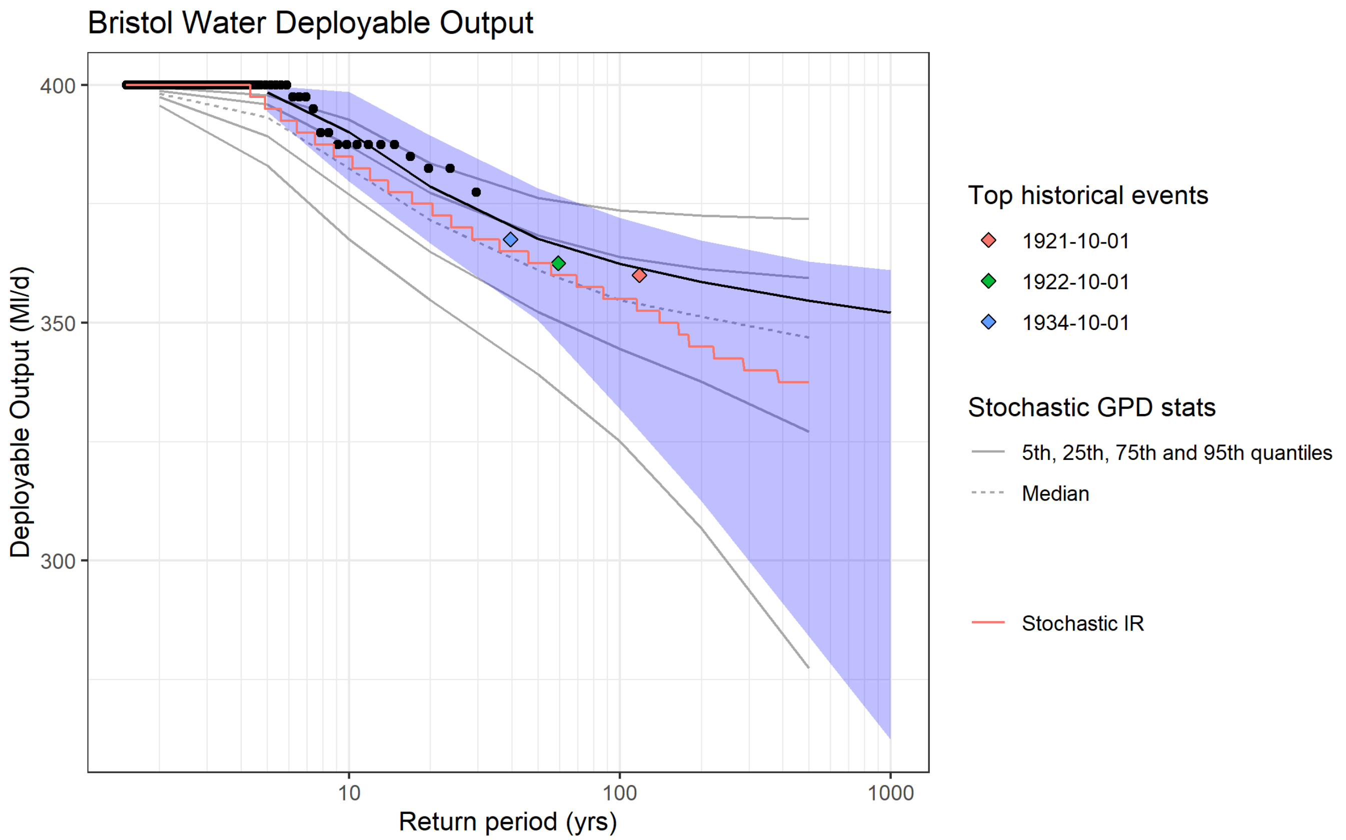


Figure 5-3: Overview of stochastic DO assessment using inverse ranking and EVA. Historical data appears in black points and lines. The historical EVA uncertainty is shown in blue shading. The stochastics are shown as an inverse ranked assumption (red line) and EVA

Compared with the worst historical DO of 360 Ml/d both approaches produce a stochastic DO that is lower for an equivalent return period. This assumes that the worst historical DO lies somewhere in a range of 1 in 100 to 1-in-200 year return period. In the context of the stochastics dataset the worst historical drought DO has a return period of approximately 1 in 60 years as shown in **Figure 5-3**. This difference between the historical DO and the stochastic DO highlights the uncertainty in assessing the 1-in-500 return period event using stochastic datasets. The benefit of the EVA approach is that this uncertainty can be quantified, and the use of stochastic datasets helps to reduce the range of uncertainty compared with only using the historical record alone (see **Table 5-3**).

Table 5-2: Bristol WRZ DO

Return Period	Historical Inverse Ranking	Historical EVA	Stochastic Inverse Ranking	Stochastic EVA
1 in 100	360Ml/d	362Ml/d	355Ml/d	355 Ml/d
1-in-200		359Ml/d	345Ml/d	351 Ml/d
1-in-500	N/A	355Ml/d	337.5Ml/d	347 Ml/d

Table 5-3: Uncertainty bounds in stochastic EVA DO assessment

RP Confidence	Hist EVA	Stoc EVA
1 in 100 Upper	372 Ml/d	374 Ml/d
1 in 100 Lower	332 Ml/d	325 Ml/d
1-in-200 Upper	367 Ml/d	372 Ml/d
1-in-200 Lower	312 Ml/d	306 Ml/d
1-in-500 Upper	363 Ml/d	372 Ml/d
1-in-500 Lower	284 Ml/d	277 Ml/d

5.2.7 Total DO for the Bristol Water Resource Zone

The information provided from the deployable output assessments carried out using the methodologies set out above has been used to determine the deployable output we have included within our WRMP24 supply demand balance. The Stochastic EVA approach was selected as the preferred methodology as it was felt that this best reflected the requirements of the technical guidance and reduced the risk of skewing the assessment towards the characteristics of the 1976 drought (which was highlighted as an issue with the Inverse Ranking approach).

The Aquator model of the Bristol Water WRZ includes the potable water export to Wessex Water of 11.71Ml/d. This is therefore accounted for in the Aquator deployable output value. For the purposes of reporting within the WRP Tables, where potable water exports are assessed and reported separately, we have therefore added the 11.71Ml/d back onto the DO value to avoid double counting. The final DO values for the Bristol Water WRZ are set out in the table below.

Table 5-4 Bristol Water WRMP24 WRZ deployable output

	1-in-200 assessment (Ml/d)	1-in-500 assessment (Ml/d)
Aquator model Stochastic EVA conjunctive use deployable output	351	347
Potable water transfer to Wessex Water	11.37	11.37
WRMP24 Bristol Water conjunctive use deployable output (as reported in WRP Tables)	348.37	343.37

5.3 Changes in Deployable Output

5.3.1 Sustainability reductions implemented since WRMP19

As documented in our WRMP19, following over twenty years of work with Wessex Water and the Environment Agency investigating the Malmesbury area licences, a sustainability reduction was made effective in March 2019 to Bristol Water's abstraction licences at Shipton Moyne Well, Long Newnton Boreholes and Tetbury Boreholes. These licence changes were made to help improve flow in the River Avon upstream of Malmesbury, an investigation triggered from a period of very low flows on the Sherston Arm of the Avon in the summer of 1990. This sustainability reduction sets limits on the aggregated maximum daily abstraction from all 3 sources of 12.1 Ml/d instantaneous and an annual volume limit of 3753 Ml.

Further conditions of this sustainability reductions were based on restricting the maximum daily abstraction volume during the year based on the groundwater level control curves in the Environment Agency's regional monitoring borehole at Didmarton Observation borehole. These further reductions are as follows:

- If the groundwater level at Didmarton is below the Upper Control Curve but above the Lower Control Curve the maximum average daily abstraction volume in a consecutive 30d period from the Malmesbury Group is limited to 9.76Ml/d
- If the groundwater level at Didmarton is below the Lower Control Curve daily abstraction volume in a consecutive 30d from the Malmesbury Group is limited to 8.29Ml/d.

As part of the agreement on the Malmesbury area abstraction licence reductions, a raw water bulk supply agreement between Wessex Water and Bristol Water was produced. Wessex Water agreed to provide a bulk supply of raw water from its Cowbridge Water Treatment Works to Bristol Water's Shipton Moyne WTW. The quantities of the supply are described in **Section 5.5**.

In developing our draft WRMP24 we have updated our assessments and included the licence changes in our deployable output assessment of the Bristol Water conjunctive use system. The updated licences are also reflected in WRP table 1b. *Base Year Licences*, and the raw water bulk supply is listed in WRP table 1f and included in WRP table 3a DYAA – Baseline, row reference 2BL.

At present there are no further sustainability reductions planned for Bristol Water's Malmesbury area abstraction licences.

5.3.2 Confirmed Sustainability Reductions – AMP7 investigations

Under the AMP7 WINEP we are investigating eight of our abstraction licences. Six of these investigations were completed and signed off in March 2022 in accordance with the required deadlines. A seventh investigation at our Dundry & Elwell Sources has since publication of the dWRMP also been signed off, and an investigation at Chelvey is ongoing. Abstractions under investigation and the applicable drivers are shown in the table below.

Table 5-4: Bristol Water AMP7 WINEP Abstraction Investigations

Bristol Water source	Drivers	Deadline
Oldford, 2 boreholes	WFD_INV_WRFlow	31st March 2022
Tickenham Road Well/Borehole, Clevedon		31st March 2022
Winscombe Boreholes and Spring (Pond)		31st March 2022
Cheddar Yeo (Cheddar) At Cox's Mill Pond	WFD_NDINV_WRFlow, WFD_INV_WRFlow	31st March 2022
Dundry & Elwell Sources, Barrow Gurney		31st December 2022
Rodney Stoke Group (Honeyhurst Well and Wellhead Spring)	WFD_NDINV_WRFlow	31st March 2022
Chelvey Well	WFD_NDINV_WRFlow, WFDGW_NDINV_WR	31st March 2025
Banwell Spring	WFD_INV_WRHMWB	31st March 2022

Noting that seven of eight of the investigations have now been signed off, no sustainability reductions have yet been confirmed because of these investigations. At Winscombe and Rodney Stoke our investigations concluded no threat to WFD status at the water body scale under recent actual abstraction rates (Winscombe) and fully licensed abstraction rates (Rodney Stoke). However, at both sites we are continuing to collect data to better understand groundwater and surface water interactions such that we can devise conditions that could be added to the licences to protect the environment; these may include Hands off Flow or Hands off Level conditions.

We are also continuing to collect data at Oldford to inform a 'No Deterioration' investigation on the AMP8 WINEP making use of a newly developed hydrogeological model of the East Mendips. At Tickenham Road Well we will continue to collect data before and after the well comes back into service (planned for 2023), and we are also proposing to install a new observation borehole to better understand if and to what extent abstractions at this source may affect shallow groundwater levels and levels in the nearby Tickenham, Nailsea and Kenn Moors SSSI. Informed by the Banwell and Cheddar Yeo investigations we are proposing local river restoration projects under the PR24 WINEP.

Following discussions with the Environment Agency during consultation on the dWRMP we have agreed a level of risk to our DO considering yet unconfirmed outcomes of AMP7 & 8 abstraction investigations. This is explained further in Section 8.3.

5.3.3 Long term Environmental Destination

The Environment Agency Water Resource Planning Guideline requires water companies to include a long-term environmental destination in our WRMP24, setting out how we will achieve and maintain sustainable abstraction to 2050 (and beyond), taking into account climate change impacts and future demand. This requirement is in addition to the current statutory requirements and regulatory expectations set out in **Section 5.3.2.**

We have worked collaboratively with the WCWRG to develop a regional view and approach to environmental destination. The WCWRG commissioned consultants Wood to assess the environmental destination requirements for trial catchments across the West Country region[28]. In the Bristol Water supply area this included the Rural Bristol Avon catchment. abstraction licences associated with 3 river systems, the Chew, Nunney Brook and the Yeo were assessed to determine if they were likely to impact the environment in the context of the future climate and forecast future demand position. This work identified that under the business as usual 'plus' (BAU+) scenario there could be a requirement for up to 3.28 Ml/d reduction in licensed resource in the Nunney Brook catchment at our Egford Wells groundwater source (17/53/12/G/015).

We have therefore included a 3.28Ml/d deployable output reduction in our supply demand balance assessment as an estimated environmental destination BAU+ allowance, plus an additional 4.1 Ml/d risk of change to deployable output due to yet unconfirmed outcomes of AMP7 & 8 ongoing abstraction investigations. This is an initial estimate based on the trial catchments assessed. We have set out more information on our wider environmental destination approach and commitments in **Section 8.4**.

5.3.4 Climate Change

Allowances for climate change impacts result in a reduction in baseline DO under the best estimate scenario. The uncertainty around the potential extent and timing of the effect of climate change is included within the headroom uncertainty assessment.

Since WRMP19, there has been a suite of new climate projections release by the Met Office: UKCP18. Further to this, the guidance on climate change assessment was updated (although the wholesale principals for the analysis are not changed). The climate change assessment has been updated to reflect these changes and is provided in **Section 9.**

5.4 Outage

Outage is an assessment of the risk of temporary or short-term losses of supply. The outage allowance assessment carried out to support Bristol Water's revised draft WRMP is reported in detail in a separate supporting report[29]. A summary of this assessment is provided in the following sections.

5.4.1 Background

Outage is defined as a temporary loss of DO in a dry year due to planned and unplanned events. An allowance for outage is required in the WRMP supply demand balance in order to recognise that at any given time some assets will temporarily be out of action for one reason or another. Our outage assessment for the WRMP24 uses the Basic Reference method used at WRMP19 and the latest DO assessments. Using the same approach as for WRMP19 maintains consistency and is entirely appropriate given our problem characterisation and baseline supply demand balance. This Basic Reference method is based on the principles set out in the outage allowances guidance, whereby the distributions for each outage type and

[28] Wood, Feb 2022. *WCWRG Environmental Destination. Pilot catchment plans to increase future water supply and low flow environmental resilience in the West Country*.
[29] HR Wallingford, 2022. Bristol Water Outage Assessment for WRMP24 – Outage Summary Report.

location are developed using three different variables namely the duration, magnitude and likelihood of events which are then combined using Monte Carlo simulation.

5.4.2 WRMP24 Approach

To produce this WRMP24 analysis we followed the updated guidance, including the Water Resources Planning Guideline[30] and WRMP24 supplementary guidance on the outage[31]. We have also used UKWIR *Outage Allowances for Water Resources Planning*[32] and UKWIR *WRMP 2019 Methods – Risk-Based Planning*[33].

This WRMP24 outage analysis includes a review of time-series data covering a period from 2008 to 2021. The data from the last three years is particularly robust, therefore, it was selected for the analysis. The outage events were sorted into various categories and types and each unplanned outage was then allocated to one of the specific outage categories set out in the UKWIR (1995) methodology as follows:

- Pollution of source
- Turbidity
- Nitrate
- Algae
- Power failure
- System failure

This data was used to develop a list of outages for each WTW over the 3-year assessment period. The data was further screened and validated via a workshop with the Bristol Water, water resources team to assess the outages identified, confirm them as legitimate outages, and that they are reflective of how such outage events would be managed under a dry year scenario. This review also included a sense check against any effects of recent or future investments that could alter the frequency and magnitude of specific outage events captured in the database.

The 2018-21 dataset covers a more recent and is broadly representative of current conditions and resource utilization to enable accurate estimation of magnitude, duration and frequency distributions of event types for each operating source.

5.4.3 Modelling approach

The dry year outage assumptions developed from the data collation exercise, were processed using the Monte Carlo Crystal Ball[34] modelling software. Triangular distributions were developed from the outage data collated to reflect the likely duration (in days), magnitude (the proportion of 'normal' daily output which is lost) and frequency of outage events under each outage category at each water treatment works.

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[30] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[31] Environment Agency 02/09/2020, Water resources planning guideline supplementary guidance – Outage.
[32] UKWIR, 1995a. Outage allowances for water resource planning. UK Water Industry Research Ltd Report WRP-0001/B.
[33] UKWIR, 2016. WRMP 2019 Methods – Risk Based Planning. UK Water Industry Research Ltd Report 16/WR/02/11.
[34] Oracle Crystal Ball Software

The triangular distributions are developed by identifying minimum, best estimate and maximum values. For each water treatment works, at the water resource zone levels, outage is calculated as:

$$\frac{\text{Duration (d)} \times \text{Magnitude (\%)} \times \text{Frequency}}{365.25} = \text{Outage (\% Production)}$$

The model runs 1000 iterations of the above calculation for each outage assumption by drawing randomly from the input distributions. A cumulative distribution function (CDF) of outage is calculated from the individual outage results. Outage is calculated by apportioning the treatment works outage according to the DO of each treatment works. The analysis we undertook explored a range of risk percentiles 50th - 100th which were used as the uncertainty levels. A risk percentile is then chosen from the CDF and used as an outage allowance for the WRMP supply demand balance.

5.4.4 Results

Table 5-5 shows the results of the analysis for the 1-in-200 DO assessments and 1-in-500 DO assessments. As with previous WRMPs we have used the 95th percentile to represent the outage allowance in the Bristol Water resource zone.

Table 5-5: Our outage assessment for different percentiles and the 1:200 and 1:500 DO assessments

	1:200 DO apportionment	1:500 DO apportionment
Percentiles	Outage DO with algal blooms (Ml/d) (337.50)	Outage DO with algal blooms (Ml/d) (332.49)
50	3.68 (1.09%)	3.65 (1.10%)
55	3.73 (1.10%)	3.69 (1.11%)
60	3.77 (1.12%)	3.73 (1.12%)
65	3.82 (1.13%)	3.78 (1.14%)
70	3.87 (1.15%)	3.83 (1.15%)
75	3.92 (1.16%)	3.88 (1.17%)
80	3.98 (1.18%)	3.94 (1.19%)
85	4.05 (1.20%)	4.01 (1.21%)
90	4.14 (1.23%)	4.09 (1.23%)
95	4.27 (1.27%)	4.22 (1.27%)
100	5.25 (1.56%)	5.23 (1.57%)

5.4.5 Opportunities to Reduce Outage

Given the relatively low outage for our company, there are few options to reduce outage across the company, however the use of catchment management measures to reduce nutrients can help reduce algal blooms at our reservoir sites. These algal blooms can block the filters in our treatment processes, reducing the output of the sites. We have therefore included catchment management as a feasible option in our options assessment process (see **Section 12**).

5.4.6 Changes to deployable output from prolonged outage reduction

We have recorded several planned outages that are in excess of 6 months as 'prolonged outage reduction' in the water resource planning tables (row 7.4BL). This amounts to a total of a 4.76Ml/d reduction in deployable output until the end of AMP8 (2029/30). The sites that are affected by prolonged outage are, Charterhouse (DO of 1.24Ml/d), which was affected by a fire and is undergoing a re-build, and Sherbourne (DO of 3.52 Ml/d), which is undergoing a review to identify the optimum use of this water within our network.

5.5 Raw and Potable Water Transfers and Bulk Supplies

The raw and potable water transfers and bulk supplies for Bristol Water's WRZ to other water companies have not changed materially since WRMP2019. The WRZ has 4 minor potable water imports from Wessex Water with an average daily flow of less than 1 Ml/d. There are 2 minor and 1 major potable water export to Wessex Water west of Bath. The major potable water bulk export at Newton Meadows has a contracted maximum of 11.37 Ml/d.

Bristol Water receives a raw water transfer at Shipton Moyne WTW from Wessex Water's Cowbridge groundwater source in the Malmesbury area. The raw water supply is operated under an agreement with Wessex Water whereby when groundwater levels at the Environment Agency's Didmarton observation borehole fall below a control curve, up to 1.5Ml/d will be provided to Bristol Water. A DYAA volume of 1.06Ml/d has been assessed based on assumed export being active for 8.5 months during a drought as per 1976 groundwater levels. This may be reviewed ahead of WRMP29 with any updated analysis (the maximum annual average volume is 1.5 Ml/d). In the event of an outage at Bristol Water's Malmesbury groundwater sources that results in a risk to supply then a flow of up to 3Ml/d can be requested.

In WRMP19 there were 2 treated inset agreements with the NAVS in the Bristol Water WRZ with an average volume supplied of <1 Ml/d. The number treated inset agreements is expected to increase by at least 13 from 2022 onwards however the actual average volume supplied is expected to continue to be below 1 Ml/d to the end of AMP7. These new agreements are listed in the planning tables as potable water transfers. We have no data on which to base future NAV properties although there are contracts for new sites being agreed at the time of writing. Our demand forecast uses local authority data for new connections and all of the demand for these are built into our forecasts. It is therefore not possible at this stage to fully disaggregate the NAV demand from the demands of our own customers. We therefore estimated demand for NAVs to equal the agreed maximum contractual volumes for the known NAV sites at the time of writing and to reflect the WRMPs of our NAV partners. In the short-term i.e. AMP8, this is likely to be a significant over-estimate of the actual demand from NAVs.

5.5.1 Raw Water Transfers within WRZ

We operate several raw water transfers within our supply network. The majority of which are supplied directly to water treatment works. A small number of transfers are between water bodies and catchments. Some of these transfers shown are used very infrequently, but include:

- Blagdon Lake to Barrow Tanks and Cheddar Reservoir
- Cheddar Reservoir to Barrow Tanks and Blagdon Lake
- Chew Magna Reservoir to Chew Valley Lake
- Chew Valley Lake to Barrow Tanks, Blagdon Reservoir and Ubley Hatchery
- The River Axe to Cheddar Reservoir.

Raw water quality is monitored via Operational Monitoring which is used to inform operational procedures and if poor water quality is detected, the transfer of water is halted. Some high risks sites have specific treatment to manage the risks of poor water quality, for example the River Axe abstraction is treated via Actiflo[35] enhanced clarification system prior to discharge into Cheddar Reservoir. The system is designed to primarily remove phosphorus but also reduces the risk of transferring invasive species.

Barrow Tanks are supplied by a number of raw water sources but predominantly Blagdon and Chew Reservoirs. These tanks are for holding water on a short-term basis prior to treatment at Barrow treatment works and are not considered to be WFD water bodies. During 2016, following issue of the draft version of our NEP (National Environment Programme) phase 1 report into Barrow 3 reservoir, the Environment Agency reviewed the WFD status of Barrow Reservoir No. 3 and concluded that the reservoir should no longer be a Drinking Water Protected Area, negating the requirement for it to be considered a WFD water body.

In AMP6 we assessed the risk of our raw water transfers on the spread of invasive species. This work has continued into AMP7 with investigations into the presence of INNS at these locations and the need for biosecurity management measures. The output of this work are a set of Rapid Response Plans and Catchment Strategies which underpin our monitoring proposals in the PR24 WINEP with regard to INNS and the above locations. Further to this, our work in AMP7 with partners such as the Bristol and Avon Rivers Trust (BART), and the Bristol Zoological Society to monitor the presence of particular INNS also underpins further work in AMP8 to support positive measures to reduce INNS and the risk of their transmission via raw water transfers.

5.6 Operational Use and Process Losses

5.6.1 Raw Water Losses, Treatment Works Losses and Operational Use

Raw water losses, treatment works losses and operational use of water is the sum of:

- Raw water lost or used as part of transmission (including aqueduct losses and draining down of mains and reservoirs for maintenance);
- Storage losses (including seepage, discharges and evaporative losses);

[35] Actiflo is a process where a coagulant is added to the raw water as a process to remove particulates and pollutants

- treatment process; and,
- Operational use of water (both raw and treated).

Some of these items can be measured directly (i.e. flows into and leaving a treatment works), but others such as raw water losses will be estimated from a balance of flows and subject to some error. In most cases, the water 'lost' flows back to the source resulting in a negligible effect on yield.

Raw water Losses

We measure raw water losses as the volume of water lost between abstraction from our raw water sources and transported to the head of a treatment works. Raw water losses are calculated using a mass balance approach on the strategic trunk main system. Daily average flow from flow meters on raw water mains are used to calculate loss rates on an annual basis. This approach means that sometimes multiple flow meters and tank storage change calculations are required to complete a mass balance, which can introduce some instrument error into the calculation.

Treatment Works Losses

Treatment works losses are defined as the losses that occur between the inlet to the treatment works to the outlet of the treatment works (our distribution input flow meter), taking into account any volumes of water which are recirculated to the head of the works as "supernatant" to avoid double counting. A mass balance approach is used to calculate the treatment works losses, using the raw water inlet flow meter, the final treated water output flow meter and netting off operational use such as sampling equipment and backwashing.

Operational Use

Operational use of water is split between raw water and treated water operational use. Raw water operational use is calculated as the volumes of water which are used to supply our fish hatchery, which is approximately 3.5 Ml/d. Treated water operational use comes from throughput water quality monitoring equipment, filter backwashing and effluent discharge.

Baseline Raw Water Losses, Treatment Works Losses, Operational Use Volumes.

In our WRMP19 we reported the raw water losses, treatment works losses and operational use as 20.27Ml/d throughout the 25 year planning period in the baseline forecast. This aligned to the reported outturn value in the WRMP14 annual review submission (June 2018). We also included an option to reduce raw water losses and treatment works losses in our WRMP19 options assessment.

In reviewing our WRMP, we have assessed the raw water losses, treatment works losses and operational use to be 18.17Ml/d throughout the planning period. This is calculated as the average of the last 3 years outturn data (2019/20 to 2021/22). We have also continued to include an option to further reduce raw water losses and treatment works losses in our WRMP24 options appraisal process. This is outlined in **Section 12**.

5.7 Zonal Summary of Baseline Deployable Output and Water Available for Use (WAFU)

Table 5-6 summarises the results of the baseline supply calculations for the Bristol Water WRZ for the 2021/22 base year and the first year of the planning period in 2025/26, including our best estimate of the effects of climate change.

Table 5-6: Summary of baseline supply side components for 2021/2 base year and first year of the planning period in 2025/26

Year	DO before forecast changes	Reductions in DO* Ml/d	Total Outage allowance Ml/d	Water Available for Use (Own sources) Ml/d	Balance of imports and exports (Ml/d)	Total Water Available for Use (Ml/d)
2021/22	358.37	31.06	4.27	323.04	-14.02	309.02
2025/26	358.37	38.15	4.27	315.95	-7.05	308.90

*climate change, sustainability changes (if applicable), prolonged outage and RWL, TWL & OU

5.8 Drinking Water Quality

Excellent water quality is fundamental and front and centre to providing the level of service our customers expect from us. Our aim is always to supply water that is not just safe to drink but meets the taste and aesthetic qualities that our customers expect from us every day, all year round. We achieve this using advanced treatment processes and a team of highly trained staff.

This is reflected in our water quality results, with over 99.9% of the 120,000 drinking water tests carried out each year being compliant with UK Drinking Water Inspectorate (DWI) and EU drinking water standards. We continue to invest in new treatment processes and renovation of water mains. Our work with partners in our source catchments, such as delivery of the Mendip Lakes Partnership project, ensures this high standard of water quality is maintained.

Bristol Water has also sought to be an innovator and as part of our OFWAT innovation fund successful bids we have two projects that seek to characterise and manage our raw waters using novel environmental DNA (eDNA) analysis to predict and manage phytoplankton blooms and the follow-on project "to mix or not to mix". This industry and academic led consortium project aims to optimise destratification of reservoirs to manipulate algal blooms and prevent customer taste and odour events.

Both ensure that not only is sufficient water is available for use but that it is in the most treatable form and raw water quality is understood and maximised.

Bristol Water complies with section 68(1) of the Water Industry Act 1991 that covers our duty to supply wholesome water. Wholesomeness[36] requirements are set out in the Water Supply (Water Quality)

[36] Regulation 4 - water is wholesome if it contains concentrations or values in respect of various properties, elements, organisms and substances that do not contravene the prescribed maximum, and in some cases, minimum concentrations or value.

Regulations 2016 (in England) and the Water Supply (Water Quality) Regulations 2018 (in Wales), and associated amendments.

Bristol Water does not treat sewerage so our impacts on the environment from a water quality perspective are relatively limited, although we do work with Wessex Water to consider effects of our abstractions in terms of dilution of effluent discharged by their infrastructure. Where we are undertaking investigations and improvement projects we work closely with local communities, for example where we have adapting reservoir compensation flows to benefit the downstream River Chew around Chew Magna. We hope that the agricultural community in our catchments will continue to have regard to regulations around agricultural pollution risk.

This following section provides an overview of the key ways by which we protect water resources. These include operational monitoring of raw water, working with farmers to improve water quality in our reservoirs and sources, to sampling the compliance at customer taps. Risks are identified and resolved via the Drinking Water Safety Plans (DWSPs)[37]. Drinking water compliance standards are regulated by and reported to the Drinking Water Inspectorate (DWI).

5.8.1 Catchment Management

We have for the past ten years worked closely with farmers in our Mendip catchments and in the Cam and Frome catchments to the Gloucester & Sharpness Canal. We have developed good working relationships, and supported capital improvements on many farms, and have provided free advice and management planning on many more. Focus has been on nutrient management, soil management, but also water resources.

Through our catchment management programme, we help farms to become more resilient, for example by offering rainwater harvesting equipment (tanks, pipework etc.) under our grant scheme, and by providing farms with free soil and nutrient management plans. We plan to continue this work. Since the start of our Mendips catchment management programme, the phosphorus concentrations and algal bloom frequencies in the Mendip Lakes have reduced, making the reservoir water easier to treat.

We work with farmers and other stakeholders in our source catchments to manage potential risks to raw water quality in our reservoirs and sources, mainly around agricultural use of organic and inorganic fertilizers. This not only provides resilience benefits from reduced outage but also provides a sustainable and cost-effective approach in comparison to traditional treatment approaches.

We have also worked with the Environment Agency to identify catchments where pollution is likely to require increased levels of treatment, and we are working across these catchments to control and where possible reduce these risks.

Metaldehyde

Metaldehyde has now been banned from use effective 31st March 2022. As the active ingredient in conventional slug pellets, it was used widely by the agricultural industry and domestic growers to protect

[37] A Drinking Water Safety Plan (DWSP) is the most effective way of ensuring that a water supply is safe for human consumption and that it meets the health based standards and other regulatory requirements. It is based on a comprehensive risk assessment and risk management approach to all the steps in a water supply chain from catchment to consumer.

crops and seedlings. Metaldehyde is very difficult to remove from raw water, so we have over previous AMPs run a programme of catchment water quality monitoring, engagement and training to reduce the frequency of metaldehyde concentration spikes in the Gloucester and Sharpness Canal. Now that metaldehyde has been banned, we continue to monitor on a surveillance basis recognising that there remains a risk that legacy stocks could be deployed.

The Mendip Lakes Partnership

Chew Valley, Blagdon and Cheddar Reservoirs have in recent years recorded increasing frequencies of algal blooms. These algae make the water more difficult and expensive to treat resulting in increased costs. Blue green algae can pose a public health risk and may also adversely affect the taste and odour of treated water. The reservoirs are all designated as Sites of Special Scientific Interest (SSSI), and Chew Valley Reservoir is also a Special Protection Area (SPA) under the Birds Directive, so we have a responsibility to ensure their condition is maintained appropriately from an ecological perspective. The reservoirs are also water bodies under the Water Framework Directive; to be assessed at 'Good' status, nutrient concentrations must be reduced from their current levels.

In 2014, Bristol Water set up the Mendip Lakes Partnership to bring together organisations working to reduce the impacts of diffuse pollution from agriculture. The Partnership continues to work with farmers across the Blagdon, Chew and Cheddar Reservoir catchments to protect and improve water quality in the reservoirs and associated watercourses, and to enhance wildlife habitats. As part of the project, Bristol Water has implemented a comprehensive water quality monitoring programme so that we can understand risk areas and identify improvements over time. Improved water quality will result in lower treatment costs and protection of the designated features of the reservoirs. It will also help to improve the resilience of our raw water supply should climate change or socio-political factors affect land use and soil and water interactions in the future.

5.9 Upstream Competition

Ofwat approved and published our trading and procurement code in July 2018[40]. We publish key information in a consistent format to support the bidding market for water resources, demand management and leakage services. The market information is available on our web site and is aligned to our WRMP19. We review this data every year following the statutory WRMP Annual Review process and confirm to Ofwat whether any of the information has changed due to our review. Our latest water resource market information tables are available here: Water Resources (bristolwater.co.uk).

6 Water Demand Forecast

6.1 Introduction

The EA Water Resources Planning Guideline[38] requires water companies to use assessment methods for supply and demand analysis that are appropriate to the level of planning concern in each water resource zone. As identified via the Problem Characterisation process in **Section 4** our 'modelling complexity' category showed a 'Medium level of concern'. An assessment of suitable methods for demand forecasting was carried out, and details of the selected assessment method for each element of the demand forecast are set out below. We commissioned Experian to deliver population projections and non-household demand forecasts, and Ovarro to support the development of our household demand forecasts

6.2 Base Year

The base year selected for developing the WRMP demand forecast is 2021/22 using the annual outturn data reported in the WRMP Annual Review for 2021/22 (AR22). This outturn data was consistently lower than the forecast population presented in WRMP19, hence why overall the population forecast for this time period out to 2030 is lower in the WRMP24 than was forecast in the WRMP19. Demand forecast components are therefore reconciled to the observed levels of consumption within the base year. This is the most recent year for which we have out-turn data. It is also the most up to date indication we have relating to what demand for water is likely to be following the COVID-19 pandemic and the various lockdown restrictions implemented between March 2020 and March 2022.

6.3 Population, Properties and Occupancy

In accordance with the Water Resources Planning Guideline, our approach to developing population, property and occupancy forecasts for the draft WRMP24 followed the methodology set out in the UKWIR *WRMP19 Methods: Population, Household Property and Occupancy Forecasting Guidance Manual*[39]. This approach recommends the data should be based on local plans published by the local council or unitary authority, where the data are available. Where data are not available, companies are recommended to use their own property forecasts.

Several data sets have been used to develop the population and property forecasts. The two main methods are via the use of relevant local authority information, termed 'plan' data, for local authorities within the Bristol Water supply area, and via official statistics from the Office of National Statistics (ONS), termed 'trend' data.

The outputs from this analysis were incorporated within the household consumption forecast model and report. Within the model there is a calibration step to ensure that the final population and property

[38] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[39] UKWIR, 2015. WRMP19 Methods: Population, Household Property and Occupancy Forecasting Guidance Manual. UK Water Industry Research Ltd Report 15/WR/02/8.

forecasts are in-line with the reported figures from the WRMP Annual Review 2022 (AR22). The trends from the figures reported were then used to forecast from the base year reported figures.

Details of the analysis to develop the population and property forecast are provided in the following sections.

6.3.1 Methodology

We appointed Experian to produce a consistent property and population forecast as a joint regional project with South West Water. A range of population and property projections for several variables have been produced, each constructed using different assumptions and methodology, including trend based, econometric-based, plan-based and a hybrid ("most-likely") forecast.

Table 6-1 shows the breakdown of how the data is presented by Lower Super Output Area (LSOA) and Water Resource Zone (WRZ) levels.

Table 6-1: Bristol Water area breakdown

Water Resource Zone (WRZ)	Local Authority District (LAD)	Lower Super Output Areas (LSOA)
Bristol Water	Bath & North East Somerset	57 LSOA
	Bristol	263 LSOA
	South Somerset	7 LSOA
	Stroud	5 LSOA
	Cotswold	6 LSOA
	Mendip	66 LSOA
	Sedgemoor	28 LSOA
	Wiltshire	15 LSOA
	North Somerset	135 LSOA
	South Gloucestershire	166 LSOA

Trend-based approach

Trend-based projections have been produced using a range of official statistics as detailed below. The projections provide a consistent and comparable set of projections for each area based on historic growth. Trend-based forecasts are subsequently used as input to produce the plan and econometric forecasts. The UKWIR report recommends producing trend-based projections since they are widely used and importantly, are required to produce plan-based and other forecasts. It can also be used to objectively assess the plan-based figures and help to produce a balanced view of likely growth.

Experian's approach started with local authority district level projections, using DLUHC (Department for Levelling Up, Housing and Communities) housings stock statistics, council tax statistics to produce historic estimates of households. A detailed description of employed approach is discussed in Experian's report[40].

[40] Experian, February 2022, *Population and properties forecasts: Bristol Water*.

Data sources used

The forecast of population and properties growth up to 2080 was developed using:

- **Local authority plans:** Dwelling stock statistics 2001-2020 – Department for Levelling Up, Housing and Communities
- **The Office for National Statistics (ONS)**:
  - 2018 sub-national population projections
  - 2011-2020 mid-year population estimates at output area
  - 2018 based sub-national household projections
- **Census 2011**

The **Table 6-2** shows populations, households and dwelling projections derived based on trend-based approach.

Plan-based projection

To meet the requirement set out in the WRMP guidance, Experian contacted each local authority on behalf of Bristol Water, asking for their latest information on the number of dwellings they were planning for in their local plan. Experian specifically asked local authorities to identify the most relevant figures for water companies to use i.e., to take account of the status of the local authority plan in the area and anticipated changes to draft plans. Experian also asked the local authority to cite the source of the information. The data collection exercise was run over a four-week period and was conducted via e-mail and telephone.

All eight local authorities responded to the request for the annual dwelling allocations from the local plans. Most local authority local plans extend to 10-20 years into the future and therefore need to be extended to cover the entire forecast period. Experian extrapolated the dwelling targets outlined in the local plan in accordance with UKWIR guidance. A detailed description of employed approach is discussed in Experian's report[41].

Data sources used

The forecast of population and properties growth up to 2080 was developed using several different sources:

- Annual housing target from local plans
- Trend-based projections

The **Table 6-3** shows populations, households and dwelling projections derived based on plan based approach.

Econometric-based approach

The guidance suggests that relationships related to historic changes to population, households and occupancy are only likely to hold at larger geographical levels. Experian has identified a link between economic growth and the rate of house building and produced forecasts for the number of new housing completion at UK and regional level (**Figure 6-1**). The regional model is fully linked to our local forecasting model so that the regional econometric forecasts can be further disaggregated to a local authority level.

[41] Experian, February 2022, *Population and properties forecasts: Bristol Water*

Similar to the plan-based forecast, the rationale for this approach is that limiting the supply of housing over the long-term will potentially limit population growth in a local area. At the same time, additional supply of housing can attract inward migration. Both these factors are recognised in this approach.

Table 6-2: Trend based approach

Based approach	Series	2015/16 - 2019/20	2020/21 - 2024/25	2025/26 - 2029/30	2030/31 - 2034/35	2035/36 - 2039/40	2040/21 - 2044/45	2045/46 - 2049/50	2050/21 - 2054/55	2055/56 - 2059/60	2060/61 - 2064/65	2065/66 - 2069/70	2070/71 - 2074/75	2075/76 - 2079/80
Trend	Population	1199820	1242760	1287540	1329840	1368760	1406580	1447900	1487900	1527900	1567800	1607800	1647800	1687760
Trend	CE population	13860	14500	15540	16820	18240	19520	21000	22500	24000	25580	27200	28880	30580
Trend	Households	504560	527680	549620	570760	591180	610980	629700	646480	663260	680020	696820	713600	730380
Trend	Total Dwellings	514860	538560	560820	582360	603220	623380	642520	659640	676760	693880	711020	728140	745260
Trend	Vacant dwellings	10300	10860	11200	11600	12020	12420	12800	13160	13500	13860	14200	14560	14900
Trend	Household population	1185960	1228260	1272020	1313000	1350520	1387060	1426900	1465400	1503880	1542260	1580600	1618920	1657180
Trend	Average household size	2.35	2.33	2.31	2.30	2.28	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27

Table 6-3: Plan based approach

Based approach	Series	2015/16 - 2019/20	2020/21 - 2024/25	2025/26 - 2029/30	2030/31 - 2034/35	2035/36 - 2039/40	2040/21 - 2044/45	2045/46 - 2049/50	2050/21 - 2054/55	2055/56 - 2059/60	2060/61 - 2064/65	2065/66 - 2069/70	2070/71 - 2074/75	2075/76 - 2079/80
Plan	Population	1199820	1245920	1293880	1336560	1375080	1411780	1452980	1494800	1536920	1579300	1621980	1664900	1708020
Plan	Communal establishment (C	13860	14500	15540	16820	18240	19520	21000	22500	24000	25580	27200	28880	30580
Plan	Households	504560	530380	555060	576580	596780	615640	634000	651840	669640	687460	705260	723100	740900
Plan	Total Dwellings	514860	541320	566360	588300	608900	628160	646940	665120	683300	701460	719660	737840	756020
Plan	Vacant dwellings	10300	10940	11300	11740	12160	12540	12920	13280	13640	14020	14380	14740	15120
Plan	Household population	1185960	1231420	1278360	1319740	1356820	1392200	1432000	1472320	1512940	1553740	1594760	1636000	1677400
Plan	Average household size	2.35	2.32	2.30	2.29	2.27	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26

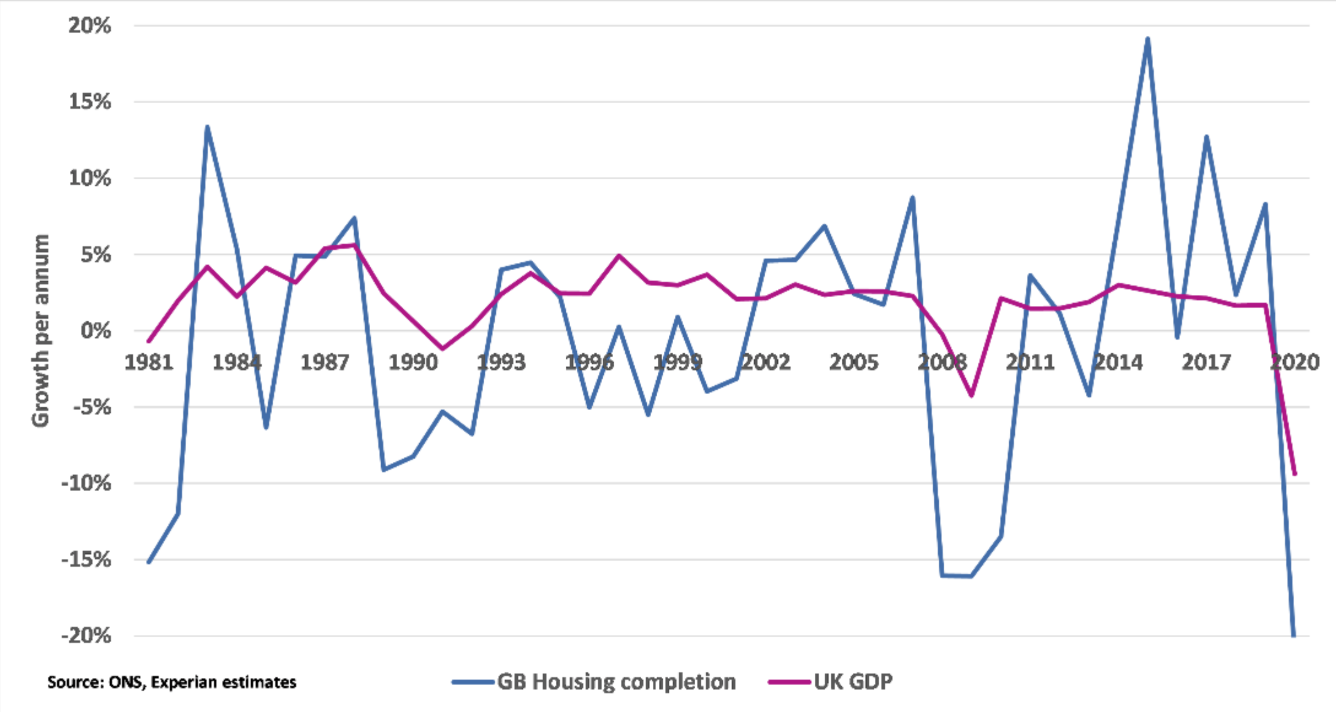
Table 6-4: Econometrics-based approach

Based approach	Series	2015/16 - 2019/20	2020/21 - 2024/25	2025/26 - 2029/30	2030/31 - 2034/35	2035/36 - 2039/40	2040/21 - 2044/45	2045/46 - 2049/50	2050/21 - 2054/55	2055/56 - 2059/60	2060/61 - 2064/65	2065/66 - 2069/70	2070/71 - 2074/75	2075/76 - 2079/80
Econometrics	Population	1199820	1236680	1273040	1310680	1349780	1391280	1435820	1481940	1528300	1574960	1621900	1669120	1716640
Econometrics	Communal establishment (C	13860	14500	15540	16820	18240	19520	21000	22500	24000	25580	27200	28880	30580
Econometrics	Households	504560	525080	543360	562400	582880	604220	624340	643840	663480	683260	703200	723220	743380
Econometrics	Total Dwellings	514860	535900	554420	573880	594740	616560	637060	657000	677040	697220	717540	738000	758620
Econometrics	Vacant dwellings	10300	10840	11060	11440	11880	12300	12720	13120	13540	13960	14380	14800	15220
Econometrics	Household population	1185960	1222200	1257520	1293860	1331560	1371720	1414860	1459480	1504300	1549380	1594700	1640240	1686040
Econometrics	Average household size	2.35	2.33	2.31	2.30	2.28	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27

Table 6-5: Hybrid-based approach

Based approach	Series	2015/16 - 2019/20	2020/21 - 2024/25	2025/26 - 2029/30	2030/31 - 2034/35	2035/36 - 2039/40	2040/21 - 2044/45	2045/46 - 2049/50	2050/21 - 2054/55	2055/56 - 2059/60	2060/61 - 2064/65	2065/66 - 2069/70	2070/71 - 2074/75	2075/76 - 2079/80
Hybrid	Population	1199820	1241320	1281520	1319880	1356340	1392100	1432800	1475000	1517640	1560680	1604140	1648020	1692260
Hybrid	Communal establishment (C	13860	14500	15540	16820	18240	19520	21000	22500	24000	25580	27200	28880	30580
Hybrid	Households	504560	525060	541680	559160	577540	595980	613860	631380	649020	666820	684700	702800	721000
Hybrid	Total Dwellings	514860	535880	552700	570560	589300	608100	626360	644220	662240	680380	698700	717100	735720
Hybrid	Vacant dwellings	10300	10840	11040	11380	11760	12140	12500	12860	13220	13580	13960	14340	14720
Hybrid	Household population	1185960	1226840	1266020	1303040	1338080	1372560	1411800	1452520	1493640	1535120	1576980	1619140	1661680
Hybrid	Average household size	2.35	2.33	2.31	2.30	2.28	2.27	2.27	2.27	2.27	2.27	2.27	2.28	2.28

Figure 6-1: The relationship between UK economic growth and housing completion growth, 1981- 2020



The housing completions forecast model takes into account the following factors:

- Private investment in housing
- Government investment in housing
- Construction of buildings Gross Value Added

The methodology applied was to first sum the local authority trend-based property targets to regions and control to the econometric housing completion forecast for each region. Trend-based vacancy rates were applied to the local authority property levels to derive vacant properties, and vacant properties were subtracted from the total property count to calculate household levels.

Following this, the trend-based average household size was applied to the household levels to produce a first cut of the econometric model's total population. The mid-point of the population between the trend-based and first cut econometric model was taken for the final total population forecast. As in the plan-based forecast, the communal population were kept at trend-based levels and were subtracted from total population to derive household population at local authority level. For the final step, the set of OA estimates were aggregated to the WRZ level using a similar approach as outlined in the trend-based projections.

Data sources used

The forecast of population and properties growth up to 2080 was developed in-house using:

- Experian's forecasts: the macroeconomic and regional level economic forecasts produced by Experian
- Trend-based projections

The **Table 6-4** shows populations, households and dwelling projections derived based on econometric-based approach.

Hybrid approach

Experian's approach for the hybrid ("most likely") forecasts were constructed using elements of the trend, plan-based and econometric forecasts. This helped to produce more robust projections and capture uncertainty as it selected the most appropriate forecasts for each local authority area based on a quality assessment of the underlying data. Each of these forecasts provided an alternative view of the future however, there was still a large degree of overlap between the different forecasts.

Table 6-5 shows populations, households and dwelling projections derived based on hybrid-based approach.

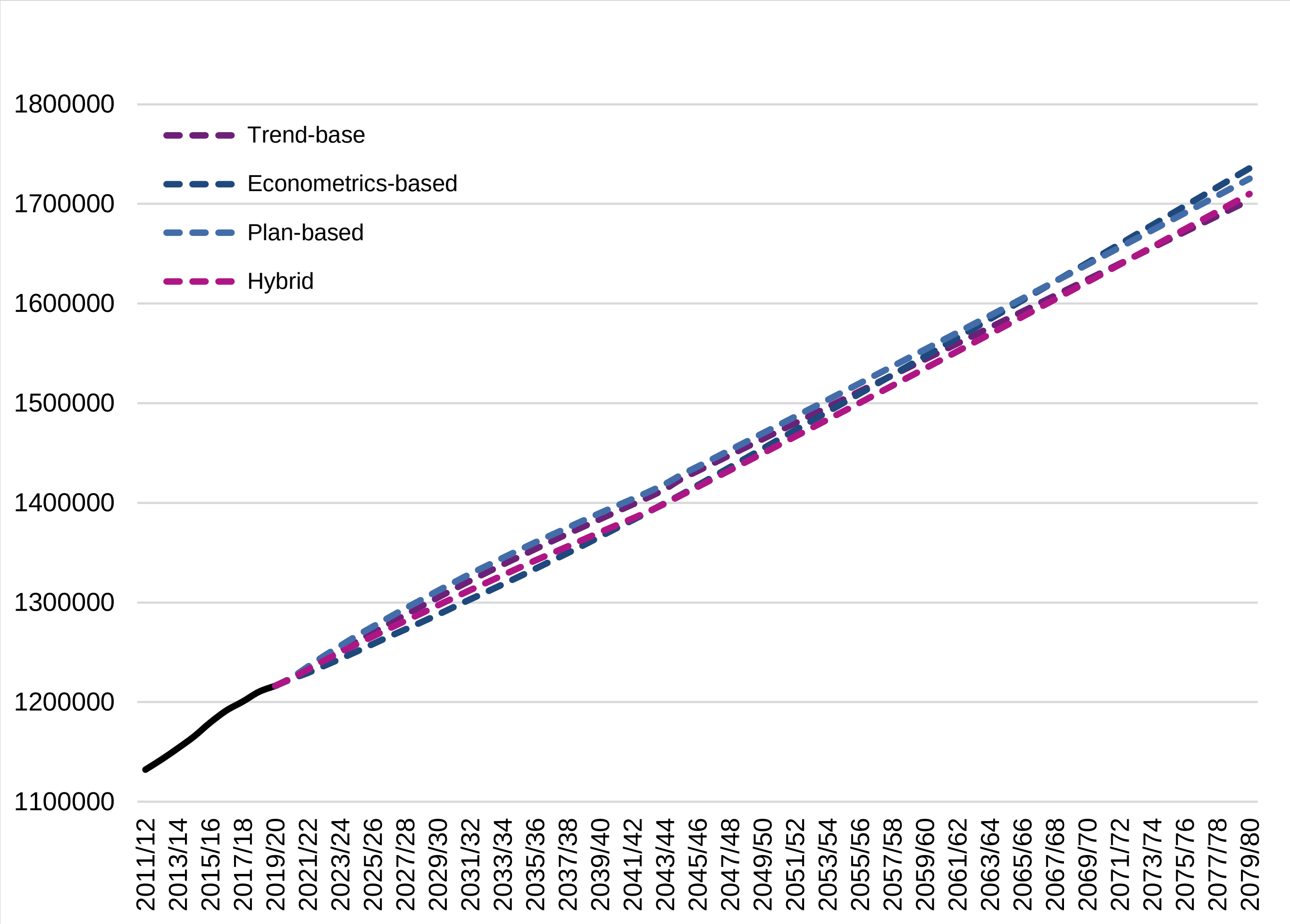
6.3.2 Population projections

Total population, shown in

Figure 6-2, has an increasing trend over the forecast period (2019/20 to 2079/80). Comparing the methods used, the trend-based approach forecast the smallest increase from 1,216,400 to 1,703,700, an increase of 40.1% over the forecasting period. The econometrics-based approach estimates the largest increase of 42.7%. The hybrid-based approach projects population growth of 40.6% by 2079/80 to 1.7 million people.

The average annual growth rate for all approaches is 0.67-0.75%.

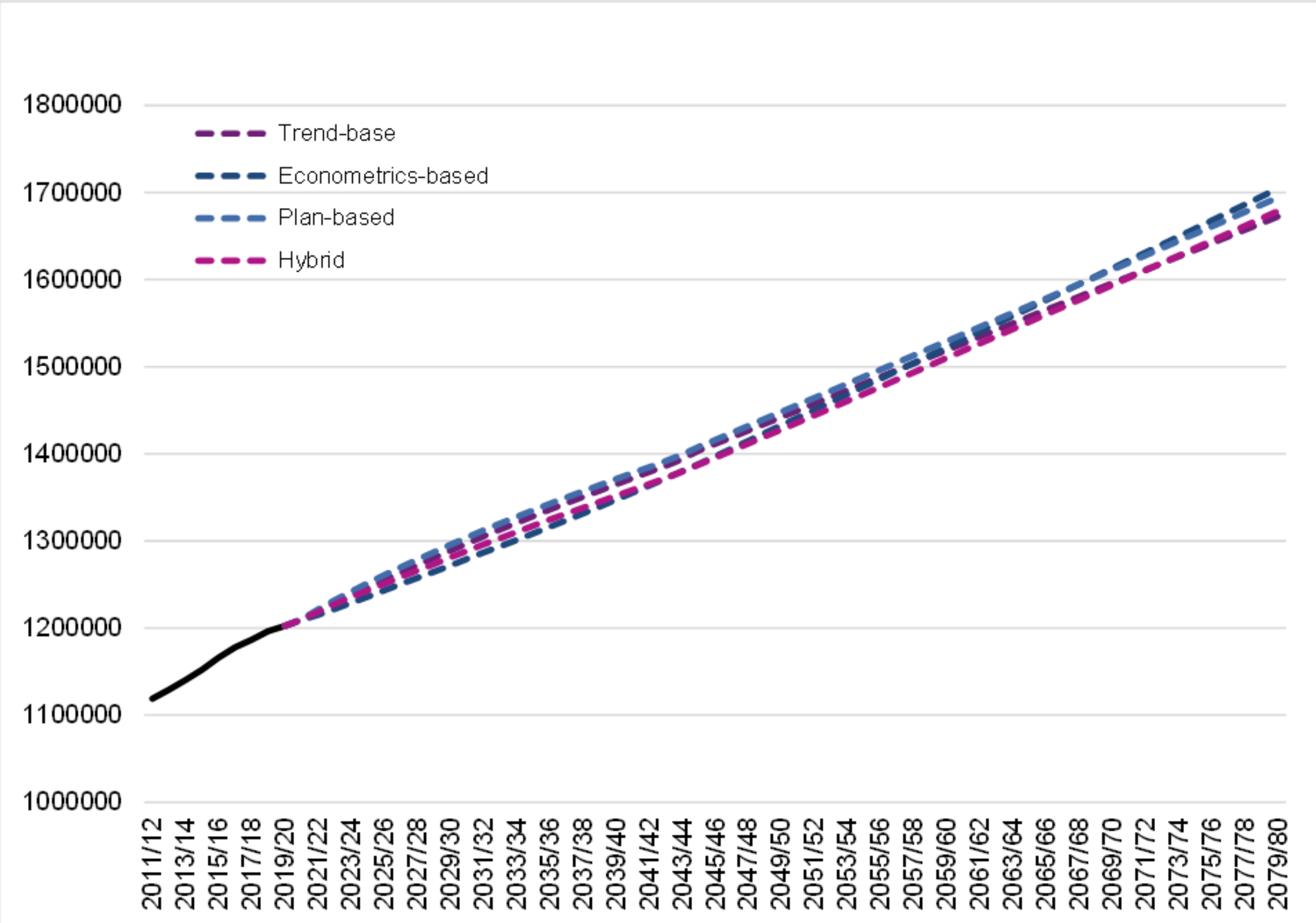
Figure 6-2: Population growth comparison



6.3.3 Household population projections

Household population, shown in **Figure 6-3**, has an increasing trend over the forecast period (2019/20 to 2079/80). Comparing the methods used, the trend-based approach estimates the smallest increase from 1,202,400 to 1,672,500, an increase of 39.1% over the forecasting period. The econometrics-based approach estimates the largest increase of 41.8%. The hybrid-based approach projects household population growth of 39.6% by 2079/80 to 1.68 million. The average annual growth rate for all approaches is 0.65-0.70%.

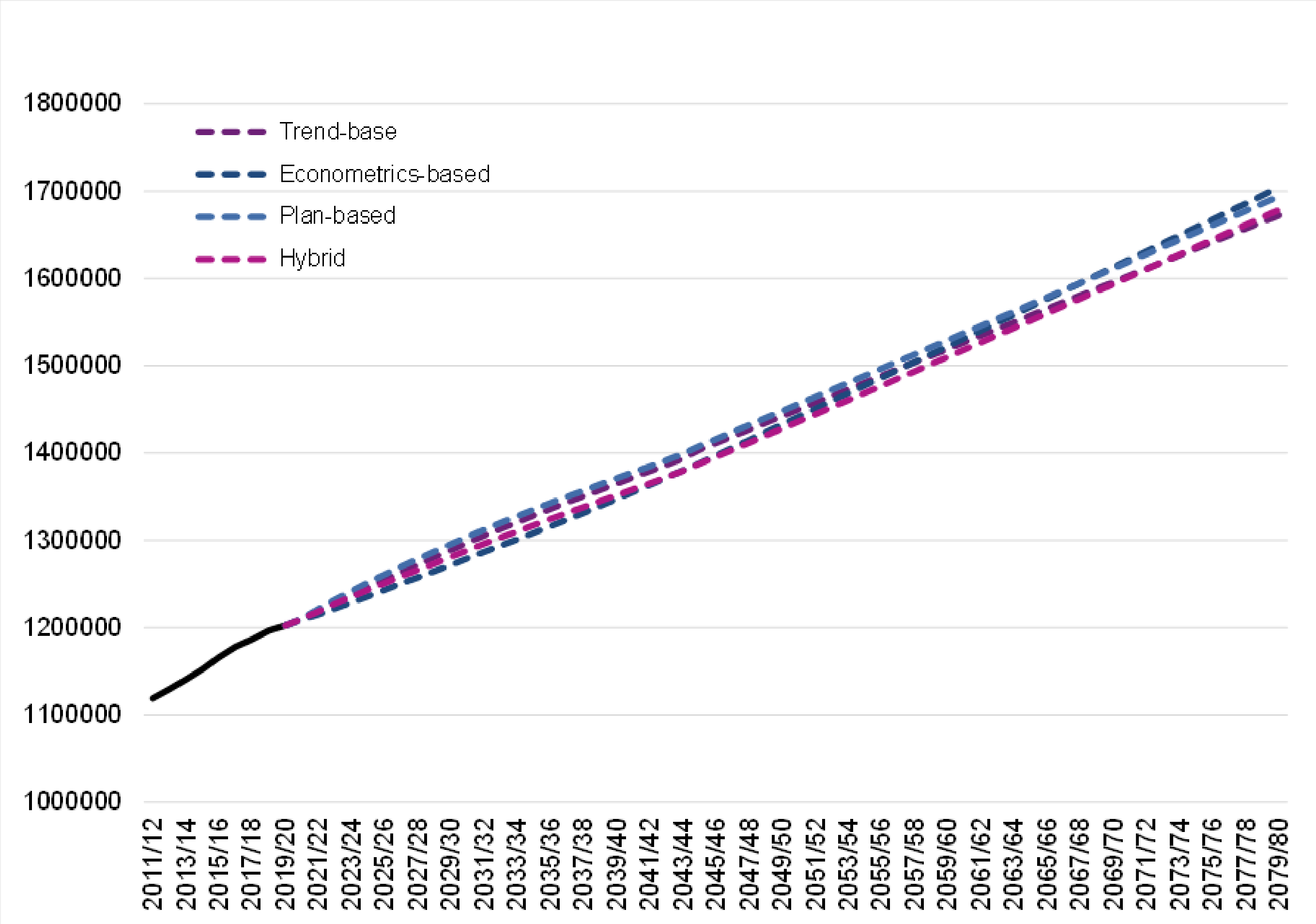
Figure 6-3: Household population growth comparison



6.3.4 Household projections

The number of households, shown in **Figure 6-4**, has an increasing trend over the forecast period (2019/20 to 2079/80). Comparing the methods used, the hybrid approach estimates the smallest increase from 514,200 to 728,300, an increase of 41.6% over the forecasting period. The econometrics-based approach estimates the largest increase of 46.1%. The average annual growth rate for all approaches is 0.69-0.77%.

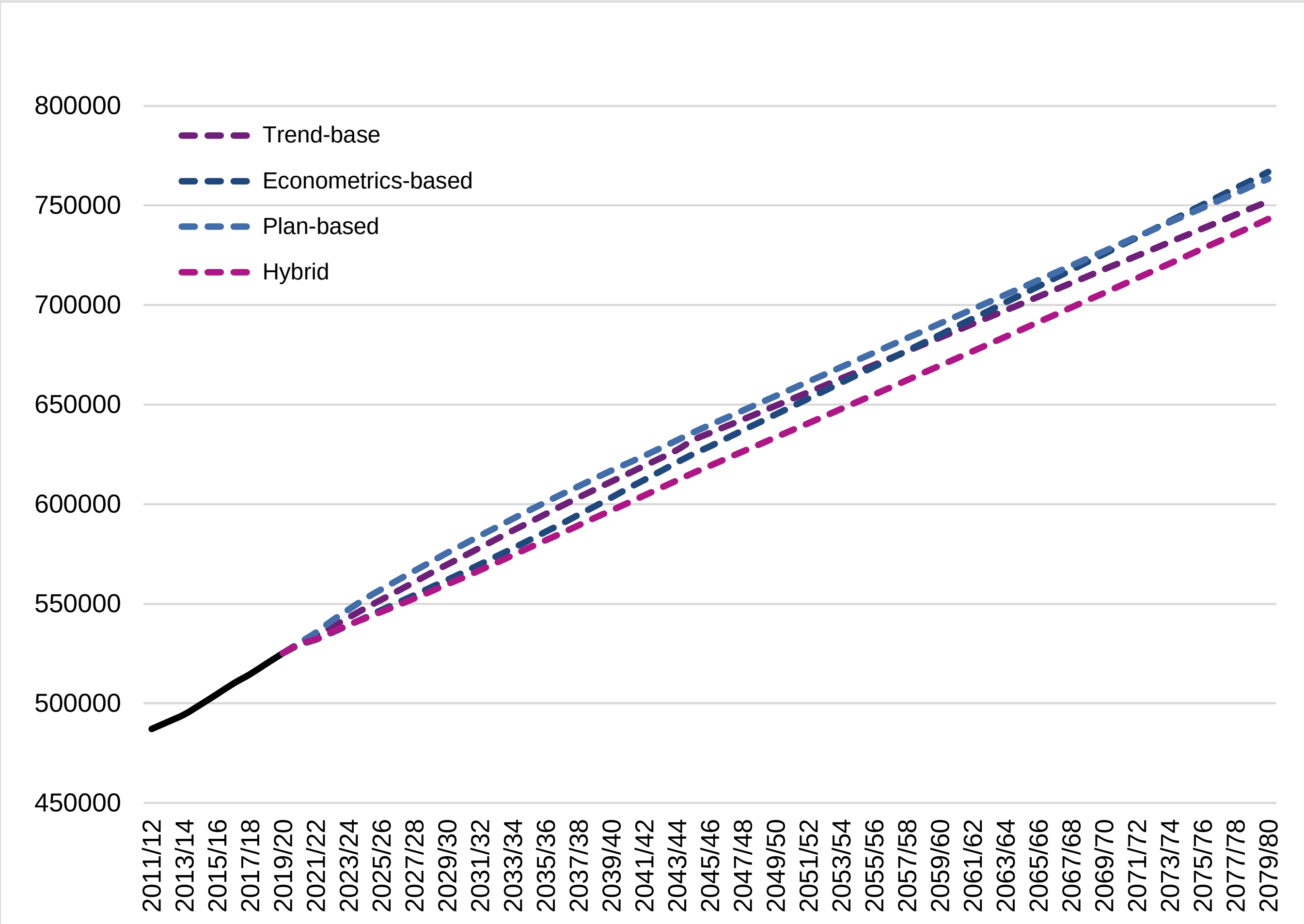
Figure 6-4: Household growth comparison



6.3.5 Property count projections

The total number of houses, shown in **Figure 6-5**, has an increasing trend over the forecast period (2019/20 to 2079/80). Comparing the methods used, the hybrid approach estimates the smallest increase from 525,100 to 743,200, an increase of 41.5% over the forecasting period. The econometrics-based approach estimates the largest increase of 46.0%. The average annual growth rate for all approaches is 0.69-0.77%.

Figure 6-5: Property growth comparison

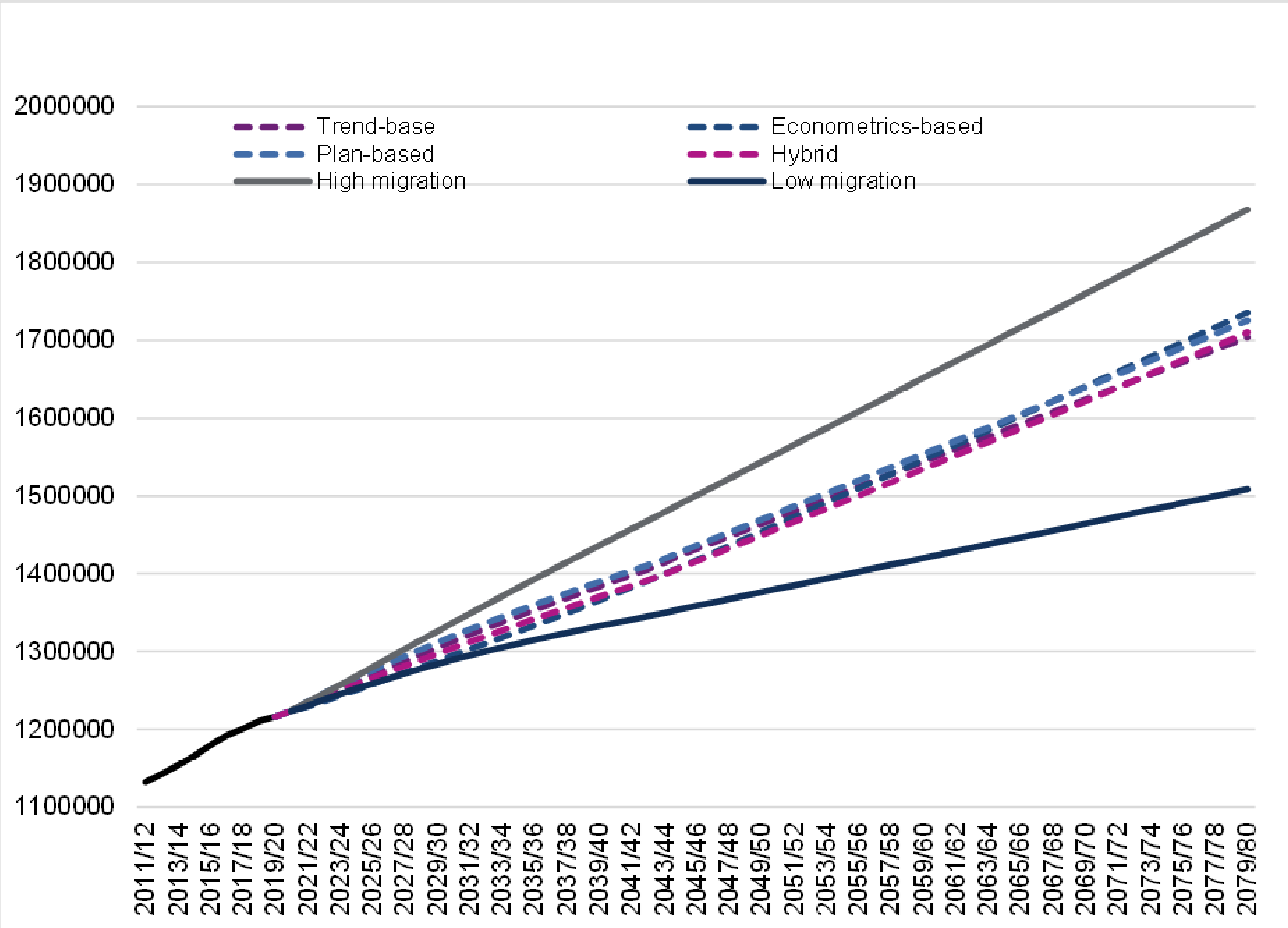


6.3.6 Sensitivity analysis

The four approaches outlined in the earlier sections are primarily based on the 2018-based national and sub-national principal projections produced the ONS. The principal projections are themselves based on a set of long-term assumptions considered to best reflect recent patterns of future fertility, mortality and net migration. The performed sensitivity analysis gives us an indication of the inherent uncertainty of demographic behaviour and show what the potential outcomes could be from different assumptions of future demographic change.

The high and low international migration scenarios were chosen as the uncertainty associated with international migration in the post-Brexit world. The high and low international migration variants assume either higher or lower levels of net international migration to England as a whole, but the proportional distribution at local authority level remains the same.

Figure 6-6: Forecast population range for Bristol Water



6.3.7 Planned-based forecast refresh

In June 2023, we reached out to 10 Local Authorities within our WRZ, requesting updated forecasts for completed dwelling figures. We received responses from 9 of these Local Authorities.

Table 6-6 presents the estimated difference between the dwelling completion forecasts provided by the Local Authorities in 2021 and 2023.

Table 6-6 Difference between 2021 and 2023 new dwelling completed forecast

	2022/23	2023/24	2024/25	2025/26	2026/27
New dwelling completed forecast 2021	6701	5947	6071	5322	5040
New dwelling completed forecast 2023	6144	6451	5907	5735	5939
Difference	-556	504	-164	413	899

Owing to the significant uncertainties in the Local Authorities' forecasts for new dwellings, these predictions cannot solely determine the housing completion forecast, as outlined in the plan-based section. Consequently, we consulted ONS sources that Experian utilised to offer us the plan-based population forecast. The following sources have remained unchanged since the Experian modelling work:
• Subnational population projections for England

- Census Output Area population estimates from mid-2001 to mid-2020
- Household projections for England

Additionally, we incorporated data from the Census 2021. The estimates, taken as of Census Day on 21 March 2021, indicated a population increase of 8,157 person (or 0.66%) for our region. Due to different methodologies for generating Census data and generating population projection, that difference is acceptable.

Given the absence of updated ONS data post-2021 and the uncertainties surrounding the new Local Authorities' projections, we have chosen not to modify our plan-based forecast. We intend to update our plan-based population figures as soon as the latest ONS population and household datasets become available.

6.4 Baseline Household Demand Forecast

6.4.1 Method Selection

The method selection was carried out in accordance with the UKWIR (2016) guidance on selection of appropriate household consumption forecasting methods, and application of these methods[42]. This work was developed as a group project for the WCWRG by consultants Ovarro, and it was agreed that micro-component forecasting was the preferred approach for the development of the regional demand forecasts.

6.5 Micro-component Model Development

6.5.1 Summary of Approach

The development of the household demand forecast comprises of a number of constituent parts:

- The development of a micro-component forecast to determine the likely changes in demand because of appliance efficiency and societal trends.
- The derivation of the base year household demand for the dry year annual average planning scenario.
- The derivation of the impacts of climate change scenarios on household demand.

6.5.2 Data Availability

Bristol Water and WCWRG specific data

The base year selected for the draft WRMP is 2021/22. Base year figures were derived from the Bristol Water WRMP19 Annual Review 2022 and associated regulatory reporting for 2021/22 for:

- Per capita consumption (PCC) for measured and unmeasured properties.
- Property, population and occupancy figures for measured and unmeasured properties.

Additional data were used either to develop the forecast or used for validation of the model including:

- Our WRMP19 demand forecast and WRMP19 micro-component model.
- Base year property and population numbers from the company billing databased.
- Measured household billed volume data.
- Historic reported data from the WRMP Annual Review/Ofwat annual performance reporting process, including distribution input.
- Historic weather data.
- Wessex Water Home Check data collected in 2016-2019 using in-home surveys.
- The Wessex Water GetWaterFit dataset collected in 2020-2021 on a self-reported basis.

[42] UKWIR, 2016, *WRMP19 Methods – Household Consumption Forecasting 15/WR/02/09.*

National datasets

In addition to the company and regional specific data, national datasets were used to increase the understanding of historic, present and future micro-component consumption notably the research documented in the 2018 Energy Saving Trust report on water labelling options that collated previous evidence[43].

Allocating properties and population from growth scenarios

The total household population and property counts are taken from the selected growth scenario delivered by Experian population, households and dwellings projections.

All new households are assumed to be measured. A proportion of previously unmeasured households are assumed to switch annually based upon that observed in recent years. We assumed that 4.5% (annually) of properties switch to be metered. It is assumed that there will always be a small number of properties that cannot be metered. The threshold is set at meter penetration of 95% and, above this, no further properties are assumed to switch to metered billing. It is assumed that the switching households will have the same occupancy as the average occupancy of the unmeasured customer base.

6.5.3 Household Consumption Forecasts

Micro-component forecasting approach

The standard Ownership, Frequency and Volume (OFV) micro-component forecasting approach as previously used by WCWRG member companies and described in Customer Behaviour and Water Use, UKWIR Report ref: 12/CU/02/11 has been applied.

The micro-component modelling is focused on deriving baseline changes in water consumption associated with appliance efficiency and societal trends. A specific occupancy assumption has been used for the Bristol WRZ and the frequency factors adjusted across the model to align the Per Capita Consumption (PCC) with the base year. The results of the micro-component modelling are subsequently adjusted to align with the forecast PCC.

Household consumption

It is assumed that switching to measured status will lead to a 15% reduction in PCC, in line with previous research, regardless of the PCC prior to switching. This amount is subtracted from the unmeasured consumption from the previous year and added to the measured consumption.

An assumption of 125 l/head/d has been made for new builds, based upon the value stated in Building Regulations. If this assumption for a given year is higher than the PCC of the existing measured housing stock, then the PCC of existing measured housing stock is applied to new builds. Occupancy is assumed to be the same as the average for measured properties. The total consumption associated with these properties is added to the measured consumption total.

[43] Energy Saving Trust, 2018. Independent review of the costs and benefits of water labelling options in the UK, Extension Project, Technical Report – Final.

The results of the micro-component analysis are used to calculate proportional annual changes in consumption for unmeasured and measured households associated with appliance efficiency and societal trends that are not linked to any water efficiency activity. This adjustment is applied to the unmeasured and measured consumption from the previous year. A percentage uplift for climate change is applied to the resulting consumption based upon the scenario being applied.

Long-term COVID-19 impacts

The long-term impacts of the COVID-19 pandemic on household consumption, for example as a result of increased homeworking, remain unclear. Additional household consumption related to increased homeworking may be offset by changes in personal washing and clothes washing habits. The future balance between office-based working and homeworking is uncertain although we expect there to be a permanent change from pre-pandemic levels. Except where stated as part of the base year adjustments, no specific assumptions have been made regarding these impacts. We have used 2021/22 as our base year for the WRMP24 assessments. This year best reflects the 'post COVID' demand we have experienced as lockdowns were easing, and people were establishing the 'new normal' in terms of work habits.

6.5.4 Micro-component modelling

Detailed assumptions for the micro-component modelling are discussed in the following sections. These are based upon the following sources of information:

- The WW Home Check (HC) data collected in 2016-2019 using in-home surveys
- The WW GetWaterFit (GWF) dataset collected in 2020-2021 on a self-reported basis
- Published industry research, notably the 2018 Energy Saving Trust (EST) report on water labelling options[7] that collated
previous evidence
- PR19 micro-component analysis carried out on behalf of the WCWRG member companies

Toilet flushing

Ownership

All households are assumed to own at least one toilet. Multiple toilet ownership is not assumed to impact on frequency of use.

Frequency

The recent survey data provided by WCWRG does not contain any new information regarding toilet flushing frequency. The EST report assumes 4.71 flushes per person per day in household consumption modelling and suggests total correct toilet use of 1 large flush per day and 5.2 small flushes per day based upon medical research. The total number of flushes is assumed in the EST report to be an overestimate for households as it will include toilet use in non-households. It should be noted that the EST report was written prior to the increase in homeworking resulting from the COVID-19 pandemic.

Given the limitations of the current evidence, particularly in the context of any changes in home-working practices, a constant value of 5 flushes per day has been used. It is considered reasonable to assume that there is no difference in flushing frequency between measured and unmeasured properties. However, there are potential explanations for differences (e.g., proportion of retired people less likely to use the toilet in a workplace) that mean this assumption may be varied for reconciliation purposes. It is assumed that there will be no change in flushing frequency across the different planning scenarios.

Volume

Since 2001, a maximum flush volume of 6 litres has been mandated by legislation. Between 1993 and 2001, the maximum flush volume was 7.5 litres. Prior to that, flush volumes were higher and could be up to 13 litres in the 1960s. The EST report quotes an assumed toilet lifetime of 15 years.

The HC dataset suggested an average flush volume size of 6.32 litres for unmeasured properties and 6.29 litres for measured properties. This is consistent with the majority of pre-2001 toilets being replaced in the last 20 years.

A 1% p.a. reduction in toilet volumes is assumed in respect of replacing the remaining stock of older toilets and minor incremental improvements in reducing flush volumes and/or promoting the effective use of dual flush toilets.

Personal washing

Ownership

The HC dataset suggests ownership of different types of showers as shown in Table 6-8. For the reasons discussed below, these have been grouped into standard showers and powerful showers.

Table 6-7: Shower ownership by type

	Unmeasured	Measured
Electric	48.5%	38.6%
Gravity	3.7%	5.0%
Standard showers	***52.2%***	***43.6%***
Mains pressure/ combi	38.4%	47.1%
Multijet/ Pumped/ Power	9.3%	9.3%
Powerful showers	***47.8%***	***56.4%***

It is assumed that the following proportions of properties have a bath that is routinely used based upon the HC dataset (baths that are never or rarely used are excluded).

Table 6-8: Bath ownership

	Unmeasured	Measured
Bath ownership (in-use devices)	43.9%	37.0%

Ownership of baths has been assumed to remain constant in the absence of strong evidence to the contrary. The anecdotal historical trend towards an increasing preference for showers over baths is noted, but the Trend Monitor report found that 66% of new bathrooms include a bath. Given that this is a higher proportion than that of baths currently in regular use, it seems reasonable not to include a decreasing ownership trend.

Frequency

The assumed frequency of baths and showers, based upon the HC dataset, is as follows in **Table 6-910.** It is assumed that the frequencies for both baths and showers will remain unchanged in the absence of specific activity to promote water-efficiency.

Table 6-9: Personal washing frequency by type

	Unmeasured	Measured
Showers (per person, per week)	7.0	6.5
Baths (per household, per week; if applicable)	4.2	3.5

It is assumed that the frequencies for both baths and showers will remain unchanged in the absence of specific activity to promote water-efficiency.

Volume

A bath volume of 72.2 litres is used in the EST report. This is consistent with a typical capacity of approximately 180 litres and average filling of slightly less than half-full as suggested by the HC dataset. The HC dataset also indicates slightly less filling in measured households, so volumes of 75 l for unmeasured households and 70 l for measured households have been assumed.

- Bath volumes have assumed to remain constant over time.
- The HC dataset suggests the following typical flow rates for different types of showers:
  - Electric: 6.88 l/min (from 7,535 responses)
  - Gravity: 7.82 l/min (from 816 responses)
  - Mains pressure / combi: 9.46 l/min (from 8,511 responses)
  - Multijet / Pumped / Power: 9.61 l/min (from 1,688 responses)

Whilst there is some evidence that electric showers have a lower flow rate than gravity showers, given the limited proportion of gravity showers in the dataset and relative similarity of flow rates, these have been combined in the analysis as standard showers with an assumed flow rate of 6.97 l/min.

Given the similarity of flow rates from mains pressure/ combi showers and multijet/ pumped/power showers, these have been combined in the analysis as powerful showers with an assumed flow rate of 9.48 l/min. The direction of trend in shower flow rates is difficult to forecast and a material factor in future household consumption. Shower head technology is continuing to improve to develop more aeration and less water use for a similar experience.

Conversely, higher perceived flow by the user is a characteristic of a good shower experience and seen as important in a modern shower. In the absence of strong evidence for either direction, a constant assumption has been used.

A shower duration of 7.43 mins for unmeasured customers and 7.01 mins for measured customers has been assumed based upon the HC dataset; this is consistent with other published research. The resulting shower volumes are relatively consistent with the EST report and UKWIR research using monitored shower data.

Shower durations have been assumed to remain constant in the absence of specific activity to promote water efficiency

Clothes washing

Ownership

Ownership of washing machines is very high and has been estimated at 99.4% based upon the GWF dataset. The HC dataset did not specifically ask about washing machine ownership. Given the already high ownership figures, overall ownership of washing machines is assumed to remain unchanged over time.

Frequency

Washing machine frequencies of 4.3 times per household per week for unmeasured customers and 3.6 times per household per week for measured customers have been assumed based upon the HC dataset.

Volume

Modern washing machines typically have a volume per use in the range 37-56 litres per use as indicated by the Ecodesign standards quoted in the EST report and manufacturer guidance. Previous consumer research indicates an expected lifetime of typically 6-7 years. Therefore, given that the Ecodesign standards were based upon best available technology in 2010, the vast majority of washing machines can be considered 'modern' in this context. An average current volume per use of 56 litres has been used on the basis that more efficient current washing machines will be offset by less efficient older machines. An assumed reduction of 1% p.a. has been applied, resulting in an average volume of use reducing to 50 litres by 2032.

Dishwashing

Ownership

Ownership of dishwashers is estimated at 60.2% for unmeasured properties and 65.7% for measured properties. Households are assumed to do some dishwashing by hand, with the extent of this dependent on whether or not they own a dishwasher. Dishwasher ownership has been significantly increasing in recent decades. It is assumed that trends in increased dishwasher ownership will continue over the forecast period, irrespective of specific water efficiency activity. A 3% p.a. increase is assumed, up to a maximum of 85% ownership on the basis that it may not be feasible to install dishwashers in all properties.

Frequency

The following frequency of dish washing is assumed, based upon the HC and GWF datasets. Frequencies are assumed to remain unchanged in the absence of specific water-efficiency activity.

Table 6-10: Dishwashing frequency

	Unmeasured	Measured
Dishwasher use (per household, per week; if applicable)	4.8	4.4
Hand dishwashing (per household, per week; owning dishwasher)	8.1	8.4
Hand dishwashing (per household, per week; no dishwasher)	15.7	14.6

Volume

Modern dishwashers typically have a volume per use in the range 7-13 litres per use as indicated by the Ecodesign standards quoted in the EST report and manufacturer guidance. Surveys of consumers and manufacturers indicate an expected lifespan of approximately 10 years. An average current volume per use of 13 litres has been used on the basis that more efficient current washing machines will be offset by less efficient older machines. An assumed reduction of 1% p.a. has been applied, resulting in an average volume of use of 12 litres by 2028.

Previous research suggests that manual dishwashing by UK consumers of a full dishwasher load typically uses 49 litres. It is considered reasonable to assume that measured customers would use less. Volume estimates of 45 l and 50 l for measured and unmeasured customers have therefore been used instead for customers without dishwashers.

For customers with dishwashers, it is likely that manual dishwashing is restricted to items that do not clean well in dishwashers, or are fragile, plus some pre-rinsing of items prior to placing them in the dishwasher. A volume estimate of 10 litres (approximately equal to one washing up bowl) has been assumed.

Miscellaneous internal use

For this analysis, miscellaneous internal use (other than plumbing losses) has been assumed at 5 uses per person per day, with an average volume of 3 litres for unmeasured properties and 2 litres for measured properties. This is relatively consistent with previous assumptions made by the WCWRG companies.

Plumbing losses are currently estimated as set out in **Table 6-11**, based upon information provided by each of the WCWRG companies. Miscellaneous internal use has assumed to remain constant in the absence of evidence to the contrary.

Table 6-11: Plumbing losses estimates

Company	Unmeasured estimate (l/prop/day)	Measured estimate (l/prop/day)	Source
Bristol Water	15.4	15.4	Value of 0.64 l/prop/hour provided for leakage analysis

Garden watering

Ownership

The assumptions related to proportions of households using different methods of garden watering are based on the HC dataset and set out in **Table 6-12**.

Table 6-12: Garden watering device ownership

	Unmeasured	Measured
Hosepipe (% properties)	15.2%	11.7%
Pressure washer/ irrigation system (% properties)	0.4%	0.6%
Watering can (% properties)	10.5%	10.5%
Recycled water (% properties)	25.5%	35.6%

Properties using recycled water are assumed not to use significant volumes of clean water for garden watering and are not considered further.

Frequency

The frequencies of use during the summer that have been estimated using the HC dataset are set out in **Table 6-13**. The summer period for regular garden watering is assumed to be 6 months (approximately mid-March to mid-September) and therefore the values are halved in the analysis when calculating annual average demand.

Table 6-13: Garden watering device frequency

	Unmeasured	Measured
Hosepipe (per property, per summer week; where applicable)	4.08	3.66
Pressure washer/ irrigation system (per property, per week; where applicable)	4.80	3.73
Water can (per property, per summer week; where applicable)	3.59	3.54

Volume

The EST analysis quotes values of 11 litres per use and 7179 litres per year for hose attachments. It is assumed that this actually means a flow rate of 11 l/min with an implied 10.8 hour total duration of use throughout the year. A flow rate of 11 l/min has been used in the analysis. The following durations have been assumed, based upon the HC dataset:

Table 6-14: Garden watering device durations

	Unmeasured	Measured
Hosepipe use duration (minutes)	16.6	15.2
Pressure washer/ irrigation system use duration (minutes)	21.3	21.1

The volume of water used by watering cans has been assumed as 10 litres, which equates to one fill of a very large can or multiple fills of smaller cans.

Miscellaneous external use

Miscellaneous outdoor use (in respect of car washing, cleaning garden furniture, etc) of 1 l/head/d has been assumed in addition to the devices calculated on the OFV basis. The GWF and HC datasets contained information on car washing, which indicated associated consumption of < 1 l/head/d. This is considered likely to form the largest component of outdoor use excluding garden watering. Miscellaneous external use has assumed to remain constant in the absence of evidence to the contrary.

6.6 Base Year Calibration

The following normalisation adjustments are required:

- Estimates of Normal Year Annual Average (NYAA) household consumption in the base year, for each WRZ, that take into account:
    - Observed consumption during NYAA weather conditions and any trends
    - Any changes from historical consumption reporting that apply from 2020-21 onwards (e.g., as a result of the Ofwat reporting guidance for leakage published in March 2018)
    - The impact of COVID restrictions on 2020-21 demand meaning that it does not represent a typical consumption year

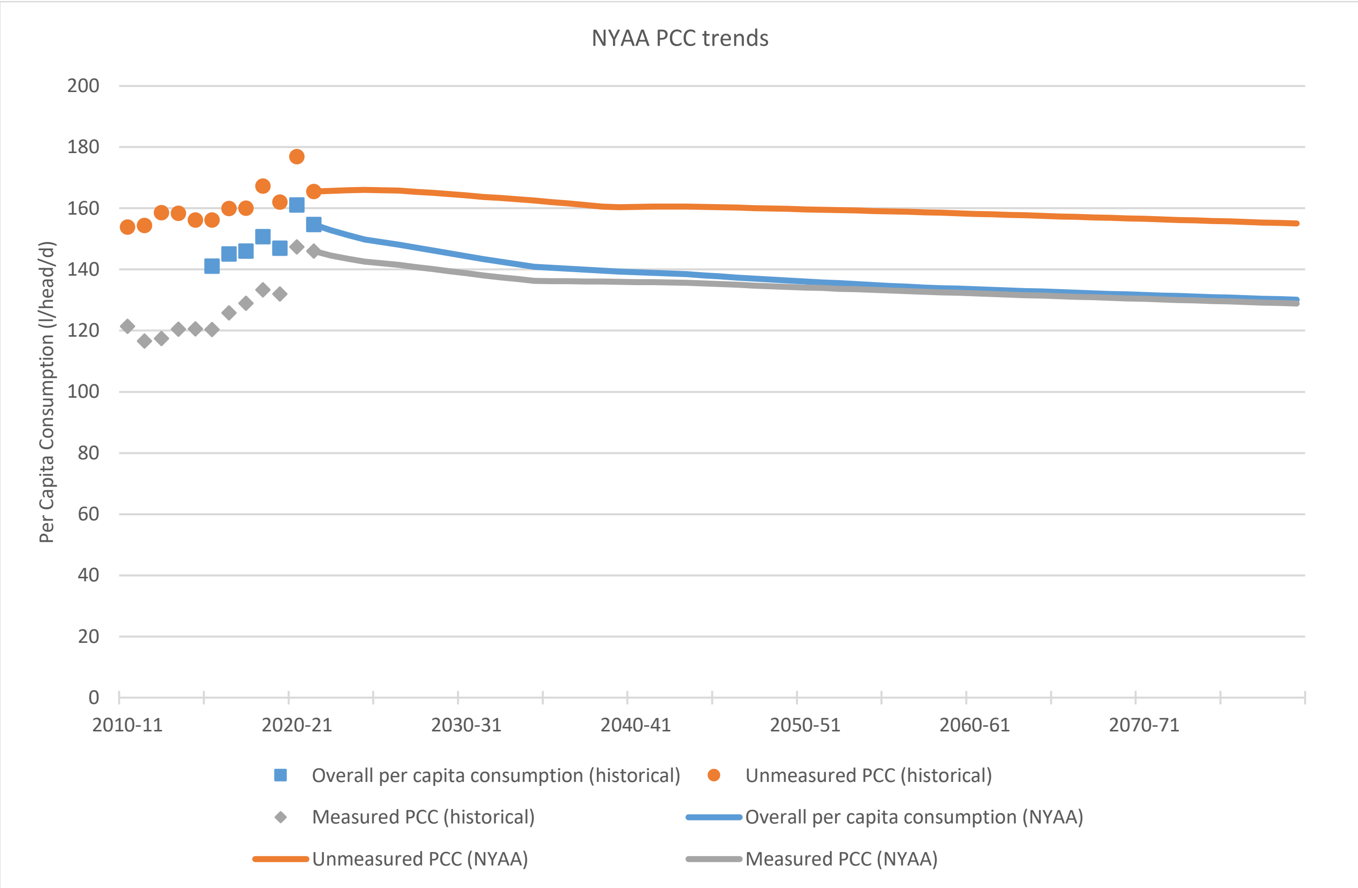
  - Any evidence of long-term impacts of the COVID-19 pandemic on household consumption, in particular as a result of the increase in homeworking
- Estimates of the proportional increases in household consumption during DYAA conditions compared with NYAA conditions, for the WRZ

The base year for the forecast is 2021-22.

6.6.1 NYAA base year consumption (excluding homeworking adjustment)

The historical PCC since 2010-11 and NYAA PCC for the whole planning horizon is shown in **Figure 6-7**. We estimate unmeasured PCC to be 165.46 l/head/d and a measured PCC estimate 146.0 l/head/d for the NYAA base year.

Figure 6-7: NYAA PCC trend

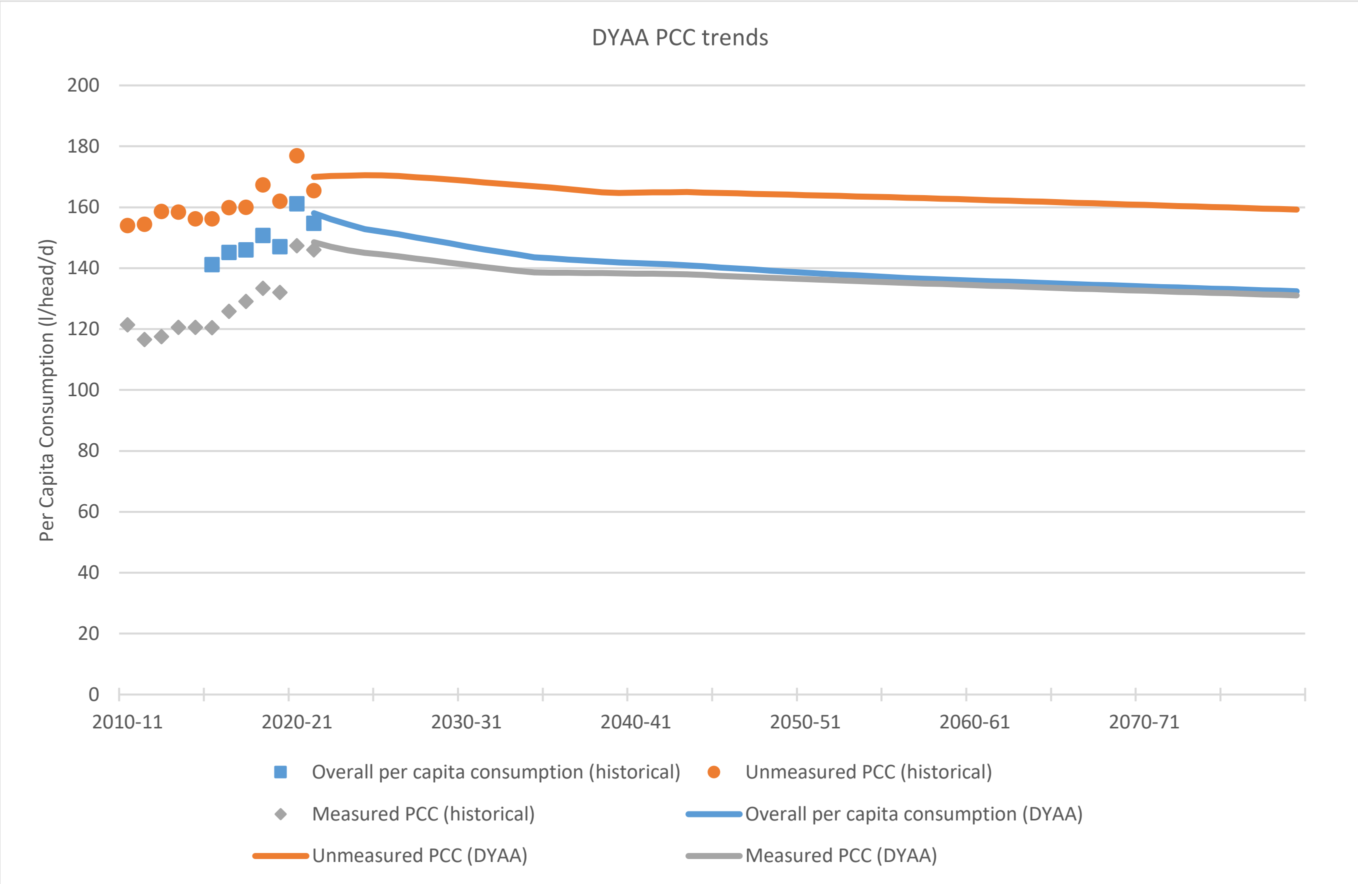


6.7 Defining Dry Year Factor

2018-19 was a warm, dry year in the Bristol region. The DYAA factors have been obtained from the ratio of the observed 2018-19 consumption to the trend forecast for that year. This gives factors of 1.027 for unmeasured households and 1.017 for measured households. The resulting DYAA base year PCC estimates are 169.93 l/head/d for unmeasured households and 148.5 l/head/d for measured households.

The historical PCC since 2010-11 and DYAA PCC for the whole planning horizon is shown in **Figure 6-8.**

Figure 6-8: DYAA PCC trends



6.8 Accounting for the Effect of Climate Change on Demand

Three scenarios regarding climate change have been developed based on the UKWIR research (2013)[44]:

- No impact; No adjustment to consumption is made because of climate change
- Medium impact: Based on the 50th percentile results in the UKWIR analysis
- High impact: Based on the 90th percentile results in the UKWIR analysis.

The UKWIR report provides look-up tables by UKCP09 river basin region. For Bristol Water, a weighted average of the South West England and Severn regions was used, this is consistent with the approach we used in our WRMP19.

The UKWIR report contains two models that forecast the climate change impact on household demand over a 28 year period for the different planning scenarios. The climate change impacts derived over a 28-year period using the average of the two models is set out in **Table 6-15.** The percentage increase is applied linearly and extrapolated to the end of the forecast period.

Table 6-15: Climate change scenario impact

	No climate change impact scenario	Medium climate change impact scenario	High climate change impact scenario
NYAA impact after 28 years	0.00%	0.78%	1.42%
DYAA impact after 28 years	0.00%	0.78%	1.42%

6.9 Total Household Consumption Forecast

The company household consumption for DYAA baseline scenario increases from 186.65 Ml/d in 2021/22 to 195.46 Ml/d by 2049/50 and up to 218.96 Ml/d 2079/80. This is a 4.72% increase between base year and 2050, and a 17.31% increase between base year and 2080. Uncertainty in the household demand forecast is addressed in **Section 10** and incorporated into target headroom allowance.

The increase in company level household demand is largely due to the increase in the number of properties throughout the forecast period (increase by 22% by 2050). PCC declines slightly over the planning period which reflects the increase in meter penetration and the assumed baseline improvement in the efficiency of household devices that use water. The average PCC in 2050 in the baseline forecast is 138.8l/h/d, reducing to 132.4l/h/d by 2080.

6.10 Non-Household Demand Forecast

6.10.1 Overview

The non-household water demand data shows that the consumption has declined over the period from 2012/13 to 2020/21. The water consumption level decreased from 56.5 Ml/d in 2012/13 to 47.7 Ml/d in 2020/21 representing 15.6% fall in water consumption over the 9-year period. Analysis of the historic data

[44] UKWIR, 2013, *Impacts of Climate Change on Water Demand, ref: 13/CL/04/12*

showed large fluctuations in water consumption for some sectors, which could potentially distort the relationships derived from econometric equations. Therefore, to minimise large fluctuation in the data, the water consumption data was combined into six larger sectors: Accommodation, Food Services & Recreation (1), Agriculture (2), Education (3) Non-Services (4), Public Sector and Health (5) and Private Services (6). We acknowledged that the water consumption data between 2011/12 and 2016/17 was of lesser quality and therefore more weight should be given to the more recent data.

6.10.2 Methodology

As part of the WCWRG we appointed Experian to deliver the non-household water demand forecasting model.

To develop the non-household water demand forecasting model, a set of historical water consumption data for non-household customers between 2011/12 – 2020/21 was analysed. The data consisted of water demand by industry for each billing period (financial year).

As it was not possible to foresee the impact of Covid-19, the 2020/21 data is excluded from the analysis, instead the analysis examines the period between 2016/17-2019/20. The WRMP19 forecasts predicted the water consumption would be 1.9% higher in 2019/20 compared to 2016/17, the latest data shows the water consumption is 1.6% lower in the actual out-turn.

The following data sources were used as explanatory variables during the modelling process:

- Experian's forecasts: the macroeconomic and regional level economic forecasts produced by Experian
- Output – Gross Value Added (GVA)
- Employment – Workforce jobs (WFJ) or Full-time equivalent (FTE) employment
- Mid-year population estimates produced by the Office for the National Statistics (ONS)
- Historic rainfall and temperature data from the Meteorological Office.

The UKWIR *Impact of Climate Change on water demand*[45] report found that there was no significant effect found for non-household demand, except for agriculture and horticulture industry in the South East. Nevertheless, Experian carried out regression analysis to establish whether non-household water demand is affected by different weather variables. It could be assumed that for drier or hotter periods more water is needed for the agriculture sector and water consumption levels would increase for the sector. Thus, Experian used the gridded Met Office weather data and assigned it to the relevant areas for Bristol Water. Several variables were selected, which includes the total rainfall, average daily temperature as well as the average monthly summer rainfall and average daily temperature in the summer months. These variables were tested in the final model for agriculture to see if they had any positive impacts on the model fit. Experian concluded that weather related explanatory variables had negligible impacts on water consumption level and so were also excluded from the final agriculture model.

Experian followed an established process of model development. In the first instance, they began by exploring economic theories, available data, and the desired output. Once a model has been designed,

[45] UKWIR, 2013. Impact of Climate Change on water demand. UK Water Industry Research Ltd Report 13/CL/04/12.

candidate equations were estimated. The statistical properties of these equations were assessed. In particular, the following are considered:

- The fit of the equation (including the significance of individual estimated coefficients);
- The signs and magnitude of estimated coefficients;
- The dynamic properties of the equation;
- The suitability of the equation for forecasting or simulation (as may be required).

Experian identified the following variables that could potentially be used as explanatory variables in the non-household water demand econometric model:

Gross Value Added (GVA): GVA and water demand is expected to have a positive relationship. This means when output for a sector increases water consumption, represented as an input, will also increase.

Full-time equivalent employment / Work force Jobs (FTE/WFJ): Employment and water consumption is expected to have a positive relationship. As the number of people employed increases, water, representing indirect use that is consumed by people in the working environment, will also increase. In addition, we can assume that as the number of employees increases, output will rise and represented as an input, so will water consumption.

Weather data: The UKWIR *Impact of Climate Change on water demand* report found that there may be justification to include climate change variables for the Agriculture and Horticulture. However, water consumption in other industries may be affected by weather variables but the evidence is not conclusive at this stage. Experian has nevertheless included weather variables, such as historical temperature and rainfall, to examine the relationship between these variables and water consumption.

Time trends: Some broad sectors showed a decline in non-household water consumption that could not be easily explained through other economic factors. Potential explanations include the impact of increasing water efficiency and the aggregate impact of other factors that are not in themselves statistically significant. The time trend variable is therefore used to assume there is some permanent deterministic pattern across time. For instance, if the coefficient of using the actual year (e.g. 2002 = financial year 2001/02) is positive this means water consumption demand increases overtime.

Experian proposed the following model non-household water demand model specification for each industry. The general model specification used was as follows:

$\log(NHWD_{i_t}) = \alpha + \beta_i(exogenous\_variable_{it}) + \alpha 1 Trend + \alpha 2 Dummy\ variables + \varepsilon$, where:

- NHWD is measured non-household water demand (Ml/d)
- Exogenous variable refers to the economic activity index which provided the best fit to the historical data. This includes:
  - Total output (Gross Value Added (GVA) in 2018 prices)
  - Full-Time equivalent employment (FTE)
  - Workforce Jobs (WFJ)
  - Population

- Trend refers to the time trend
- Dummy term is included to correct for structural break within the dataset
- Log is the natural logarithm of the relevant variable
- Subscript t refers to the time period
- Subscript i refers to the industry sector
- α and β are parameters to be estimated
- ε is a random error term

Water consumption, Gross Value Added (GVA), and employment have been transformed into logarithm form to represent elasticity for an additional unit of input.

In the agricultural model, there was a steep incline in water consumption in 2018/19 so a dummy variable for the financial year was included, whilst a dummy for 2014/15 helped to control for some of the variation in the FTE (Full-Time Equivalent) data. Additionally, data for the non-services and services sector from 2019/20 skewed results, likely because of the national lockdown imposed by the government as a result of Covid-19 pandemic. Therefore, it was decided to remove this year of data when modelling for those two sectors.

Model specifications by industry sector are presented in **Table 6-166**. “Plus sign” indicates that corresponding explanatory variable was used in the sector specific econometric model.

Table 6-16: Model specification by industry sector

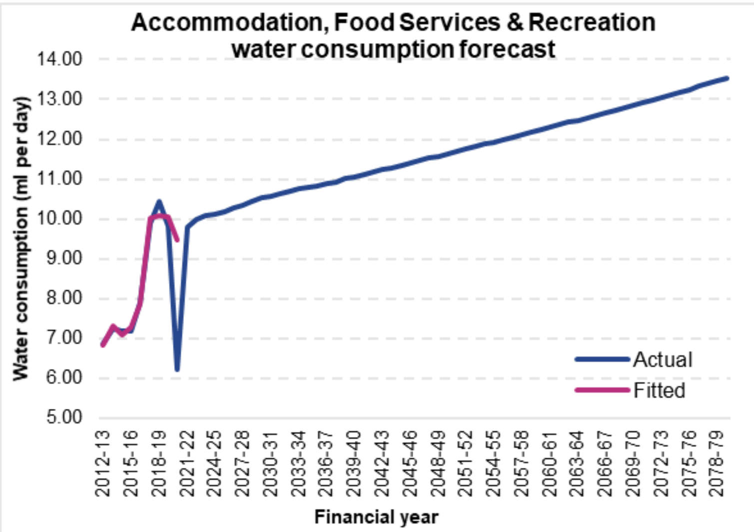
Industry sector	GVA	FTE	WFJ	Trend	Dummy
Accommodation, Food Services & Recreation			+		+
Agriculture	+				+
Education		+			+
Non-Services		+			+
Public sector + Health		+		+	+
Private Services		+			

6.10.3 Non-household Demand Forecast

Accommodation, Food Services and Recreation

The historical data for the accommodation, food services and recreation sector show a strong upward trend for the sector's water consumption demand. However, in 2019/20 and 2020/21 we see a sharp decline in consumption as Covid-19 related restrictions meant that businesses within this sector could not operate. Water consumption is expected to bounce back in 2021/22 as restrictions ease and consumers spend their pent-up demand within this sector. For our forecast, we model that the workforce jobs (WFJ) variable has a positive relationship with consumption, resulting in an expected rise for water demand over the forecast period as shown in **Figure 6-9**. This can be explained through an expansion of old and new businesses operating in the sector to meet the demands of the increasing population and tourism within the UK. Overall, water demand in the accommodation, food services and recreation sector is forecast to increase from 10.45 Ml/d in 2018/19 (pre-pandemic) to 13.52 Ml/d in 2079/80.

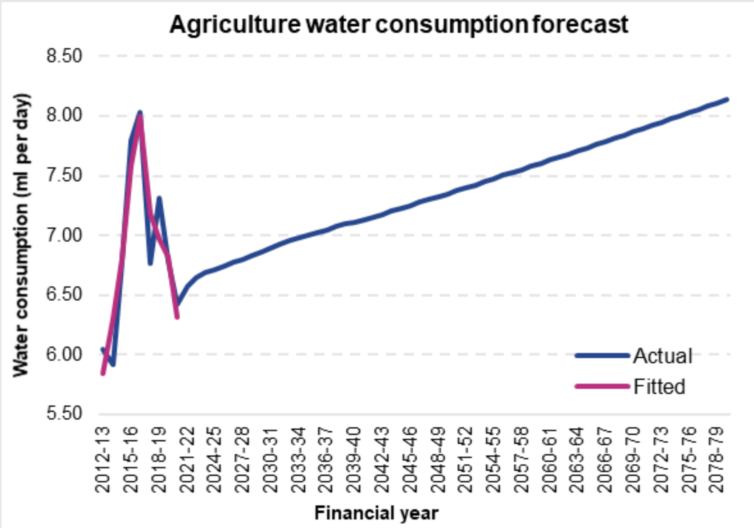
Figure 6-9: Accommodation, food services and recreation water consumption forecast for Bristol Water supply area



Agriculture

The agricultural water consumption data shows that demand has been falling in general since 2016/17. This decline can be attributed to improvements in water efficiencies rather than a decline in output. Following a sharp decline in consumption in 2020/21, which was induced by the Covid-19 pandemic, agriculture water demand is expected to recover at a steady pace over the forecast period as the whole economy recovers. The upward trend is supported by the GVA data, which shows a generally increasing trend for agricultural activity. Overall, agriculture water demand is forecast to increase from 7.31 Ml/d in 2018/19 (pre-pandemic) to 8.14 Ml/d in 2079/80.

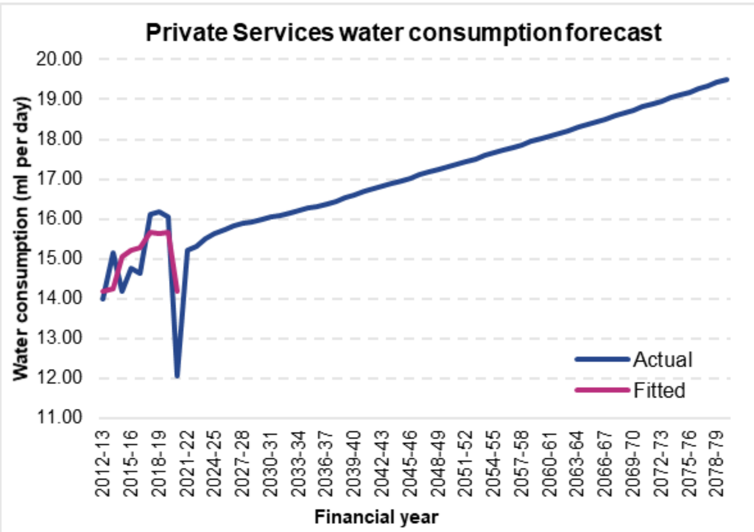
Figure 6-10 Agriculture water consumption forecast for Bristol Water supply area



Private Services

For the private services industry, the historic data shows an upward trend in the sector's water demand. Consumption and the full-time equivalent employment (FTE) variable have a positive relationship, resulting in an expected rise for water demand. The private sector was hit hard during the Covid-19 pandemic, which reflects the sharp decline in water consumption by 25% in 2020/21 as the restrictions put in place meant that most businesses had to close. As the economy recovers from the impacts of the pandemic, as businesses reopen and consumers spend their pent-up demand, water demand is expected to bounce back to levels seen pre-pandemic in 2021/22. Thereafter, we expect a steady increasing trend as shown in **Figure 6-11**. Overall, water demand in the private services industry is forecast to increase from 16.17 Ml/d in 2018/19 (pre-pandemic) to 19.50 Ml/d in 2079/80.

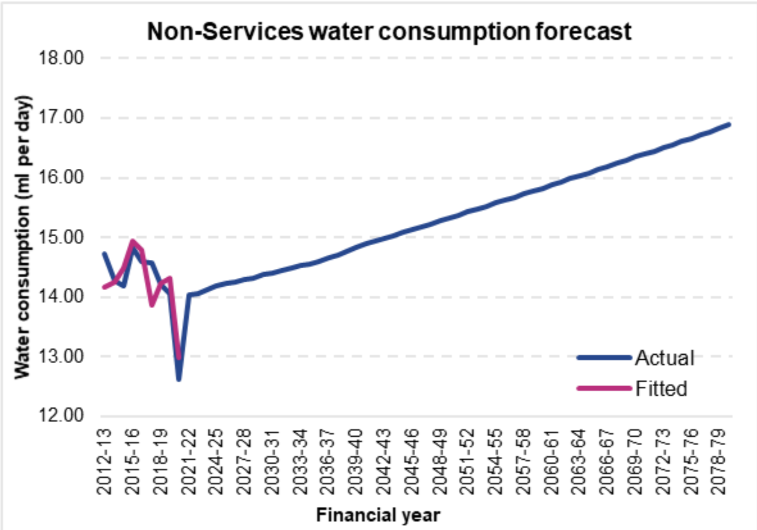
Figure 6-11: Private Services water consumption forecast for Bristol Water supply area



Non-Services

The pattern of water consumption in the non-services industry is more varied, as the historical data shows a decreasing trend except for 2015/16, which saw an increase in consumption, and during the pandemic, the industry witnessed a large drop. However, full-time equivalent employment (FTE) has a larger impact on water consumption than the trend and therefore, consumption is expected to bounce back quickly in 2021/22, as the economy recovers from the pandemic and jobs are restored. This follows an upward trend, with water demand in the non-services industry forecasted to increase from 14.21 Ml/d in 2018/19 (pre-pandemic) to 16.88 Ml/d in 2079/80.

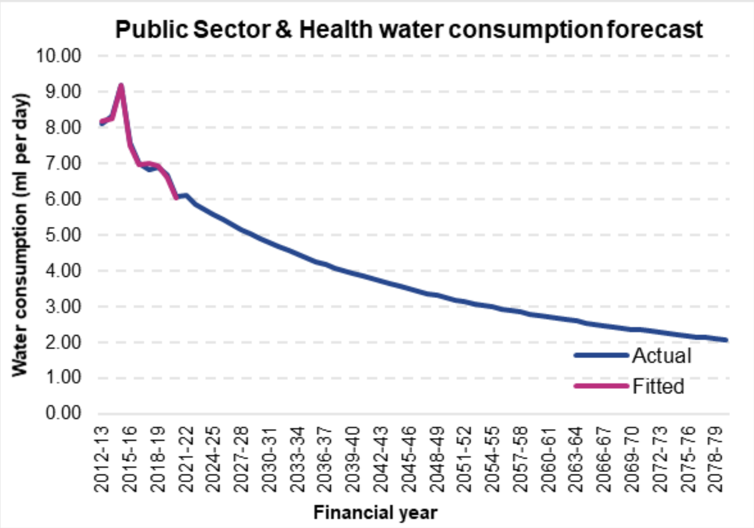
Figure 6-12: Non-Services water consumption forecast for Bristol Water supply area



Public Sector and Health

The historical data for the public sector and health industry shows that water consumption has been falling since 2014/15. This decline can be attributed to improvements in water efficiencies rather than a decline in output. Although full-time equivalent employment (FTE) shows a positive relationship with water consumption, the trend has more of an impact on the model, resulting in an expected decline for water demand over the forecast period, as can be seen in **Figure 6-13**. Overall, water demand in the public sector and health industry is forecast to fall from 6.91 Ml/d in 2018/19 (pre-pandemic) to 2.08 Ml/d in 2079/80.

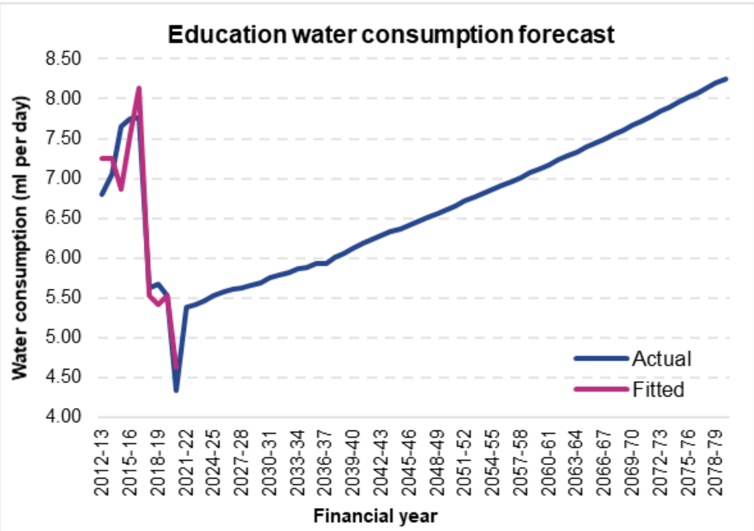
Figure 6-13: Public sector and health water consumption forecast for Bristol Water supply area



Education

In general, the historical data for water consumption in the education sector shows an increasing trend, with the exception of a large decline in 2017/18 and 2020/21. Consumption and the full-time equivalent employment (FTE) variable have a positive relationship, resulting in an expected rise for water demand over the forecast period, which is shown in **Figure 6-14**. This can be explained through the demands of the increasing population and international students demanding education in the UK. Overall, water demand in the education sector is forecast to increase from 5.67 Ml/d in 2018/19 (pre-pandemic) to 8.26 Ml/d in 2079/80.

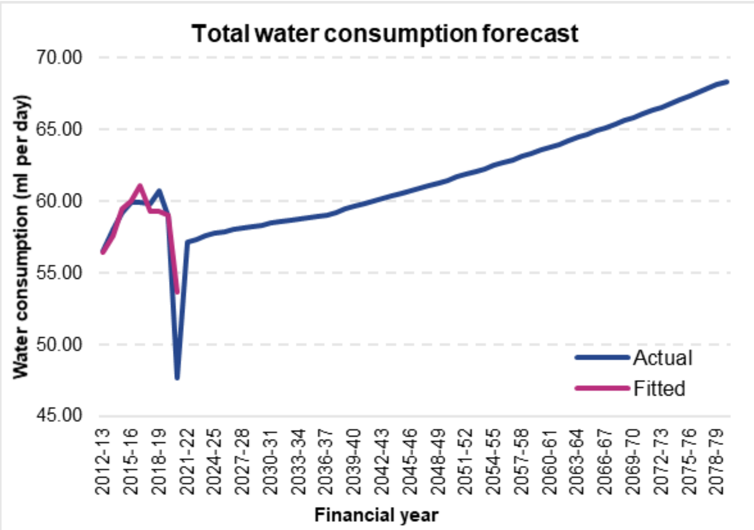
Figure 6-14: Education water consumption forecast for Bristol Water supply area



All industries

By combining the forecasts for all the industries, total water consumption is forecast to increase, following the trajectory of all industries except for the public sector and health industry. Overall, total water demand by summing up all industries is forecast to increase from 60.71 Ml/d in 2018/19 (pre-pandemic) to 68.37 Ml/d in 2079/80.

Figure 6-15 Total water consumption forecast for Bristol Water supply area



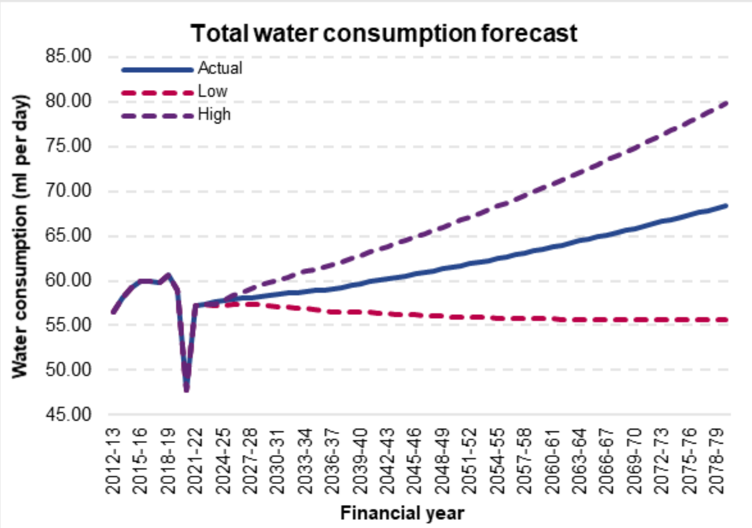
High and low scenarios

The non-household demand forecasts are likely to be influenced by changes in the future economic environment. To capture uncertainty in the economic climate, we ran alternative scenarios to determine the impact that different economic outcomes would have on non-household water demand. Two alternative scenarios have been produced – one high growth (+0.3% GDP growth per annum relative to the central case) and one low growth (-0.3% GDP growth per annum relative to the central scenario).

The high and low GDP growth range was set based on an analysis of historical GDP growth rates in the UK over extended periods. This suggested that the +/-0.3% a year range covers the vast majority of 30-year periods for which we have GDP data (the data is available on a consistent basis from 1948 so we can look at 30-year periods ending from 1978 onwards).

The small difference in annual growth rates does accrue to large differences in output levels at the end of the forecast period. A persistent 0.3% annual growth rate difference accumulates to around a 10% difference in the level of GDP after 30 years – equivalent to more than 20% between the high and low cases. For the 30-year periods for which we have data (33 periods on a rolling basis), around just 5% of these have average annual growth rates that are outside the range of +/-0.3% of the average long-run growth rate for the overall period. Therefore, the +/-0.3% range is a good approximation to a 95% confidence interval for long-run growth rates.

Figure 6-16 Total water consumption forecast for Bristol Water supply area under high and low scenarios



6.11 Dry Year Annual Average Baseline Demand Forecast

Taking account of the above forecast changes in household and non-household consumption, along with our baseline leakage assumptions (see **Section 7** for more details), baseline water efficiency policy (see **Section 7** for more details) and our estimated changes to water operational use and water taken unbilled (**Table 6-177**), we forecast that the total DYAA baseline demand (or DYAA Distribution Input) will rise gradually across the planning period from 279.54Ml/d in 2021/22 to 288.93 Ml/d in 2049/50 and up to 319.36 Ml/d by 2079/80 (Table 6-16).

Base year operational water use and water taken unbilled was calculated based on a mix of operational records and licensed standpipe use plus estimates of water used for mains flushing and other operational activities, as reported in our WRMP19 Annual Review submission in June 2022. We assume a constant consumption over the planning period for these components of the baseline demand forecast (**Table 6-177**).

The base year demand components value and total distribution input were reviewed as part of our WRMP19 Annual Review June 2022 submission according to the water balance reconciliation approach.

The total leakage profile is divided between distribution losses from our water supply system and leakage from customer supply pipes. The measured and unmeasured demand forecast for water consumption presented in the WRP Tables includes leakage from customer supply pipes except for leakage arising from empty (void) properties. This shows that around 28% of total leakage occurs from customer supply pipes, with the remainder from our distribution system.

In April 2023, the Government confirmed that Bristol Water may accelerate the scheme for customer supply pipe replacements in the Bristol area, reducing leakage by 0.25Ml/d by 2025.

The baseline leakage assumption used in the demand forecast is for leakage to remain static and be held at the end of AMP7 target level of 31.85 Ml/d throughout the planning period. This is consistent with the requirements set out in the WRPG.

Table 6-17: Baseline Dry Year Annual Average (DYAA) Demand Forecast (Ml/d)

Demand Components	2021/22 Base year	2025/26 AMP8	2029/30 AMP9	2034/35 AMP10	2039/40 AMP11	2044/45 AMP12	2049/50 AMP13	2079/80
Water delivered measured non-household	57.64	58.38	58.83	59.35	60.12	61.03	61.96	68.84
Water delivered unmeasured non-household	0.38	0.39	0.39	0.40	0.40	0.41	0.41	0.46
Water delivered measured household	98.67	125.52	137.12	148.35	160.00	169.88	178.20	208.05
Water delivered unmeasured household	93.43	64.21	53.12	41.87	33.10	26.65	21.54	15.20
Water taken unbilled	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Operational water use	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
Supply pipe leakage from void properties*	0.28	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Distribution losses	25.51	22.95	22.95	22.95	22.95	22.95	22.95	22.95
Total DYAA Distribution Input (Ml/d)**	279.54	275.32	276.28	276.77	280.44	284.78	288.93	319.36

*Note: customer supply pipe leakage from measured and unmeasured properties is included in the water delivered values.

**Note: Total Distribution Input value may not equal the sum of components at 2 decimal places due to rounding.

7 Baseline metering, leakage control and water efficiency

7.1 Overview

Metering is widely regarded as the fairest way to pay for water. Customers on a water meter have a lower use of water due to the increased understanding of water consumption. There is a demand management benefit as a result and an improvement in understanding of customer side leakage. However, the Bristol Water area is not water-stressed and compulsory metering is not an option currently available to us. On this basis, we have not proposed in this plan a baseline change from our existing policy of metering all new domestic properties; promoting voluntary take-up of water metering by unmetered household customers; and change-of-occupier metering for household properties.

Nevertheless, active promotion and implementation of our existing metering policy will continue, in order to increase meter penetration rates to 75% by the end of 2024/25 and progressively increased to over 90% (average) by 2044/45. The process of regional water resource planning has given us a clear insight into the need to help customers drive down their water consumption, and we will work towards our long-term aspiration of an average per capita consumption of 110 litres/person/day by 2050.

We will also work towards the environmental improvement interim target of 122 l/h/d by 2037/38. The impact of COVID-19 on per capita consumption - and the societal changes that have occurred as a result of increased home working - have however led us to take a cautious approach when making our baseline predictions of water consumption, as we do not wish to produce a WRMP24 that could be less than fully resilient to an uncertain future. We forecast that average per capita consumption will reduce from 152.8 to 138.8 litres/person/day between 2024/25 and 2049/50 under our baseline planning scenario (i.e., with limited intervention other than baseline activity). This leaves a 28.8 litre/head/day gap to our 110 litre/head/day policy driven target for 2050.

Closing this gap will require collaborative working with other water companies and local authorities as well as action by government over the coming years to:

- Influence customer consumption behaviour to become more water efficient
- Modify government policy to better support water efficiency actions, such as mandatory water labelling, more water efficiency standards for water using appliances and enhanced water efficiency requirements for new homes
- Incentivise manufacturers and innovators to reduce water consumption rates for household and commercial water using appliances.

A significant area of water efficiency, where reductions in demand can be made without compromising customers' lifestyles or livelihoods, is in helping people to change their water using behaviour. This remains a less well understood area of activity but is also an area of increased interest to customers as a result of the growing cost of living crisis, so we are working in partnership with other utility organisations, partner water companies in the West Country Water Resources Group (WCWRG) and academic partners, to help identify the most effective cost-saving, water-saving, energy-saving and carbon-saving approaches we can take.

7.2 Baseline Metering Policy and Demand Savings

Metering is widely regarded as the fairest way to pay for water. Customers on a metered tariff generally pay less than those on an unmetered tariff and have a financial incentive to make efficient use of water in their homes and businesses. Meter installation can, however, be relatively expensive especially when not undertaken universally across a geographical area. There are also ongoing costs in relation to reading and maintaining the meters. Our current policy is to offer free meter installation for customers who request a meter and to install a meter upon change of occupancy of an unmeasured property.

We promote our free optional metering via our company website and carry out metering on change of occupier of properties. The level of household meter penetration in our supply area is currently at 61% (2021/22 average). With continuation of our baseline policy to promote free meter optants, meter all households on change of occupier and meter all new properties, our baseline demand forecast takes account of the metering policy demand savings for each metered customer segment (as explained earlier in **Section 6**).

7.2.1 What our customers think about metering and cost-effectiveness considerations

Our customers have mixed views on metering, some customers are strongly in favour of metering and others are concerned about the effects on those already struggling with bills.

This view matches the findings of our PR19 valuation research which shows that, on average, customers do not value the roll-out of meters compared to other service areas. We have found that customers in our three highest income segments (Safely Affluent, Comfortable Families and Thirsty Empty Nesters) are more likely to prioritise water meters as a means of reducing demand, while those in the three lower income segments (Social Renters, Mature and Measured, and Young Urban Renters) are more likely to say that metering is a low priority.

When we ask our customers more about their views, they confirm that the potential for increased bills to those less able to manage them is the key concern for those opposed to meter rollout. Our 2022 focus groups with vulnerable customers, those struggling with bill affordability and future customers shows that the potential for higher bills, and the idea of feeling restricted in the use of water is a significant concern in the context of the cost-of-living crisis, where a significant number of customers might feel unable to cope with another rising bill. Real life experience amongst the groups varied. Some saw their bill rise significantly, while others were able to monitor and reduce their water use – leading to savings on their bill. They said that Bristol Water should be doing more to educate customers on the benefits of water meters and incentivise them to have them installed voluntarily: one key factor in successful implementation of metering will be for us to install smart meters even where they are not used for billing, in order to promote the benefits of metering to customers and to obtain the information we need to identify customer-side leakage and help customers reduce their water use.

7.3 Baseline Leakage Policy and Demand Savings

Managing leakage is one of our most important responsibilities and our low level of leakage is industry leading.

Total leakage is the sum of losses from our distribution mains, service reservoirs, trunk mains and from customer supply pipes. Our baseline total leakage policy assumed in the baseline dry year annual average demand forecast (presented in **Section 6**) comprises the continuation of our active leakage detection and control activities, district metering and leakage data analysis to identify underground leaks, maintaining our pressure management activities, providing a free LeakLine number for the public to report leaks to us, and our Leakstop initiative to provide a subsidised supply pipe leak repair service to our domestic homeowner customers to address customer supply-pipe leakage (see **Section 7.3.1**). The baseline leakage policy also assumes the continuation of our water mains capital maintenance programme necessary to manage the 'natural rate of rise' of leakage (associated with deterioration of the water mains network and customer supply pipes.

In recent years, focus has been placed on the importance of developing leakage targets that consider a wider range of environmental and social costs and benefits of leakage related activity, and not just the direct financial costs and benefits. Aspirational target levels of leakage have been set by public interest commitments (PIC) to 2030 and National Infrastructure Commissions (NIC) 50% reduction challenge to 2050. These targets move beyond what can be described as the 'sustainable economic level of leakage' (SELL) and drive total leakage to near background levels of leakage. There are also the environmental improvement leakage reduction targets; 20% by 2026/27, 30% by 2031/32, and 37% by 2037/38 from 2017/18 leakage levels.

We have steadily reduced our total leakage over the last decade, regularly delivering leakage performance at the forefront of the industry ahead of the 50% NIC reduction curve to 2050. The recently published Water UK "A Leakage Routemap to 2050" showed that we are at the frontier of leakage performance in England and Wales and the only company to have already delivered the 2030 leakage reduction target. Our baseline total leakage forecast for assessment of our baseline supply-demand balance assumes we will meet our target for total leakage of 31.85 Ml/d by 2024/25 and maintain this level through the planning period and meet the 50% reduction target by 2050.

We commissioned RPS to help assessing future leakage reduction options and assist in developing an intelligent pathway for delivery of the remaining reduction requirements. We consider that this strategy provides long-term value for our customers and the best possible balance of leakage management, resilience and customer bills taking account of current technology and innovation trends in leakage control.

We will continue to review this position over the AMP8 period as and when further innovation and technology changes materialise that may alter the cost-benefit assessment.

7.3.1 Baseline Leakage Control Strategy

As a frontier leakage company, we are already below the national average needed to achieve the PIC by 2030. This low level of leakage has inherent engineering and operational difficulties that we need to overcome. We will continue to work with our supply chain partners, academia and other water companies, through the Ofwat Innovation Fund, UKWIR and club projects, to develop new and innovative methods to prevent, find and fix leaks in the most cost effect manner.

We operate an active leakage control (ALC) strategy across the entire distribution network. The predominant leakage control method used is based on continuously monitored district metered areas (DMA). For this method, flow is monitored at DMA level. If such a DMA shows an unexpectedly high night flow then the area is temporarily divided into smaller districts and night flow at this level is monitored. This, together with leakage detection techniques such as sounding or use of leak noise correlators, helps to locate individual leaks and bursts. As we approach even lower levels of leakage and near what may be considered background leakage, innovative approaches need to be considered such as the widespread adoption of lift and shift noise correlators to help locate individual leaks and bursts. Concentrated ALC effort in problem areas needs to be considered to further drive leakage down.

Continuously monitored district metering and combined metering covers 98% of all properties. The remaining properties are covered by a policy of annual sounding. Pressure management schemes which reduce leakage use specialised pressure reducing valve installations cover over 60% of all properties across our water distribution network, further coverage will be required to help drive leakage down. The visibility and use of this data alongside the adoption of noise correlators permanently installed in the distribution network will further assist in the detection of leaks and bursts and progress the network towards a smarter network.

Leakage at service reservoirs is monitored by means of a standard volumetric drop test performed on all service reservoirs as part of the routine structural inspection programme. This is based on a rolling cycle of inspections every 10 years. Additional tests are undertaken if unusual losses are detected.

All Trunk Mains are inspected for leakage through a programme of route tracing with sounding on valves and fittings. For sixty trunk main systems a water balance is calculated through logging of all inlets and outlets. The balance is used to highlight any large meter errors or inaccuracies within the balance. The balance is resolved to within +/- 5%, after which the balance is deemed stable. Forty-four of the sixty trunk main systems are now within tolerance, with the other sixteen being dealt with at present to improve metering accuracy.

These leakage control methods locate both Company and customer leakage. Leaks identified as being the responsibility of the customer to repair. Domestic homeowners receive a free leakage detection and contribution to the first repair under the Leak-stop programme, with additional support provided to vulnerable customers. By providing this assistance to domestic home owner a reduction in the running time of identified leaks will be enabled.

To help maintain the lower levels of leakage achieved through AMP7 activities and overcome the Natural Rate of Rise in leakage (NRR) of an aging asset base, leakage driven asset renewals need to be undertaken with consideration of full renewal of mains pipes and connecting communication pipes and customer supply pipes within target areas.

7.3.2 What our customers think about leakage

Leakage is consistently ranked in the top five customer priorities. Our 2021-22 Customer Survey Report found that 100% of respondents thought that repairing leaks as quickly as possible was very or quite important, putting it in third place overall against other priority areas. 98% found Bristol Water to be performing well or very well in this area, placing it at number one overall.

This is up from our 2020 Customer Survey, which placed repairing leaks as quickly as possible in fifth place for importance and fifth place for performance overall. Repairing leaks as quickly as possible was the third highest priority area for our 2021 Youth Board (our innovative engagement project with future customers), with 76% classing it as very important. By the end of the workshops however, the Youth Board prioritised resilience and future planning higher.

The WCWRG 2022 Quantitative Customer Research programme undertaken by Eftec consulting to inform our regional plan shows that household respondents have a clear preference for the 50% reduction in leakage target to be achieved by 2050. Business customers, however, do not favour enhanced efforts for reducing leakage over continuing levels of repair and maintenance.

Through the 2022 Customer Forum, respondents ranked 'Cutting leakage further' as the second most important theme in Bristol Water's strategy. Our 2022 focus groups with vulnerable customers, those struggling with bill affordability and future customers, found that resilience and leakage together is a high priority area, but customers said this relates to it being a core area of responsibility for Bristol Water and not because of poor performance.

7.4 Baseline Water Efficiency Policy and Demand Savings

7.4.1 What our customers think about water efficiency activity

Customers would like to see us reduce waste through leakage reduction and water efficiency measures before developing new supply options.

We recognise we need to help our customers to value water and use it wisely. If customers can improve their water efficiency, this not only helps to reduce water demand (and therefore the impact on the environment) but can also help them to save money on their water bill.

Our household customers have indicated a strong preference for support on water efficiency and we understand that customers primarily look to us for advice and assistance to help achieve these savings. Our plan looks to meet these needs with sound, achievable ideas combined with useful and easy to install equipment whilst broadening our engagement strategy through an increased focus on education underpinned by further research and partnership projects.

7.4.2 Our Baseline Water Efficiency Policy and Activities

Societal changes resulting from the COVID-19 pandemic, have caused a switch in water usage from the workplace to the home. Whilst the trend was most pronounced during periods of lock down, we continue to see the ongoing impact of a sustained shift to home and hybrid working. This is reflected in measured per capita consumption, which is based on water usage in the home and not in places of work. Whilst per capita consumption has increased, there has not been a material change in overall demand for water.

Based on this change in the way that water use is accounted for, it is unrealistic for Water Resource Management Planning purposes that we will be able to achieve our PCC target of 139.5 l/h/d by the end of AMP7. We have instead made an end of AMP7 assumption that PCC remains at the higher level of 152.8 l/h/d (2024/25). We recognise that our PCC figure in the latest Annual Return 2023 was lower than this, however, we are choosing to take a precautionary approach, to our plan. No-one predicted Covid-19 nor the impacts on household water use. It is better for our customers and our environment to assume that our PCC is a little higher.

Our baseline water efficiency policy is as follows:

- Optant and change of occupancy metering
- Promoting the benefits of metering
- Providing water efficiency education and advice
- Providing free water-saving equipment on request

In response to these baseline activities, we forecast that average per capita consumption will reduce from 152.8 to 142.2l/h/d in 2038/39 to 138.8 litres/head/day by 2050. This leaves a 20.2l/h/d gap before 2038 to the policy target of 122 l/h/d and a 28.8 l/h/d gap before 2050 to the policy target of 110 litre/head/day to address through our demand management plans. Plans to close this gap are covered in section 15. Below we describe our current strategy within AMP7.

Our AMP7 strategy

Throughout AMP7 we have provided water efficiency support and advice to our customers via our website; through engagement at public events; promotion through paper billing; and articles in other literature such as our customer magazine “WaterTalk”, which is issued to every household in the area we supply. We have also worked with schools to promote the value of water to school children, such as through our classroom education material and water but campaigns.

Through this range of approaches, our customers are provided with information on how to access free water saving devices for use within the home, obtain bespoke information on the financial savings that can be made by being more water efficient, and get access to subsidised water-saving garden equipment such as water butts and hand-pumped pressure washers. Our baseline water efficiency policy will build and improve on this on work, striving to meet our customers’ needs and expectations for both for metered and unmetered customers whilst offering the advice, education and means to help them lower their water usage without diminishing the overall value of the water service and utility they receive

Further details on each of these areas are set out overleaf.

Promotion of water metering:

We meter on change of occupancy and promote the installation of a water meter on a request basis (optant metering). Under our '*Cheaper with a Meter*' refund scheme, customers who choose to switch to a metered tariff after 18 February 2022 are entitled to a refund if their metered bills are higher than their unmetered bills. This scheme is heavily promoted on social media. We are currently also offering customers a free water butt when they request a meter.

Provision of free water efficiency equipment:

The provision of a range of free water saving devices thorough a third-party website (Save Water Save Money) has been a staple offering for the last 10 years. This equipment can be used in the bathroom, kitchen and garden with each one capable of saving measurable amounts of water. We will continue to offer a wide range of devices and help, and we will be open to and looking for new ideas and equipment as they come to the market.

Bespoke water efficiency calculations (through our website) to empower customers to choose the most effective way to save water and save money:

From our customer research and engagement, we know that customers find it hard to visualise or quantify their water usage and link this consumption to their water and energy bills. We offer an online water and energy calculator service that allows users to fully engage on all aspects of their water usage as well as key aspects of how this usage is linked to energy consumption. Our current platform allows us to offer free water saving equipment following a user's interaction.

Develop new partnerships with stakeholders across our supply area to create new and innovative ways to help customers become more resource efficient:

We have developed a stakeholder partnership focussed on water efficiency, known as Resource West. This partnership with utility companies and academia is working to promote cross-utility resource efficiency through a single joined up voice and message. In addition, it aims to support vulnerable customers and address resource poverty through a better understanding of the issues and the opportunity to work together. The partnership has undertaken the first of a series of trials to test alternative approaches and messages. The short-term goal is to gather an in-depth understanding of current resource consumption and the effectiveness of approaches to support a reduction in consumption. Learnings will then be scaled across our supply area. Initial finds suggest a positive reaction to single efficiency messages from energy and water providers with consequent efficiency improvements.

This partnership provides a real opportunity to join forces and simplify the message for customers, at a time when water and energy poverty have already affected many more families as factors in the cost-of-living crisis.

Our school's education programme on water efficiency and its links to environmental sustainability:

It is our view that to encourage more efficient use of water, 'mindful consumption' linked to an appreciation of the environmental value of water is required. This is the basis of our school's engagement and education programme. We seek to inspire young inquisitive minds, to make the link between water use and the health of the environment. We hope that future generations of customers will retain this regard for the environment, as well as manifesting more directly in 'pester power' to encourage family members to reduce consumption.

We engage with schools in a range of ways, including through school visits, hosting school trips to our lakeside sites and through our mentoring programmes.

Bristol Water the Foundation is a dedicated part of our website which provides a range of educational resources, including fact sheets and experiments linked to water efficiency.

Work with retailers to help them help their non-household customers use water efficiently:

We recognise the need for a collaborative approach with the retail market to reduce non-household demand and deliver water efficiency savings. We have a good working relationship with each retailer in the non-household retail market and provide support and information on promoting water efficiency advice to business customers. We also aim to promote water efficiency at home through engaging with employees of our non-household customers.

MOSL research has indicated that wholesaler led initiatives are the most effective short-term route to delivering non-household demand reductions. Through these initiatives and the clear national drive towards water efficiency, engagement with retailers will be required and lead to the development of retailer led initiatives.

8 Sustainable Abstraction

8.1 Overview

We have to consider the sustainability of our water abstractions from the environment, as water resource availability can be affected by reductions in our licensed abstraction volumes implemented by the Environment Agency, to support and restore the wider water environment. These reductions are known as 'sustainability reductions'. Currently we have five licences which are at risk of reduction as a result of the outcome of AMP7 and AMP8 WINEP abstraction investigations. As a result, we have reduced supply availability in AMP 8 and 9 by a total of 4.1Ml/d to demonstrate the impact of such a change if it were to be confirmed in our WRMP24 (see **Section 8.3.1**).

Through environmental monitoring for our Drought Plan environmental assessment work, and for the WINEP, we have built up a comprehensive dataset across ecological and hydrology parameters. These data are very valuable for characterising the baseline environment and also help us to understand our sources in terms of their resilience.

The following sections describe the work undertaken by us and wider stakeholders to assess and, where required, mitigate the impacts of our operations on the environment. We will continue to work with the environmental regulators to deliver environmental investigations and enhancements, to meet our legal commitments, and, where appropriate, to go beyond these minimum requirements.

8.2 Existing Sustainability Reductions

Bristol Water does not operate any abstractions which have been identified by the Environment Agency through the RSA (Restoration of Sustainable Abstraction) mechanism as unsustainable. As stated in **Section 5.3.1** the company has for many years worked in partnership with Wessex Water to mitigate the impact of unsustainable abstraction by Wessex Water in the Malmesbury area, close to Bristol Water's area of supply. As part of this scheme, Bristol Water has voluntarily reduced the amount of water abstracted from its sources at Shipton Moyne and Long Newnton, so that water can be abstracted from this aquifer by Wessex for local river support. This river support programme and voluntary reduction in abstraction by Bristol Water helps reduce the negative effect of Wessex Water's groundwater abstraction upon the local environment.

8.3 AMP7 and AMP8 Projects

8.3.1 Abstraction Sustainability Investigations

Our AMP7 programme of WINEP abstraction investigations is ongoing as described in **Section 5.3.2**. No sustainability reductions have arisen as a result of the investigations which have concluded so far. Following discussions with Environment Agency during consultation on the dWRMP, we have agreed that potential risk to deployable output is 1Ml/d dependent on outcomes of the Winscombe and Chelvey investigations, which would arise in AMP8, and a further 3.1Ml/d is at risk dependent on outcomes of the planned AMP8 WINEP investigations (Table 8-1), which would arise in AMP9. These reductions would help to ensure any future environmental impact of our abstractions is minimised. The loss of 4.1Ml/d from DO has been included in the baseline of the WRMP24 to demonstrate the impact of such a change, if it were to be confirmed, in our WRMP24; approximately 1Ml/d is at risk starting in AMP8, the remaining 3.1Ml/d starting in AMP9. These abstraction reductions, because of WFD driven investigations around serious damage and potential deterioration, are different to those planned under our Environmental Destination investigation programme for AMP8, for which no loss of DO is currently envisaged, and different also to the Environmental Destination DO reductions already programmed into the plan. We have clearly set out the DO at risk from WFD driven abstraction reductions (no deterioration and serious damage), versus reductions which are produced to arise on account of Environmental Destination requirements, such that these will not be double counted.

Table 8-1: Sustainability (Deployable Output) Reductions as Agreed with EA in March 2023

Licence Serial No.	Source Name	Agreed Driver	Investigation	Potential DO at risk (Ml/d)	Reduction
16/52/15/G/018	Chelvey	WFD_ND_WRFlow	AMP7	0.55	AMP8
17/53/14/S/016	Chew Stoke	WFD_INV_WRFlow	AMP8	0.23	AMP9
16/52/12/G/046	Winscombe	WFD_ND_WRFlow	AMP7	0.42	AMP8
16/52/12/G/047	Honeyhurst	WFD_ND_WRFlow	AMP7	0	NA
17/53/11/G/094	Oldford	WFD_NDINV_WRFlow	AMP8	0	NA
17/53/12/G/015	Egford Sub & Main	WFD_NDINV_WRFlow	AMP8	0	NA
18/84/23/S/013	Alderley	WFDGW_NDINV	AMP8	1.04	AMP9
17/53/06/G/007	Shipton Moyne	WFDGW_NDINV	AMP8	0	NA
17/53/06/G/006	Tetbury	WFDGW_NDINV	AMP8	0	NA
17/53/06/G/008	Long Newnton	WFDGW_NDINV	AMP8	0	NA
16/52/12/S/051	River Axe	WFD_INV_WRFlow	AMP8	0	NA
17/53/14/S/014	Chewton Mendip	WFD_INV_WRFlow	AMP8	0	NA
16/52/10/G/047	Forum: Windsor/Yelling Spring	WFD_INV_WRFlow	AMP8	0	NA
16/52/15/G/017	Clevedon	WFD_INV_WRFlow	AMP7	0	NA
17/53/14/S/013	Sherbourne	WFD_INV_WRFlow	AMP8	1.82	AMP9
			Total	**4.06**	

8.3.2 Catchment and Water Quality Investigation

We have undertaken an investigation in the Forum WTW catchment to determine causes of turbidity in the raw water. As there is considerable connectivity between the surface and sub-surface hydrology some level of turbidity would be expected in response to rainfall. Although no obvious examples of poor agricultural practice were evident, it was concluded that the catchment should be included in the Mendips catchment management programme.

Given that the existing membrane treatment system requires upgrade, it was also concluded that resilience to turbidity should be a key criterion in selection of appropriate technology. During the investigation turbidity monitoring apparatus was installed which may allow future management of the source dependent on real time turbidity data. The investigation and report will driver future investment via the PR24 Business Plan to make Forum WTW more resilient and less prone to outages.

Bristol Water, as a water only company, is not responsible for any sewage discharges or intermittent overflow discharges. Bristol Water is aware of the risks of its operations to water quality, which primarily arise from permitted discharges from water treatment works, and from discharges of silt to watercourses from excavations. We have processes in place to control the latter and are engaged in a process of MCERTS accreditation around the management of our permitted discharges as part of our AMP7 WINEP.

8.3.3 Water Framework Directive – Adaptive Management of River Flows

Following investigations in AMP6, we have continued to manage outflows from Chew Valley and Blagdon Reservoirs to improve the ecology in the downstream rivers. This work acknowledges the potential effects of the impoundments on the downstream rivers in terms of effects on flow magnitude, timing and rate of flow changes, seasonality of flows and flow variability. Reservoirs can also affect downstream water quality, temperature, sediment mobility, and the movement of migratory fish such as eels.

We have implemented a changed compensation flow regime and have delivered spate flows to mimic the effects of a naturalised flow regime. We have done this in concert with a comprehensive range of monitoring to determine first the baseline and any effects of the changed flows. Alongside this, and particularly in the Chew catchment, we have engaged regularly with downstream stakeholders with concerns around fisheries, recreational use of the river and flood risk. This work is ongoing, and we hope to continue it into AMP8 through agreed changes to conditions on the abstraction licences.

8.3.4 Eel Protection

Acknowledging the impact of the reservoir impoundment on elver migration, we will, during AMP7, be installing an elver pass at Chew Valley Reservoir. This will enable upstream passage of elver across three separate structures; the gauging flume downstream of the reservoir, the reservoir dam, and the weir between Heriots Mill Pool and the main reservoir. This means that elver will be able to access not only the reservoir but also the upstream River Chew.

8.3.5 Invasive Species and Biosecurity Investigations

We are undertaking many INNS and biosecurity projects within AMP7 both to prevent the spread of INNS but also to promote native species and to try and ensure their survival. We are liaising with partners such as the Bristol and Avon Rivers Trust (BART), and the Bristol Zoological Society to monitor the presence of particular INNS, and to create refuge sites to promote native species such as white clawed crayfish and water voles. We are undertaking monitoring for species such as mink and have commissioned river fly monitoring training to support community-based fly guardian work that will provide future monitoring resilience for INNS. We are completing INNS Rapid Response Plan and Catchment Strategy projects that will set out the ongoing monitoring and management work to ensure the risk and effects of INNS is kept low.

For AMP8 we have included several projects within WINEP24. We will continue to build on the foundations created by the AMP7 work, and previous projects, and undertake further work that will extend or enhance the current initiatives such as the expansion of activity into new areas, and the implementation of biosecurity management measures with partners.

8.3.6 Future Investigations

We are currently developing our environmental programme for AMP8. Most of this programme will be captured within the PR24 WINEP, but there will also be biodiversity and catchment management elements which fall outside of WINEP. Most of the implementation projects in our WINEP are nature-based solutions, such as restoring rivers to ensure they can adapt and function with flows provided via compensation from our reservoirs.

Proposals listed under the Environmental Destination drivers are discussed below. Across the wider WINEP we are proposing several actions which reflect the Environment Agency's WINEP Methodology[46] and principles around co-delivery and co-funding, and catchment and nature-based solutions. These proposals will be taken through the Environment Agency's Options Development Methodology so that we can demonstrate that our proposals are 'Best Value.'

8.4 Environmental Destination

The Environment Agency Water Resource Planning Guideline requires water companies to include a long-term environmental destination in our WRMP24, setting out how we will achieve and maintain sustainable abstraction to 2050 (and beyond), taking into account climate change impacts and future demand. This requirement is in addition to the current statutory requirements and regulatory expectations under the WINEP.

As set out in **Section 5.3.3**, we have included an allowance for environmental ambition in our baseline supply demand balance, based on an initial assessment of trial catchments under the WCWRG project.

The Environment Agency guidance requires us to consider our long-term Environment Destination and set out the actions we will take to achieve this in the short, medium and long term.

The principle of Environmental Destination is understanding in advance, what the environment is going to need in the long term in the context of climate change and population growth and demand. Our environmental destination proposals are be based around this principle, aiming to address both the needs of the environment now and in the future. We have set out 7 areas where we are proposing to develop our understanding of the environmental destination needs. These cover both the short term (next 5 to 10 years) and the longer term (out to 2050/2080).

1. Existing WINEP investigations: To identify and implement additional future investigations to enhance the environment. This includes our abstraction at Winscombe and Rodney Stoke (short term).

[46] WINEP Methodology (Environment Agency/ DEFRA/ Ofwat, 2022)

2. Improvement schemes as an outcome of the WINEP for Cheddar Yeo and Banwell, where we will work with the local communities to enhance the environment at these sites (phased into WINEP for AMP9).
3. An assessment for each catchment within our supply area to identify the likely future pressures on the water environment because of climate change and demand increase. The outputs of this work will be a list of sites that may be affected in the future, the timeframe under which they are likely to be affected if no action is taken and the possible actions, we can take to ensure sustainable abstraction is maintained into the future. We will look at scenarios in the 2080s that align with climate change projections. (short term investigation work to identify long term ambition).
4. Peat investigations: An AMP8 investigation into the location of sites, and how they can be protected and restored or enhanced. This will involve working with stakeholders, Natural England and North Somerset Council (short term).
5. SSSI status assessment: A review of our existing sites and a condition assessment. This would be a consultancy led project and the output will be shared with Natural England. The outputs of the project would enable us to identify any additional environmental enhancement opportunities across our land holding (short term action with long term outlook).
6. Connectivity investigations: We will be looking to the long term and how our catchments can be managed to encourage connectivity, re-wilding and wildlife corridors. This would be done with catchment management and stakeholder engagement (i.e., other landowners etc) (long term, phased into WINEP for AMP9).
7. Linking people and the environment: This area will help Bristol Water customers understand how water consumption behaviours impact the environment and what people can do to support the environment in the face of climate change. Links will be made to Bristol Green Capital and the Climate Emergency. (Social aspect of environmental destination) (short medium and long term to address cultural change – phased into WINEP for AMP9).

As mentioned in **Section 5.3.3**, the WINEP will include investigations under the Environmental Destination driver to include these areas. These investigations will explore the effects of climate change and growth on our abstractions considering environmental need over a longer (80 year) timeframe. This will then feed into future company scale and regional water resource planning.

We will also be building on the abstraction sustainability investigations undertaken in AMP7 as described in **Section 5.3.2**. Also listed under the Environmental Destination driver are schemes to deliver river restoration informed by AMP7 investigations which indicated that there would be benefit from river restoration, but where it was concluded that our abstractions were not affecting WFD water body status. If taken forward, these projects would be delivered with local community partners. We are also proposing an education action programme coupled with citizen science initiatives which have the objective to raise awareness of the link between water provided for human consumption and the water required by the environment.

We have continued to work with our partners across the WCWRG to develop our environmental destination and to ensure that water resources across the region are managed to deliver the required level of environmental ambition as well as secure water supply to customers in the West Country.

8.5 What do customers think about environmental protections?

Overall environmental concerns are an important priority for customers, who often have ideas about actions that could support Bristol Water's environmental credentials, such as more water meters and involvement in wider environmental protection initiatives. Overall, support for this priority has increased over the last five years.

Our 2021-22 Customer Survey found that 98% of respondents rate improving the environment, particularly lakes and other water sources, as either very or quite important, and 95% say the same about supporting biodiversity. 67% and 65% respectively think that Bristol Water is performing very well or quite well in these areas. This is very similar to what we heard from our 2020-21 Customer Satisfaction Survey and our 2020-21 Annual Customer Survey. The latter also notes that 69% of respondents found that Bristol Water should be very involved in supporting the environment and biodiversity.

In our 2022 Customer Forum, customers said that preserving the environment whilst meeting a growing demand for water, is a significant challenge for Bristol Water. Environmental preservation includes reducing abstraction from rivers and aquifers, increasing biodiversity at sites, and protecting water source quality. Forum members felt that water meters could help reduce consumption and that Bristol Water should participate in discussions with the Government about the environment. In our 2022 focus groups with vulnerable customers, those struggling with bill affordability and future customers, biodiversity and environmental concerns were considered a top priority due to the importance of looking after our natural world. However, they want more information that would help them understand Bristol Water's specific environmental impact as a water company, and some wondered whether this should be a responsibility for Bristol Water or for the Government.

In our Stakeholder Survey, there is a clear trend of customer satisfaction with our performance in protecting and enhancing the environment. The Stakeholder Survey Report for 2021-22 shows customers who think we were doing well or very well in this area increased from 49% in 2020 to 78% in 2021, then 92% in 2022.

These results show a clear increase in importance for customers since the PR19 research period, which had found that 'environmental activities' were not a top priority for many customers. Similarly, while our 2017 Annual Customer Survey found 94% of customers said that it was very or quite important to protect the environment, it was still not in the top 10 priorities. Being environmentally friendly was the lowest priority for our Customer Panel in our December 2016 survey, despite 85% of customers agreeing that it should be a priority for the company.

9 Climate Change

9.1 Introduction

The Environment Agency's WRPG[47] includes a supplementary guidance note on climate change which outlines requirements expected of water companies. The main update for WRMP24 is the new UKCP18 climate change projections which have replaced the UKCP09 projections that were used for WRMP19.

Climate change should be accounted for within the deployable output assessment, but it is acknowledged within the guidance that current methods and scientific understanding do not allow an explicit 1-in-500 year drought under climate change to be determined. Instead, the supplementary guidance on the 1-in-500 resilience requires events to be *"reasonably reflective of a 1-in-500 level of risk once climate change perturbations have been applied"*[48].

The level of complexity required for the climate change DO assessment is determined by the relative vulnerability of each water resource zone (WRZ) and/or the scale of investment that may be required and should reflect the large uncertainties associated with climate change[49].

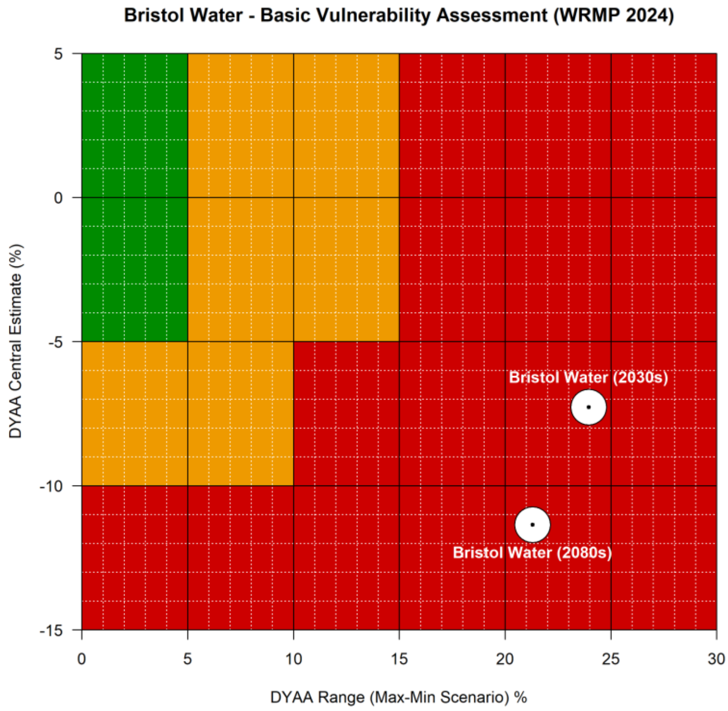
This section outlines how the impacts of climate change have been incorporated within the deployable output assessment.

9.2 Update of the Climate Change Basic Vulnerability Assessment

HR Wallingford undertook the climate change basic vulnerability assessment[50] as part of a WCWRG project to ensure regional consistency in the approach to the climate change assessment. The BVA can be summarised in a plot (Figure 9-1) which uses the climate change assessment from WRMP19 to compare the central impact of climate change with the range of impacts. The Bristol WRZ is "high vulnerability" which is determined by both the central impacts and range of impacts reported in WRMP19. The WRPG states that a high vulnerability WRZ must undertake an updated climate change assessment for WRMP24, and this assessment should consider a range of different products available from UKCP18.

[47] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[48] Environment Agency, 02/09/2020, Water resources planning guideline supplementary guidance – 1 in 500
[49] Lowe et al. (2018) UKCP18 Science Overview Report Version 2.0. Available from ukclimateprojections.metoffice.gov.uk
[50] HR Wallingford, July 2021. Regional Planning Climate Change Assessment. Climate Change Methodology.

Figure 9-1: Basic Vulnerability plot for Bristol WRZ. Red areas indicate a WRZ that is "high" vulnerability



9.3 Climate Change Assessment Methodology

9.3.1 UKCP18 Products

As outlined in the previous section, a high vulnerability climate change assessment should consider a range of products from UKCP18. Four UKCP18 products have been included within the climate change assessment:

- UKCP18 Regional projections
    - 12 projections from regional climate models (RCM)
    - Emissions scenario RCP8.5
    - Single set of projections local to Bristol Water
- UKCP18 Global projections
    - 16 projections from the global climate models (GCM),
    - Emissions scenario RCP8.5
    - Single set of projections local to Bristol Water
- UKCP18 Probabilistic projections
    - 3000 statistically derived projections informed by RCMs/GCMs
    - Emissions scenario RCP2.6, RCP6.0, RCP8.5
    - Single set of factors for England and Wales scale
    - The regional projections and probabilistic projections for RCP8.5 were provided by Atkins[51] as part of their work on climate change and stochastics for WCWRG and are the same format used by other regional planning groups in England and Wales. The probabilistic projections for RCP8.5 originally have 3000 individual projections from which a subset of 100 were provided based on Latin Hypercube sampling (LHS).

The global projections and probabilistic projections for RCP2.6 and RCP6.0 were provided by HR Wallingford as part of their work on climate change for WCWRG. The probabilistic projections for RCP2.6 and RCP6.0 originally have 3000 individual projections from which a subset of 100 were provided based on LHS.

All these climate projections have been derived from UKCP18 for a future period of 2061-2080 relative to a baseline period of 1981-2000 and provided as monthly change factors for rainfall and evaporation. The projection has a set of 12 monthly change factors which are used to perturb baseline rainfall and evaporation sequences.

9.3.2 Hydrological Modelling of Inflows

The five catchment GR6J models were each used to simulate the impacts of climate change on inflows. The baseline rainfall and evaporation for each model was perturbed by each climate change projection's monthly change factors to create new climate change sequences. This was undertaken for the baseline record of the historical period 1901-2018 and all 400 stochastics sequences for a total of 328 individual climate change projections.

[51] Atkins, November 2021. Regional Climate Data Sets: WCWRG Baseline Stochastics Roll Out.

Similarly, to the baseline DO assessment the five GR6J models are used to provide inflow sequences to Aquator using the transposition factors developed for this purpose.

9.3.3 Scenario sampling

To understand the impacts of climate change, a DO assessment needs to be undertaken for each climate change projection for the stochastics dataset. In their original form this is 400 stochastics and 328 climate change projections which is the equivalent to repeating the baseline assessment 328 times. The computational resource requirements for this are too high and it is common practice to reduce the number of stochastic sequences and climate change projections that are considered in the climate change DO assessment.

Stochastics

A sub-sample of 50 of the 400 stochastics was identified to use within the climate change DO assessment. The stochastic replicates were sampled in such a way that the statistical distribution of the baseline DO assessment would be the same with the 50 sequences compared with all 400 sequences.

Climate Change

The use of 328 climate change projections would push the limits of what is feasible within the Bristol Water's Aquator model. To limit the number of climate change scenarios that were considered in the climate change DO assessment the UKCP18 probabilistic projections were reduced from 100 projections to 5 projections ensuring the full range of expected impacts is captured in the smaller sample. This sampling was done using a simple emulator water resources model to simulate the impacts of all 100 projections. The sampling methodology uses the emulator model to assess the DO of each climate change projection and then ranks the projections in order of their DO impact. The five projections taken as a sample represent the 5th, 25th, 50th, 75th and 95th percentiles of the ranked DO impacts. This ensures that the sampled projections cover the range of impacts that would be expected if using all 100 projections. There was no sampling undertaken of the regional or global projections, resulting in a total of 43 projections for use in the climate change DO assessment.

9.3.4 Water resources modelling

Following the sampling of both the stochastic sequences and climate change projections the climate change DO assessment uses 50 stochastic sequences and 43 climate change projections. The same assumptions were made with regards to the Aquator model and Level 4 drought failure thresholds as for the baseline assessment outlined in **Section 5.2.4**. The SM DO assessment was used similarly to the baseline DO assessment, however a coarser demand step of 10 Ml/d was used in this assessment to further reduce the computational run times for the large, combined dataset of stochastics and climate change.

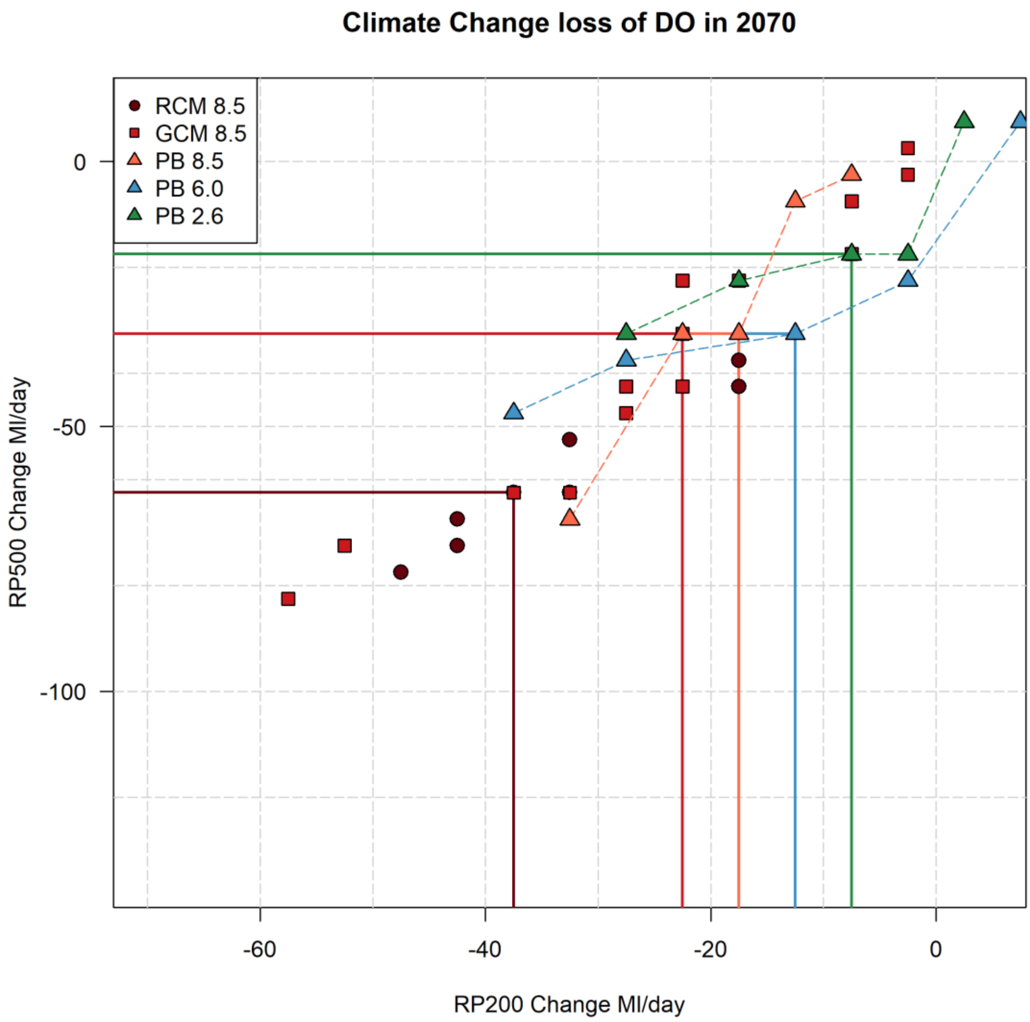
9.4 Climate Change Deployable Output

The impacts of climate change on DO have been calculated for both the 1-in-200 year and 1-in-500-year event. This was done by finding events in the baseline stochastics which reported a DO which is similar to the 1-in-200 year DO (351Ml/d) and 1-in-500 year DO (347Ml/d) and identifying what their equivalent event DO is in the climate change DO assessment. The change in DO is then taken as the difference between the climate change DO and the baseline DO. For each of the 1-in-200 and 1-in-500 year return periods, multiple events were considered in the assessment and the overall climate change impact is the median of these events. The outcome of this process is that for each of the 43 climate change projections has a single change in DO is reported for each of the 1-in-200 and 1-in-500 return periods.

The climate change results are summarised in **Figure 9-2** which shows the impacts of climate change for all 43 climate change projections. Nearly all the climate change projections lead to a reduction in DO except for the 95th percentiles of the probabilistic projections for RCP2.6 and RCP6.0 which have small increases. The largest reductions in DO are associated with the highest emissions scenario RCP8.5, with the regional projections providing the projections with the largest RCP8.5 impacts.**-**

These results are consistent with what is expected from the various UKCP18 products and the associated emissions scenarios. The regional projections are known to be hotter and drier (notably in autumn) which drive the largest impacts.

Figure 9-2: Change in DO due to climate change for the 1-in-200 (x-axis) and 1-in-500 (y-axis) year design return periods. The median impacts from each UKCP18 product type are shown as a bold coloured line.



9.5 Gloucester and Sharpness Canal

As part of the inflow review and update work we carried out (discussed in **Section 5.2.3**), we have provided the rainfall runoff modelling outputs from the catchments that feed the Gloucester and Sharpness Canal to the CRT. This includes data that has been perturbed to create new climate change sequences as set out above. The modelling of the Gloucester and Sharpness Canal is still ongoing and therefore the outputs of this work have not been used to inform the assessments in our final WRMP24.

9.6 Effects of Climate Change on Water Resources Zone Supply

The likely effects of climate change on deployable output have been determined for the future period 2061 to 2080 through the assessment process set out in **Section 9.3** and **9.4**. To account for the effects of climate change across the 55-year planning period, a scaling methodology is applied to scale back the effect of climate change.

The Environment Agency supplementary guidance on climate change[52] states that there has been no changes to the scaling approach from the method described in the 2017[53] guidance and that linear scaling is still recommended.

To scale the climate change results, the DO reduction in 2070 under the 1 in 500 for RCP6.0 (medium scenario) at the 50th percentile was taken (32.5 Ml/d). The UK probabilistic projection for the RCP6.0 scenario is illustrated to be a mid-scenario with a distribution that captures a representative amount of uncertainty associated with our understanding of the likely impacts of climate change.

From this, linear scaling of a -0.40625 change was used across the 80-year planning period (=32.5/80). The 50th percentile for RCP6.0 was chosen as the most pragmatic approach as RCP2.6 is not considered severe enough whilst the 1 in 500 demonstrated consistent median climate change loss of DO for RCP6.0 and RCP8.5 (see **Figure 9-2**). The graph in **Figure 9-3** shows the resulting forecast effect of climate change on deployable output over the 55-year planning period from 2025/26 to 2079/80. For the 1 in 500 return period, scaling results in a reduction of 14.22 Ml/d in deployable output in the first year of the planning period (2025/26). This rises to a reduction of 36.16 Ml/d by 2079/80.

This is a more significant effect of climate change on the supply forecast than was reported in the WRMP19. This is due to the move from using the UKCP09 climate change scenarios, to the updated UPCP18 climate change scenarios.

[52] Environment Agency, 02/09/2020, Water resources planning guideline supplementary guidance – Climate Change.
[53] Environment Agency, April 2017, WRMP19 supplementary information. Estimating the impacts of climate change on water supply.

Figure 9-3 Scaled reductions in deployable output as a result of climate change (2025/26-2079/80).

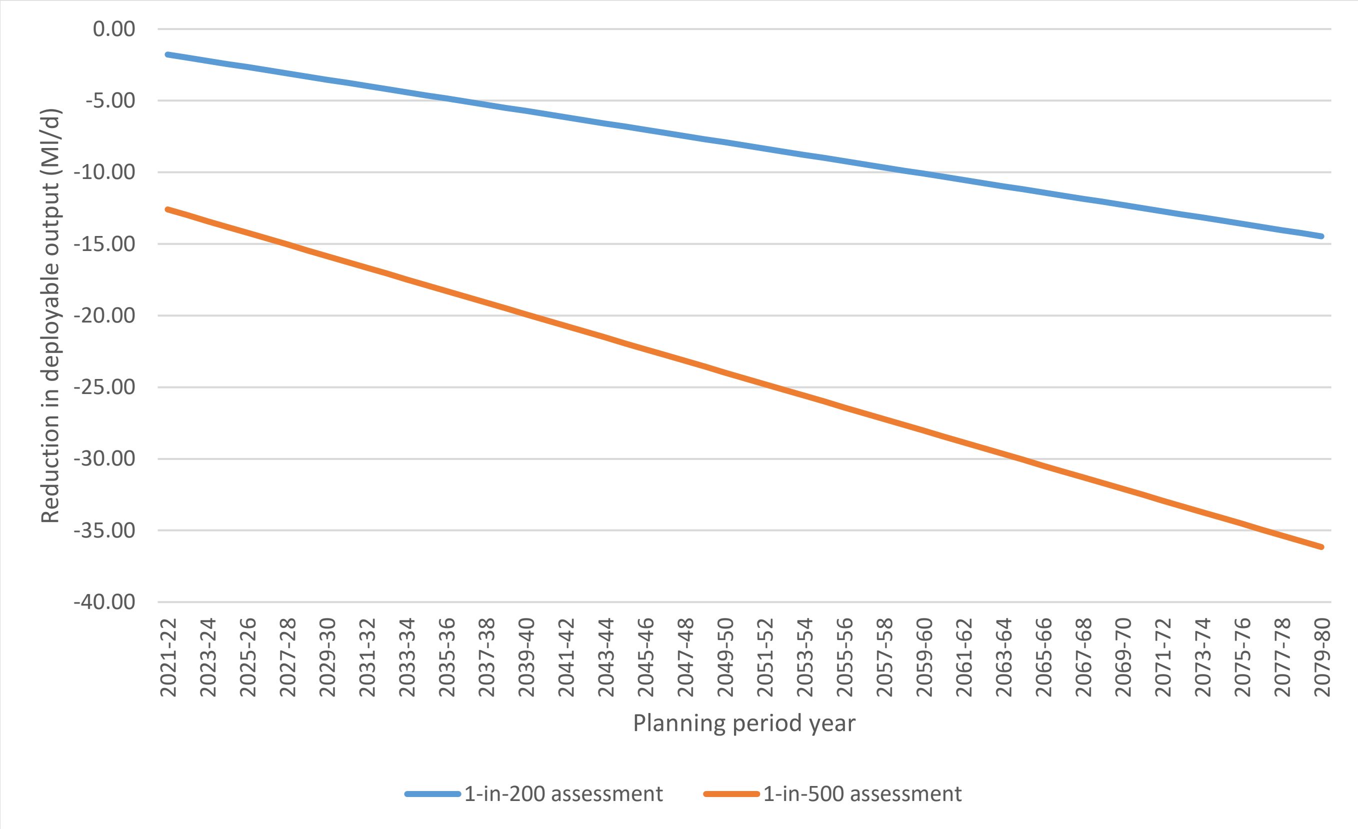


Table 9-1: Effects of climate change on deployable output across the 55 year planning period.

	AMP8 2025/26	AMP9 2030/31	AMP10 2035/36	AMP11 2040/41	AMP12 2045/46	AMP13 2050/51	End of forecast 2079/80
Scaled climate change effect on 1-in-200 year DO	-2.66	-3.75	-4.84	-5.94	-7.03	-8.13	-14.47
Scaled climate change effects on 1-in-500 DO	-14.22	-16.25	-18.28	-20.31	-22.34	-24.38	-36.16

10 Target Headroom

10.1 Background

Even though we use the most up-to-date technology, methods and data available to produce our supply and demand forecasts, there is still a certain amount of uncertainty in all these forecasts. Therefore, we are required to analyse and quantify the variability and uncertainty that exists within our calculation to develop the supply demand balance. We identify a 'target headroom' volume as a means of allowing for the uncertainty in the supply demand balance. This is a buffer between supply and demand.

A probabilistic approach to determining target headroom in the Bristol Water WRZ was used to develop the WRMP14, using the UKWIR methodology *An Improved Methodology for Assessing Headroom*[54]*.* In the context of our Problem Characterisation modelling complexity category being identified as 'Medium level of concern', we have continued to use this headroom assessment methodology as an appropriate current approach to allow for the assessment of uncertainty in the supply demand balance.

In reviewing the headroom assessment carried out for WRMP14, it was identified that some improvements could be made in terms of the Monte Carlo model used for the headroom assessment, and the assumptions used relating to the uncertainties within the supply demand balance. A full review and update of the headroom assessment process was therefore carried out with the support of consultants Atkins. Full details of this work are available in the Atkins technical report[55].

We further improved our headroom model for WRMP24 by extending the planning horizon and implementing multiple climate change scenarios simulation within one model. For each climate change scenario (PB 2.6, PB 6.0 and PB8.5) we adjusted the headroom uncertainty to reflect the scenario being modelled. An overview of the approach used, and the results is provided in the following sections.

10.2 Methodology

The headroom model has been developed using the principles of the UKWIR report *An Improved Methodology for Assessing Headroom*. The model is based in Excel and uses the Oracle Crystal Ball[56] software add-in to undertake the Monte Carlo simulations with 50000 iterations. The model was designed with a structured data entry sheet and model output sheet to ensure full transparency of input and output data. The model calculated headroom uncertainty for the whole of the planning period from 2021/22 through to 2079/80 with outputs expressed as a probability distribution function. The absolute value of target headroom is then selected according to the adopted level of risk the company wants to take for each year of the planning period.

The headroom uncertainty is calculated on a water resource zone basis, for the DYAA planning scenario. The components of uncertainty within the supply demand balance are divided into two main areas; supply

[54] UKWIR, 2002. An Improved Methodology for Assessing Headroom – Final Report. UK Water Industry Research Ltd Report 02/WR/13/2.
[55] Atkins, October 2017. Headroom Assessment. dWRMP19. Bristol Water.
[56] Oracle Crystal Ball Software

side and demand side. These are then sub-divided into respective supply or demand side components as set out below:

Supply side headroom components:

- S5 – Gradual pollution (surface water and groundwater considered)
- S6 – Accuracy of supply side data (surface water yield & groundwater yield)
- S8 – Impact of climate change on Deployable Output

Demand side headroom components:

- D1 – Accuracy of demand data (meter accuracy)
- D2 – Demand forecast variation (economic and population growth)
- D3 – Impact of climate change on demand

As required by the Environment Agency's Water Resource Planning Guideline[57], the headroom analysis has made no allowance for the risk of time-limited licences not being renewed (covered under component S3: uncertainty of the renewal of time-limited licences) or licences being revoked due to sustainability reductions (covered under components S1: vulnerable surface water licences, and S2: vulnerable groundwater licences).

In addition, Bristol Water do not have any Bulk Imports (S4) we consider to be uncertain or at risk, and so this component has not been used in our analysis. A summary of the assumptions used to assess the uncertainty for each supply side and demand side headroom component is provided in the following sections.

10.3 Supply side headroom components

S5 – Gradual Pollution

This component represents the risk of our groundwater source Egford Sub and Main becoming polluted due to hydrocarbon contamination from a known source within proximity (cone of influence) to the site. This could result in a sudden pollution event that could not be reversed, resulting in the contamination of the source and subsequent abandonment.

S6- 1/2/3 – Accuracy of supply side data

The uncertainty in component S6 is derived using the factors that determine the constraint on deployable output, for example hydrology, hydrogeology, abstraction licence or infrastructure. This component has therefore been divided into 3 sub-components to assess the uncertainty associated with each of Bristol Water's main sources of supply:

S6-1 – represents the uncertainty around the inflow data used to determine the yield of the Mendip Reservoirs. Data consists of Hysim rainfall runoff data from 1910 to 1959 and then recorded inflow data from 1960 onwards. The uncertainty associated with this data was assessed to be +/- 10% around the deployable output of the Mendip Reservoirs.

[57] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline

S6-2 – represents the uncertainty around the groundwater yield assessment and the construction of the operational drought curves used to define the deployable output of the sources. The methodology used to assess groundwater deployable output followed the UKWIR report *A Method for the Determination of the Outputs of Groundwater Sources*[58]. The uncertainty associated with this data was assessed to be +/- 10% around the total deployable output of the groundwater sources.

S6-3 – represents the uncertainty around the yield of the Gloucester and Sharpness Canal during a dry year. It is assumed in the baseline deployable output assessment that the source is licence constrained, however, there is the potential for it to be resource constrained, and especially under a River Severn Drought Order should one be put in place by the Environment Agency. The uncertainty associated with this assumption was assessed to be a maximum reduction of 5% of the yield from this source. This is reflective of the 5% cut back under the River Severn Drought Order.

S8 – Uncertainty of impact of climate change

The uncertainty in component S8 has been developed using the climate change deployable output assessment results for three emission scenarios: RCP2.6, RCP6.0, RCP8.5. We used 5th, 50th and 95th percentiles of climate change impact on deployable output as min, mean and max values for climate change impact assumed triangular distribution implemented in our headroom model. We used Crystal Ball Monte Carlo to model the climate change components of our headroom estimation for each emission scenario separately.

10.4 Demand size headroom components

D1 – Accuracy of demand data (meter accuracy)

Component D1 is to allow for uncertainty due to meter inaccuracies. A normal distribution of uncertainty has been assumed for this component. The meters that measure abstraction are different to those used for calculating distribution input, so there is no correlation between components D1 and S6-2. D1 is also not correlated to S6-1 and S6-3 as these components are based on uncertainty of hydrology assessments, based on river gauging not flow meter data.

D2 – Demand forecast variation (economic and population growth)

The D2 component comprises two separate elements, D2-1 household demand uncertainty and D2-2 non-household demand uncertainty. The uncertainty around the D2-1 and D2-2 components is represented in the headroom model as a triangular distribution for each year in the planning period, with a minimum value equal to the difference between the lower and best estimates, a maximum value equal to the difference between the upper and best estimates, and most likely value equal to zero (i.e. no difference from the best estimate).

D3 – Impact of climate change on demand

Climate change is already included within the demand forecast, so only uncertainty around the impact of climate change has been included in this analysis. Component D3-1 is the % range of uncertainty around the impact on both household and non-household demands. The component is assumed as having a

[58] UKWIR, 1995b. A Methodology for the Determination of the Outputs for Groundwater Sources. UK Water Industry Research Ltd Report 95/WR/01/2.

triangular distribution of minimum, most likely and maximum parameters derived by Artesia Consulting on behalf of Bristol Water for WRMP19. We used the minimum and maximum parameters delivered during WRMP19 process in our WRMP24 headroom modelling.

10.5 Headroom uncertainty results

10.5.1 Company Risk Profile and Baseline Target Headroom

The target headroom allowed for in the supply demand balance represents the level of risk that the company is prepared to take. After consideration of the baseline outputs, Bristol Water has proposed a standardised risk profile as shown in **Table 10-1.** This profile represents a balance between being overly cautious (which would be very expensive) and overly optimistic (i.e., accepting too high a level of risk). A glidepath of gradually reducing risk percentiles through the planning period will be adopted for the water resource zone in accordance with the WRPG due to the ability to plan for changes more effectively in the longer-term via 5-year cycles of the WRMP process.

The 95th percentile represents a 5% risk that available supplies will be unable to meet demands plus target headroom, the 90th percentile represents a 10% risk, the 75th percentile represents a 25% risk, etc.

Table 10-1: Headroom risk profile

Years	2025-29	2030-34	2035-39	2040-44	2045-49	2050-80
AMP Period	AMP8	AMP9	AMP10	AMP11	AMP12	AMP13 onwards
Headroom percentile (risk)	95th	90th	85th	80th	75th	70th

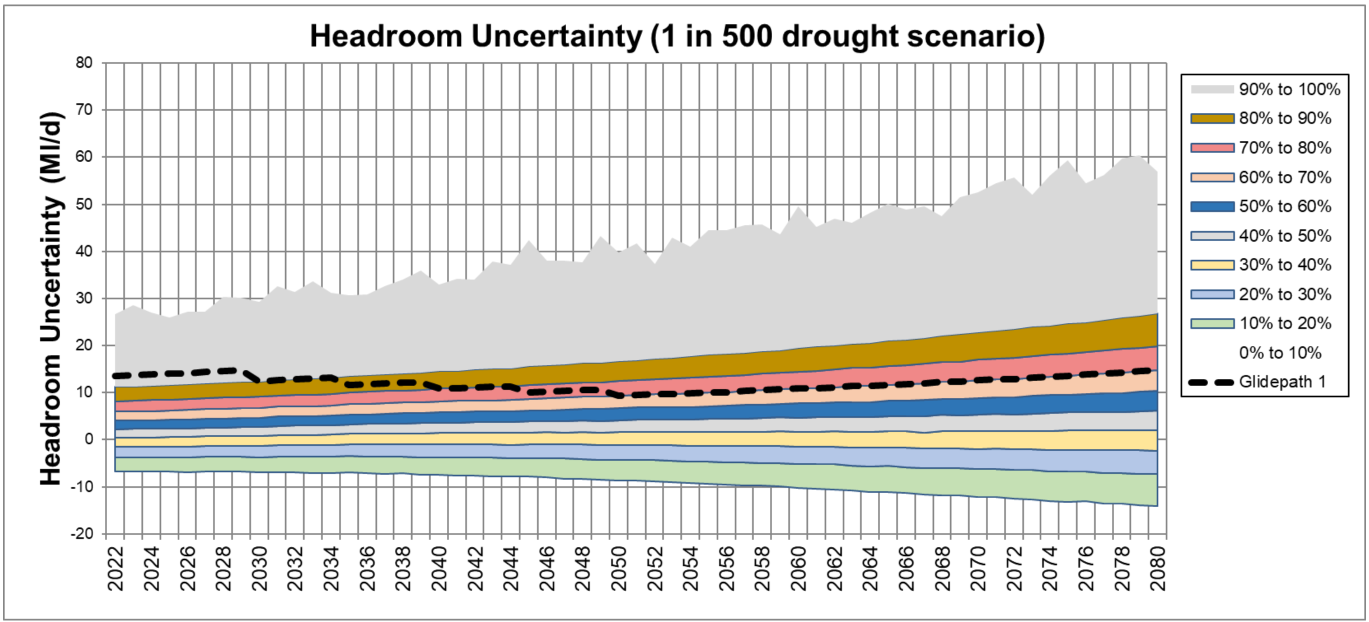
A baseline headroom analysis has been run for the Dry Year Annual Average (DYAA) planning scenario for the supply area. The outputs from the headroom analysis gives the probability distribution of headroom uncertainty for each year of the planning period for each headroom component, which are then combined to give a total headroom distribution for all components. The baseline target headroom values generated by the headroom model are presented in **Table 10-2** in five-year time steps.

Table 10-2: DYAA Target Headroom values for 2025-2080

	DYAA Target Headroom (Ml/d)					
Year	2025	2030	2035	2040	2045	2050-80
Glidepath %	95%	90%	85%	80%	75%	70%
Target Headroom Ml/d	14.06	12.65	11.72	10.94	10.18	9.54-14.73
WRMP19 Target headroom Ml/d	19.06	17.77	16.99	16.17	n/a	n/a

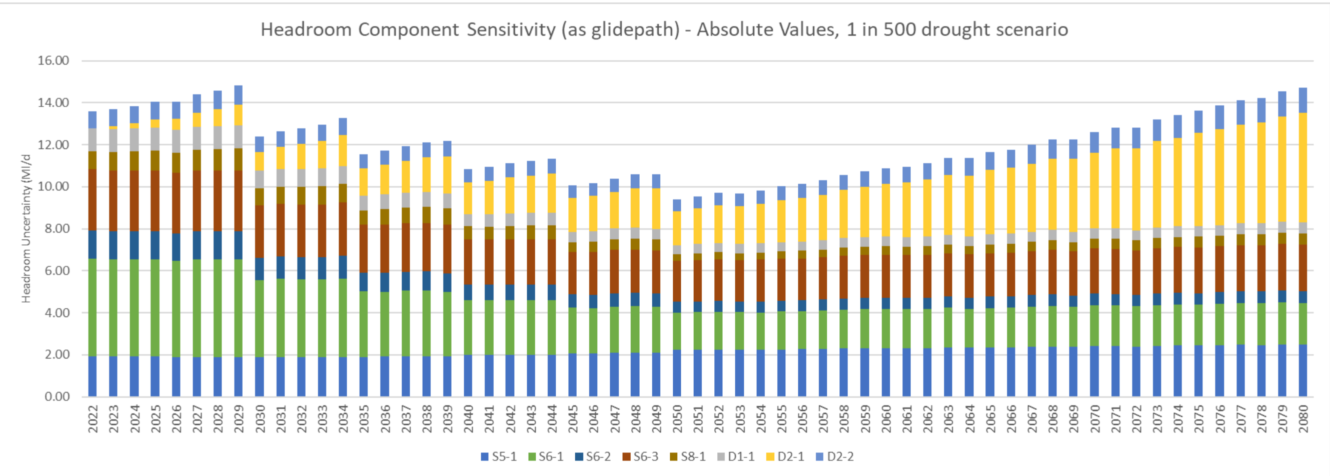
Figure 10-1 shows the headroom "plume plot" glidepath graph for baseline headroom uncertainty. The graphs show the total headroom uncertainty distributions in 10% bands, including the selected glidepath (from **Table 10-2**).

Figure 10-1: Total headroom uncertainty for glidepath 1 (1-in-500 drought scenario)



The individual target headroom components as Ml/d are presented in **Figure 10-2.** The results clearly show the highest level of uncertainty related to supply side components, in particular the effects of climate change.

Figure 10-2 Headroom uncertainty (1-in-500 drought scenario)



10.5.2 10-3 Reducing Headroom Uncertainty

As the planning period progresses, we will seek to reduce the uncertainty regarding target headroom. As demonstrated in this section, accuracy of supply side data components (S6-1 and S6-3) and household demand component re have the largest uncertainty in the headroom model. As the quality of data and modelling used in our supply-side headroom components advances, coupled with an enhanced understanding of customer demand, it is our intention to diminish the uncertainties in the forthcoming AMP period.

10.5.3 Comparison with WRMP19

The approach we used to calculate target headroom for WRMP24 is the same as we used for our WRMP19. However, we have extended the planning horizon and changed some of the components and assumptions used. These are summarised in

Factor	WRMP19	WRMP24
Supply-related, see section 10.3. for more information		
S1 - Vulnerable surface water licences	No vulnerable surface water licences identified	No change
S2 - Vulnerable groundwater licences	No vulnerable groundwater licences identified	No change
S3 - Time limited licences	Environment Agency guidelines preclude these from the headroom analysis.	No change
S4 - Bulk imports	No bulk imports that are uncertain or at risk.	No change
S5 - Gradual pollution causing a reduction in abstraction	Risk of sudden pollution event at a single, known source, that leads to subsequent abandonment.	No change.
S6/1 - Uncertainty for yields constrained by pump capacity	Uncertainty around inflows data used to determine the yield of the Mendip Reservoirs. The uncertainty associated with this data was assessed to be +/- 10% around the deployable output of the Mendip Reservoirs.	No change.
S6/2 - Meter uncertainty for licence critical sources	Uncertainty around the groundwater yield assessment and the construction of the operational drought curves used to define the deployable output of the sources. The uncertainty associated with this data was assessed to be +/- 10% around the total deployable output of the groundwater sources.	No change.
S6/3 - Uncertainty for aquifer constrained groundwater sources	Uncertainty around the yield of the Gloucester and Sharpness Canal during a dry year. The uncertainty associated with this assumption was assessed to be a maximum reduction of 5% of the yield from this source.	No change.
S6/4 - Uncertainty for climate and catchment characteristics affecting surface waters	95% probability that the value is within ±10%. Error is distributed normally around a mean of 0 Ml/d.	This component is now Accuracy of supply side data and combined with S6/2 - Meter uncertainty for licence critical sources.
S8 - Uncertainty of impact of climate change on source yield	Uncertainty developed using UKCP09.	Uncertainty developed using UKCP18.
S9 - Uncertain output from new resource developments	No allowance included (not appliable)	No change.
Demand-related, see section 10.4. for more information		
D1 - Accuracy of sub-component data	A normal distribution of uncertainty has been assumed for this component.	No change.

D2 - Demand forecast variation	The uncertainty around both the D2-1 and D2-2 components is represented in the headroom model as a triangular distribution for each year in the planning period, with a minimum value equal to the difference between the lower and best estimates, a maximum value equal to the difference between the upper and best estimates, and most likely value equal to zero (i.e. no difference from the best estimate).	No change.
D3 - Uncertainty of impact of climate change on demand	The percentage range of uncertainty around the impact on both household and non-household demands. The component is assumed as having a triangular distribution of minimum, most likely and maximum parameters.	No change.
D4 - Uncertain outcome from demand management measures	Uncertainty in the savings achieved from schemes, not the start date of demand schemes.	This uncertainty is considered in Section 16 as part of our sensitivity testing of our plan.

11 Baseline Supply-Demand Balance

11.1 Overview

The baseline dry year supply and demand data in the previous chapters has been used to produce the Baseline Dry Year Annual Average (DYAA) Supply Demand Balance for the Bristol Water WRZ. All the known changes to water available for use (WAFU) and known baseline demand management policies have been included within these calculations. The baseline supply demand balance calculation is to identify whether our WRZ is predicted to have a supply deficit at any point over the 55-year planning period from 2025 to 2080.

Our baseline supply demand balance shows, in the absence of any actions to close the gap, a DYAA deficit of 0.69Ml/d from 2048/49 which rises over the subsequent 32 years to a deficit of 48.69Ml/d by 2079/80.

This situation is similar to the forecast for WRMP19 out to 2045, with a slightly lower deficit forecast within this timeframe, despite the requirement to be resilient to a 1 in 500-year drought. In the next sections we examine options for closing the forecast supply demand gap in the most cost effective, resilient and environmentally acceptable way, whilst also delivering the government policy targets for leakage and demand reduction.

11.2 WRMP Supply-Demand Position

Our WRMP19 set out a position whereby there was not a significant supply demand deficit until 2038/39. The maximum size of the deficit was 6.99Ml/d by 2044/45. This deficit was able to be addressed largely through the delivery of leakage options. The review and update of all the components of the supply demand balance to support the WRMP24 shows that a deficit is still not predicted until later in the planning period, from 2048/49 onwards. The deficit starts at 0.69Ml/d in 2048/49, rising to 48.69Ml/d by 2080. The increase in deficit over this planning period is driven by the requirement to plan to the 1 in 500 level of drought resilience from 2025 onwards, and the effects of climate change and population increases.

Figure 11-1 presents the baseline supply demand balance for the Bristol Water WRZ.

It shows that for the first 20 years of the planning period we are in surplus and supply is exceeding the forecast demand (plus headroom uncertainty) volume. However, after 2047, the demand continues to increase, mainly as a result of an increase in the forecast population within the Bristol Water supply area. The WRZ falls into deficit in 2048.

The supply demand deficit continues to increase across the planning period as distribution input increases and WAFU decreases, as a result of the effects of climate change on forecast deployable output, but also as a result of the additional supply reductions associated with the delivery of the estimated environmental destination resilience requirements by 2030.

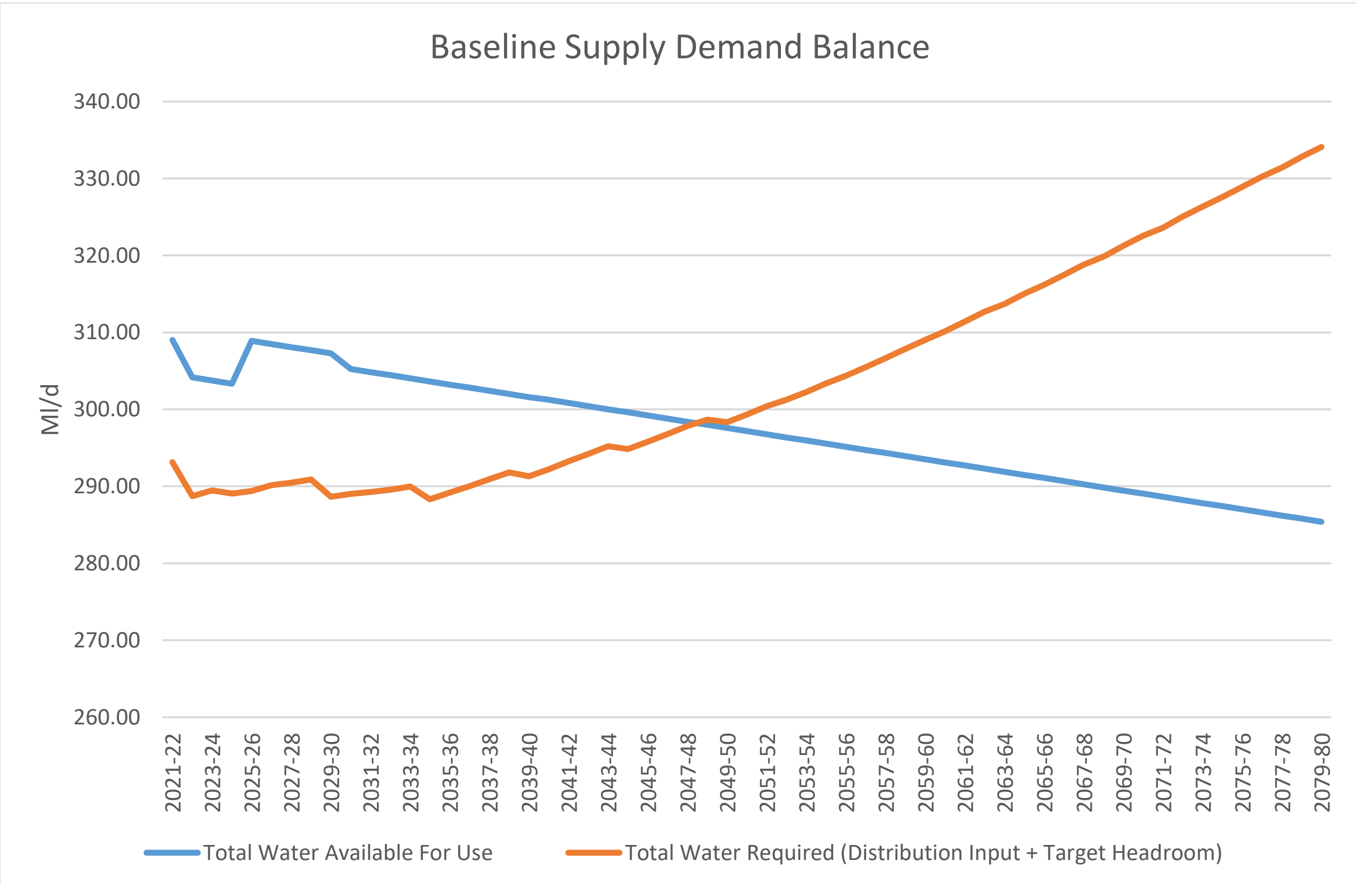
The overall effect is that the supply demand deficit is estimated to be 0.76Ml/d by 2050 and then steadily rise to 48.69Ml/d by 2080. The balance of supply for the dry year annual average planning scenario is summarised in **Table 11-1**.

As a supply demand deficit is forecast over the planning period, an assessment of the possible options available to meet this deficit is required. The options appraisal process is set out in **Section 12**, and the appraisal of the most suitable option solution is set out in **Section 14** with the final best value water resource and demand strategy set out in **Section 15**.

Table 11-1: Summary of the balance of supply across the 55-year planning period

AMP	Start of AMP8	End of AMP8	End of AMP9	End of AMP10	End of AMP11	End of AMP12	2079/80
Year	2025/26	2029/30	2034/35	2039/40	2044/45	2049/50	
Supply demand balance (including headroom) Ml/d	19.52	18.61	15.30	10.30	4.79	-0.76	-48.69

Figure 11-1: WRMP24 baseline supply demand balance



12 Options Appraisal

12.1 Overview

We have developed a wide range of possible options, alone or in combination, which could be used to close the forecast supply demand deficits across a range of different scenarios.

In total 138 separate options for closing the gap were initially developed including leakage reduction, demand management, improvements to production works and new resource options. Over the screening process this list was refined and reduced to 70feasible options which cover the same categories of leakage, demand management, production improvements and new resources/water transfers.

Options have been assessed against environmental and social criteria, carbon costs, ecosystems services impacts as well as monetary costs. The preferred programme of measures for WRMP24 can select from this wide range of options to manage the supply demand balance over the planning period to the end of the century.

All options, the outcomes of the various screening processes and explanations of decisions are reported on in this document and in separate detailed reports available in **Appendix D, E, F, G** and **H**. This reporting is an essential part of transparency of decision making and allows a formal audit trail for inspection by regulators and other stakeholders.

12.2 Introduction

The options appraisal process is compliant with the Water Resource Planning Guidelines[59]. Where relevant, the latest UKWIR and Environment Agency guidance has been used to support the appraisal.

The approach taken for the detailed appraisal of options is based upon the following assumptions:

- It was assumed that Bristol Water would aim to deliver the Environmental Improvement Plan (EIP) targets to reduce the use of public water supply in England per head of population by 20% from the 2019 to 2020 baseline reporting figures, by 31 March 2038 (with interim targets of 9% by 31 March 2027 and 14% by 31 March 2032).
- It was assumed that Bristol Water would aim to develop a plan to reduce per capita consumption (PCC) to 110 litres per head per day by 2050 as outlined by the National Framework for Water Resources[60] and the EIP and to also deliver the interim 122 litres per head per day by 2038 EIP target.
- It was assumed that a programme of works to reduce non-household demand would be undertaken and that the options selected would generally align to the programme of work for household demand reduction to deliver non-household reductions in water use of 9% by 2038 and 15% by 2050 from a 2019/20 baseline.

[59] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[60] Environment Agency, March 2020. Meeting our future water needs: a national framework for water resources. March, 91.

- It was assumed that Bristol Water would aim to develop a leakage plan to deliver leakage levels as indicated in the Public Interest Commitment (PIC) to 2030, EIP to 2027 and 2032 and National Infrastructure Commission's (NIC) challenge to 2050, aligned with West Country Water Resource (WCWR) leakage reduction scenarios. These targets include leakage reductions from a 2017/18 baseline of 20% by 2027, 30% by 2032, 37% by 2038 and 50% by 2050.
- It was assumed that the remaining deficit in the supply-demand balance, after the actions for leakage and PCC had been taken, if any, would be small. This assumption was considered during the coarse screening and detailed appraisal stage of the method. The detailed appraisal of the supply options is commensurate with these assumptions.

The method for options appraisal for Bristol Water was undertaken in three main stages:

1. Identification of an unconstrained list of possible options.
2. Development of a feasible list of options
3. Options appraisal

The approach followed a simple screening approach which aimed to exclude those options that are obviously inappropriate and keep in any options that may plausibly be feasible. In this respect a precautionary approach was take to the development of the feasible options list.

12.3 Identification of an unconstrained list of possible options

Unconstrained options were developed following the review of a number of documents and through discussion with key Bristol Water personnel. Key sources of information were:

- Unconstrained options lists from WRMP19
- Feasible options list from WRMP19
- Drought Plan 2022[61]
- Cross-referencing with UKWIR report *The Economics of Balancing Supply and Demand (EBSD) Guidelines* table 3.1[62]
- Cross-referencing with WRMP14

Other sources of information include were regional planning activities and discussion with other water companies. An initial workshop with key stakeholders at Bristol Water to discuss and add to the unconstrained list of options was held in March 2022.

The initial list of options covered a wide range of potential solutions including demand management measures, leakage control, distribution and production management and water resource options. There were also several other options such as research needs and options that may be considered more suitable to extreme drought response. No option suggested was excluded from the initial list for any reason.

[61] Bristol Water, April 2022. *Bristol Water Drought Plan 2022*. October. http://www.bristolwater.co.uk/
[62] UKWIR, 2002. *The Economics of Balancing Supply and Demand (EBSD) Guidelines.* UK Water Industry Research Ltd Report 09/WR/27/4.

The initial list of options was rationalised; duplicates were removed, and some options were either merged, expanded or replaced where new information had become available since their inception.
After the list was rationalised, key information on the options was collated. This may include but was not limited to:

(i) Summary description of the options based upon previous work including key elements of the options.
(ii) Location (GIS) data.
(iii) Opportunities or requirement for discussions with other water companies
(iv) Key risks previously identified such as customer acceptability or environmental risks.
(v) Any linked or mutually exclusive options.
(vi) Estimated yield benefit of the scheme.

The result of this stage in the process was 138 unconstrained options; 33 supply-side options and 98 demand (including 7 leakage) options.

12.4 Development of a feasible list of options

The unconstrained options were subject to a coarse screening process. Where the screening identified over-riding constraints or poor performance against a number of criteria, such options are removed from the appraisal process. The coarse screening criteria were:

i. Feasibility and risk: likely political and customer acceptability of each option.
ii. Engineering: likely complexity of engineering and technology risks and requirements.
iii. Performance: likely scale of the supply benefit or water saving relative to the deficit and scale of any resilience benefits.
iv. Operational: compliance to drinking water criteria.
v. Environmental and social: likely risks to environmental and social criteria; informed by high-level SEA assessment and proximity to nationally and internationally designated sites.

The coarse screening was qualitative; based upon the available data, information and expert judgement. The results of the coarse screening were discussed at meetings and workshops between the contractor teams and relevant personnel at Bristol Water. Each unconstrained option was appraised and colour coded during this process. A traffic light system was adopted: one "significant" red flag or two "moderate" amber flags cause the option to be rejected. All green flags or only one "moderate" flag and the option is accepted into the feasible list for further evaluation.

The screening approach was precautionary; if there was doubt or disagreement between those discussing the option as to its score, the option would be put through to the feasible list, not rejected. The result of the screening process was 87 feasible options: 11 supply-side options and 76 demand (including 10 leakage) options.

The consultation process led to the development and/or refinement of a number of options:

- Leakage option: The costs and effectiveness of the components of the leakage scenarios tested were reviewed in the context of consultation feedback and in conjunction with similar options

being tested by South West Water. This resulted in three new leakage scenario optimisation runs being evaluated:
  - 50% reduction in leakage by 2040
  - 50% reduction in leakage by 2045
  - 50% reduction in leakage by 2050
- Demand options (non-leakage):
  - Flow regulators: A further four options have been developed and added to the feasible list that have been developed in conjunction with South West Water. These options draw upon experience by South West Water installing flow restriction devices into people's homes. The different options offer different permutations of services with/without a household audit or meter and either targeted at high water users or not.
  - Metering: In response to the consultation responses we received from Ofwat, Arqiva and CCW and in collaboration with South West Water, our preferred metering option has been refined. The focus is now on AMI meters in order to enable customers to exploit the benefits of the additional information that this technology should bring.
- Supply options:
  - Cheddar 2 reservoir: As outlined in **Section 12.7.4**, there is no need in Bristol Water's supply area for an additional reservoir at the present time and no DYAA benefit from this option to Bristol Water customers. As a result, the option has been removed from Bristol's feasible options list. However, this option has been selected as a preferred option within the WCWR regional plan and is being developed within Bristol Water's supply area to serve the wider region as part of the RAPID gated process.

12.5 Options appraisal

The feasible options were appraised, to understand their potential scope and estimate their possible impact (in terms of water saved or yield), capex and opex costs, carbon cost and environmental impacts (see **Section 13**) across the planning period.

Options were evaluated separately, depending on their focus on either leakage, household demand, non-household demand or supply-side activities. No options were excluded at this stage.

12.6 Options Appraisal Findings

In total there were 191 options identified in the initial data gathering process. After duplicates had been removed and subsequently 6 options added for the WRMP, there were 138 options remaining in the unconstrained list. These comprised:

- Customer demand management options (to reduce overall customer demand and promote water efficiency): 97 options.
- Distribution options (to reduce leakage and enhance intrazonal transfers within the distribution network): 8 options.

- Production options (to increase deployable output by improvements at existing water treatment works and/or reduce water treatment works or raw water losses): 4 options
- Resource options (develop new sources or enhance existing sources): 29 options.

The outcome of the coarse option screening process for the draft WRMP24 was a final constrained, feasible list of 70 options. These are made up of:

- Customer demand management options: 58 options.
- Distribution: 2 options.
- Production options: 3 options
- Resource options: 7 options.

One supply-side option, Honeyhurst well, is also a supply-side measure in the latest drought plan. If this option were to be selected, it is considered to offer additional resilience as well as an increased yield benefit.

Demand-side drought options such as changes to temporary use bans, non-essential use bans and drought orders were considered and evaluated equally alongside all other potential options. However, these options were not taken through to the feasible list. They remain on the unconstrained list. This is because Bristol Water consider these options to be temporary methods of dealing with acute weather conditions i.e., droughts, which occur rarely.

They should not be employed on a regular basis to manage water resources under "normal" conditions as defined by the resilience level of the WRMP. Employment of such options would likely be unacceptable to customers and would place additional risk to the natural environment if employed on a more regular basis.

All the options in the unconstrained list (including those that become feasible options) are presented in the accompanying water resource planning tables, Table 5. The exception is for leakage reduction activities. These are listed below in **Table 12-1**.

Table 12-1: Individual feasible leakage reduction activities considered in the optimisation process

ID	Title
D001	Pressure reduction
D002	Mains infrastructure replacement
D003	Communication pipe replacement
D004	Communication pipe and subsidised supply pipe replacement
D005	Leak-stop enhanced
D006	Active leakage control increase
D007	Enhanced permanent zonal monitoring (includes permanent noise loggers, district meters etc...)
D008	Lift and shift loggers
D009	Customer side leakage reduction through smart metering
D010	Innovation fund

12.7 Constrained Options: Costs and Deployable Output/ Demand Saving Benefits

12.7.1 Leakage

Leakage reduction activities were optimised separately by RPS to assist in developing an intelligent pathway for delivering the reduction requirements set out by public interest commitments (PIC) to 2030, the Environmental Improvement Plan (EIP) to 2038 and National Infrastructure Commissions (NIC) 50% reduction challenge to 2050. The RPS's Strategic Optimisation of Leakage Options for Water Resources (SoLow) tool has been used to find the most efficient mix of these activities to deliver a range of leakage reduction scenarios. The optimised programme of activities for each of the different scenarios of leakage reduction are presented in our planning tables.

A range of activities and scenarios were considered with the aim to both achieve the commitments outlined above but also to be consistent with the activities of the West Country Water Resources Group (WCWRG). The results are presented in

Table 12-2. The conclusions can be summarised as follows:

- An ambitious target of 50% leakage reduction by 2049/50 has been selected that will deliver on customer expectations and with a glidepath which meets the statutory targets.
- The target of long term leakage reduction reaching 50% should be achieved though it will require significant mains replacement, along with increases in pressure management, DMA intensive ALC, and supported by the smart metering programme.
- The shorter-term leakage reduction targets of 20% by 2026/27, 30% by 2031/32 and 37% by 2037/38 will be met through targeting a 50% reduction by 2049/50.
- The accelerated programme of customer supply pipe replacements will act to reduce leakage, changing the baseline leakage level from which optimisation has been performed.
- The linear scenarios described are not strictly linear but provide an optimal programme of investment and leakage reductions to meet the long term target of 50% by respective target dates.
- Extensive sensitivity testing of the leakage reduction scenarios has shown that achieving a lower target of 30% leakage reduction by 2050 would also require significant investment in mains replacement (asset renewal), pressure management, and DMA ALC.
- By backloading leakage reductions to the latter half of the planning period, the total costs rise significantly to deliver the 50% reduction by 2050 and has been determined as unfair on future customers.
- The costs to achieve 50% reductions by 2040 rise significantly in the short term and will require a highly disruptive delivery programme of mains renewal.
- Testing has indicated that by under achieving and meeting the 50% reduction target by 2055 costs would be marginally lower, however interim leakage targets would also not be achieved.
- Customer side leakage has been identified as playing a large role in achieving target leakage reductions. This will be addressed through a combination of smart metering to identify leaks, a continuation of Bristol Waters support to customers to repair supply pipes, and a programme of customer supply pipe renewal.

Table 12-2 Summary of leakage reduction scenario optimisations for the period 2024/25 to 2049/50

Scenario	Leakage reduction (Ml/d)	Direct leakage reduction costs (£m)	Carbon Cost (£m)	Cost of Water (£m)	25yr undiscounted cost (£m)	25yr discounted cost (£m)	AIC (p/m³)
No reduction	-	-	10.44	29.32	213.23	138.49	
Linear reduction to 50% by 2050	9.89	303.27	27.64	23.79	510.15	315.91	17.56
Linear reduction to 50% by 2045	9.89	290.31	26.79	23.18	494.12	326.17	19.03

The demand savings across the planning period from the Linear reduction to 50% by 2049/50 scenario was used to inform the programme appraisal.

12.7.2 Demand side options

Demand options were optimised to reduce costs, meet Government led targets within the specified timeframe and, where applicable, reduce negative environmental impacts and increase positive environmental impacts. Since the dWRMP, in response to consultation comments and to improve consistency with South West Water's plan / policies and the regional group, a number of changes have been made to the options. The feasible demand-side options shown in Table 12-4 include combinations of compulsory and voluntary metering, efficiency visits for households and businesses alongside programmes for water saving or efficiency devices. Also listed are options over which Bristol Water has little influence but have the potential to make a large impact on water use. Such options include Government policies for water labelling and standards for new homes.

All metering options were separated into two versions (for AMI and AMR meters) for the purpose of the analysis as they incur different costs and benefits. Bristol Water has not rolled-out smart meters to customers before and therefore, we had to draw upon the experience of South West Water and the wider water industry to derive the costs and benefits of these options. Demand savings from smart metering household policies were based on assumed PCC reductions from changes in customer behaviour from increased data granularity[63] and smart-based app user engagement[64]. Lifetime costs included the ongoing maintenance and replacement of meters in subsequent years from a new installation. These apply for the duration of the 80-year discount period. The WRMP process has identified that AMI metering presents the most effective approach. The smart metering programme has been broken down into the different ways in which the meters may be installed, see Table 12-3. For options A, C and D numbers of meters were consistent with the micro component forecast model and an assumption that 1% of meters are replaced annually as they reach the end of life. Options B and E meter numbers were estimated based off calculations for the additional metering required to meet the 90% penetration target. The estimated number of optants required to meet the 90% target was well below the annual number Bristol Water receives currently, and as such is the forecast profile may be considered conservative. Installation types A and C are considered to be baseline smart metering and installation type B, D and E are enhancement

[63] Pathways to long-term PCC reduction, Artesia, Water UK AR1286 (2019)
[64] Cominola, A., et al., Long-term water conservation is fostered by smart meter-based feedback and digital user engagement, Clean Water Vol 4 (2021)

smart metering. These two options have different notations within the planning tables, the former is HH_M_009 (AMI) (15) (Baseline) and the latter is HH_M_009 (AMI) (15) (Enhancement).

Table 12-3 Roll out profile of how smart meters are installed.

Smart meter install type	Reference
Dumb meters switched to smart at end of life (EoL) (instead of remaining dumb)	A
Dumb meters switched to smart non- EOL	B
New household with smart meter (instead of dumb meter)	C
Unmetered with smart meter households selectives	D
Unmetered to smart meter households optants	E

AMI Smart metering provides an effective means for Bristol Water and our customers to understand and reduce personal water consumption; it will play a significant role in reducing consumption down to 110 litre per capita target levels by 2050. Through the data and information that smart metering provides additional demand side options are enabled and their success can be measured.

It is recognised that engagement and collaboration with the retail market is critical to deliver and maintain non-household reductions in water use of 9% by 2038 and 15% by 2050.

Table 12-4: AIC and demand savings for feasible demand-side options

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m^3) (2dp)
HH_M_009 (AMI) (15) (Baseline)	Progressive AMI smart metering & Watersmart (15 year) (Baseline)	When basic water meters require renewal they will be replaced by a smart meter.	4.01	966.33
HH_M_009 (AMI) (15) (Enhancement)	Progressive AMI smart metering & Watersmart (15 year)	Smart meters are installed by water companies at 90% of homes over 15 years. Homes are encouraged to switch to a meter using bill comparisons over a 2 year period. After this period homes are automatically switched. This option makes use of customer meter and other data to provide personalised bills and behavioural nudges (e.g. comparisons against local averages).	13.84	1467.98
HH_A_001	Home efficiency visits (HEV) - Targeted water efficiency audit with free water efficient device installation - In person.	Visits include undertaking a water audit, advice and tailored retrofit of free water efficient devices where required (e.g. leaky loo fix). The visits are selected based on high potential for water saving (e.g. highest unaccountable water, household high water usage, areas of highest leakage).	14.32	493.14
HH_A_002	Home efficiency visits (HEV) - water efficiency audit with	Visits include undertaking a water audit, advice and tailored retrofit of free water efficient devices where required (e.g.	5.42	1214.97

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
	free water efficient device installation - metered	leaky loo fix) to households with a meter already installed.		
HH_A_003	Home efficiency visits (HEV) - water efficiency audit with free water efficient device installation - New meter	Visits include undertaking a water audit, advice and tailored retrofit of free water efficient devices where required (e.g. leaky loo fix). HEV's are provided alongside the company's ongoing smart meter rollout.	13.78	824.84
HH_A_004	Virtual Home efficiency visits (VHEV) - water efficiency audit with free water efficient devices	Virtual home use assessment undertaken online. The assessment provides advice, recommendations and actions, and includes sending free water efficiency devices for self-install.	5.33	2679.45
HH_E_001	Appliance subsidies (rebates for water efficient devices and appliances)	Appliance subsidy programme for customers in WCWR region. This would include WCs, showers, smart taps, dishwashers and washing machines. The rationale behind this option is to encourage customers to exchange less efficient appliances for more water efficient appliances and thus use less water. The cost of subsidising the efficient water appliances would be borne by water company. This would 'free up' resources to be used by other customers.	0.86	17497.65
HH_E_002	Pay per use appliances (e.g. Miele bundles subscription)	The manufacturer Miele offers a service plan for washing machines and dishwashers which include flat monthly fee or pay-per-use option with a lower monthly fee and a cost per use, with online functionality (i.e. smart devices). This option assumes that the water company will subsides this service for customers taking it up.	0.11	3680.82
HH_E_004	Leaky Loos' Wastage Fix: large scale targeted fixes	This option is to find and fix leaky loos using data from metered customers, and through awareness campaigns and initiatives for unmetered customers. Customers would be able to identify leaky loos using simple measures such as leak strips or drops of food dye in the cistern. Water companies would then arrange for repair or replacement of the faulty cistern mechanism at no cost to the customer. The effectiveness of this intervention will be proportional to smart meter penetration, as smart meter	3.41	317.81

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
		data will indicate which households have high levels of continuous flow. Here listed as a stand-alone option, but most likely implemented as an add on to virtual or HEVs.		
HH_E_005	Eco branding water efficiency programme	This option relies on motivation of people to 'do the right thing'. Option could include provision of free or subsidised water efficiency devices, which are eco-branded. Could be accompanied by information on contribution of water efficiency to local environmental (e.g. river flow) and social (e.g. affordability) goals. Likely to appeal to subset of customers only.	1.18	675.44
HH_E_006	Distribution of household water efficiency kits for self-installation - via the water company of WCWR website.	This option would allow customers to request a household water efficiency kit (e.g. aerated shower heads, cistern displacement devices, shower timers, tap inserts) with a booklet containing advice on water efficiency via the website.	4.27	671.98
HH_E_008	Partnerships/targeting of large/small developers to install water efficient devices	Work in partnership with selected developers to ensure all homes are designed to enhanced water efficiency standards beyond building regulations, through the installation of high efficiency water fittings, including installation of rainwater harvesting.	5.88	0.41
HH_E_009	Home Efficiency Visits (HEVs) - water efficiency audit - local authorities, housing associations, corporate landlords)	Visits include undertaking a water audit, advice and tailored retrofit of free water efficient devices where required. Targeted at specific housing stock of local authorities or housing associations. The visits are selected based on high potential for water savings.	1.01	9201.82
HH_E_010	Home Efficiency Visits (HEVs) - water efficiency audit - combined with energy efficiency audits	Visits include undertaking a water audit, advice and tailored retrofit of free water efficient devices where required. These visits are combined with energy efficiency advice into a new joint delivery mechanism. Synergies between using less hot water and reduction in energy.	7.62	1657.15
HH_E_013	School visits water efficiency programme	This option involves working in partnership with schools across the WCWR region to promote water efficiency. The aim is that education regarding water efficiency starts at an early age and therefore will result in long	0.06	559.20

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m^3) (2dp)
		term demand savings. This would be tailored for children for the different key stages. It would provide lesson plans and material to allow teachers to deliver water efficiency lessons, this would be provided to all schools. This would also be accompanied by a set number of school visits..		
HH_E_016	Media campaigns to influence water use	This option would provide ambitious year-round campaigns to influence water use by raising public awareness of why we need to save water and to help drive uptake of water efficiency programmes and tools. Recent research has shown that customers who have a better understand of the bigger picture can make them more responsive to messages of how to save water. The central purpose and message of the campaigns are to urge all customers to conserve water, especially during periods of drought.	2.37	1762.86
HH_I_001	Targeted incentives scheme - Individual customer/community reward (e.g. Greenredeem) - New metered customers	This option will offer non-financial incentives in the form of shopping vouchers/discounts, prize draws and charity donations to increase awareness and motivation to reduce water use, it will be delivered in association with Greenredeem. The option will include the use of innovative apps and website content, whilst maximising the benefits offered through smart metering data. This will be targeted at new smart metered customers.	6.17	8.02
HH_I_004	Community competition	A competition between communities (e.g. towns or villages) to save the most water. The 'winner' may receive a prize (e.g. community asset).	0.07	7292.13
HH_T_006	Community reward tariff	The objective of this tariff to encourage community to reduce water use, by providing a reward in the form of a WCWR funded community reward. If the community reduces its combined water use during a defined period of time then they get rewarded with a WCWR funded community reward.	0.06	133705.6 4
HH_T_008	Individual reward tariff	In this option customers could be offered a financial reward for reducing their consumption below the identified	0.14	6757.74

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
		threshold level (e.g. money off their next water bill).		
HH_N_002	Home retrofit of rainwater harvesting	This option encourages the retrofitting of rainwater harvesting systems to existing housing stock.	0.56	58.31
HH_N_003	Rainshare - Communities direct harvested rainwater into a centralised shared resource	Work with the Council to identify Rainshare twinning schemes, e.g. where buildings with low demand but which can generate high rainfall yields are located next to buildings or other demands with high non-potable demand (e.g. for irrigating or dual-supply toilet flushing). The rationale behind this option is that the harvested rainwater will replace water that had been or would have been taken from public mains supply.	0.38	4087.77
HH_N_004	Grey water recycling retrofitting to existing properties.	This option retrofits grey water recycling systems into existing houses. Greywater recycling systems collect the water you've used in sinks, dishwashers, showers and baths, treat it and plumb it straight back for use in toilets, washing machines and outside tap.	1.15	4218.77
C019	Water Butts (Bristol Water subsidy)	This option would involve the installation of water butts in households. Bristol Water would subsidise the costs of the installation of water butts. The rationale is that rainwater would be used for garden water use instead of potable water from the public supply system, reducing demand.	0.40	1787.31
HH_P_001	Change WC standards	The option is a specific change to water supply fitting regulations to WC's that would prevent future installation of potentially leaky loos.	4.77	0.50
HH_P_002	Water labelling - with minimum standards	In this intervention water labelling of relevant products is legislated as mandatory and managed by government. The scheme would be operated in association with Building Regulations and minimum standards (i.e. based on changes to The Water Supply (Water Fittings) Regulations 1999). This would mean that only products performing at a baseline level will be allowed on the market and referenced in the Building Regulations. This would require not only the development of the labelling policy but also the development	51.93	0.04

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
		and agreement on the baseline standard and the amendment of the relevant Building Regulations.		
HH_P_003	Water labelling - with no minimum standards	In this option water labelling of relevant water using products is legislated as mandatory (for manufacturers and retailers similar to the current energy label regulations) and managed by government.	21.50	0.09
HH_P_004	New development standards - water neutrality	Influencing planning authorities to grant permission for larger developments to build in water neutrality to the overall masterplan. Delivered through efficient design, non-potable rainwater harvesting, and associated retrofits elsewhere within a defined radius.	2.60	0.92
HH_P_005	New home standards - mandatory	The option will require all developers to install water using devices to meet specific standards.	12.98	0.18
HH_W_001	Resource West campaign	This option continues the existing WR West campaign and innovates within it to continue to influence customers to reduce usage and reach a wider audience than currently reached.	0.15	305.34
NHH_A_001	Business Efficiency Visits (BEV) - water efficiency audit - in person audit, fix and retrofit, targeted at specific sectors/businesses	Visits to businesses including undertaking a water audit, advice and tailored retrofit of free water efficient devices to bathrooms and kitchens only (not wider process water). Business sectors are targeted based on high potential for water savings. BEV's are undertaken following liaison with Water Retailers.	0.53	1042.03
NHH_A_003 & NHH_A_006	Business Efficiency Visits (HEV) - leakage detection - in person targeted at specific sectors/businesses	BEV particularly targeted at leakage detection and fix. Targeted where high water usage would indicate that leakage might be occurring. BEV are undertaken following liaison with Water Retailers. Specific BEVs to be target individual customers through detailed analysis of MOSL data.	0.64	1091.10
NHH_E_001	Sector specific water efficiency advice e.g. partnerships with holiday rental companies Airbnb.	This option seeks to increase water efficiency within an element of the tourist sector that remains a component of household demand. The initiative assumes that South West Water will work in partnership with Airbnb, or similar accommodation providers to reduce water use amongst their members. This is a growing sector, and	0.01	2386.82

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m^3) (2dp)
		of particular relevance to the South West of England, especially during periods of peak demand.		
NHH_E_002 (AMI)	Progressive AMI smart metering & Watersmart (25 year)	Smart meters are installed over 25 years. The development of a central website/customer engagement dashboard website to provide information on water efficiency campaigns and online tools for customers to engage with that provide water efficiency advice (e.g. water calculators - effectively acting as a self-audit) and wider resources.	0.71	2560.00
NHH_I_001	Rewards to water retailers for business water use savings.	Introduce a scheme whereby water companies reward in-region retailers with a one-off payment for water saved for each of their non-household customers.	0.18	11964.48
NHH_T_003	Benchmarked rising block business tariffs	This option would require benchmarking of sector water usage to determine base water requirements. Usage would be billed at a lower rate until the benchmarked base use had been reached in a given time period (monthly/annual), and usage beyond this billed at a higher rate.	0.06	769.41
NHH_N_001	Rainwater harvesting is included in new developments to meet planning conditions - commercial/public sector developments - single or multiple	This option would work with developers to provide rainwater harvesting systems to provide a non-potable supply for use within the new commercial properties. Water is collected from roof runoff and a sustainable drainage system is created. The collected water goes through a basic level of treatment. Rainwater harvesting is included in the development to meet planning conditions.	0.02	10723.42
NHH_N_002	Rainwater harvesting feasibility assessment and/or subsidised installation - target large water users	This option would support the user through financial subsidy to carry out a feasibility assessment for the installation of rainwater harvesting systems to existing commercial buildings to provide non potable water supply. Specific commercial premises would be targeted with high water consumption.	0.18	40.42
NHH_N_003	Rainwater harvesting - target large water users	This option would involve the water company financing the retrofit of rainwater harvesting systems to existing commercial buildings to provide non potable water supply. Specific	0.33	201.92

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
		commercial premises would be targeted with high water consumption.		
C016	Water saving devices - waterless urinals	This option would involve the installation of waterless urinals in non-household properties to replace existing urinals. The rationale behind this option is to reduce demand for water used for urinal flushing. This would 'free up' resources to be used by other customers.	1.03	461.46
HH_A_005	Home efficiency visits (HEV) - HEV/retrofit visits during flow regulator installation visit.	Developed during spring 2023 in response to regulator comments on the dWRMP24 and with respect to PR19 PCC target recovery. •These are more conventional interventions but managed in the same way on a sub-contract basis initially within programmes to install flow regulators by the same contractor •This is a slightly lower outcome return and there is an increased risk of savings decay since it is more dependent on behaviour change •It is applicable in high usage household where the option of a flow regulator installation is not available	0.00	439843.84
HH_E_020	Communication and awareness campaign	Developed during spring 2023 in response to regulator comments on the dWRMP24 and with respect to PR19 PCC target recovery. This option would be a general awareness campaign, smaller in scale than HH_E_016 and less targeted that HH_E_017. •Ensure continuous public awareness of the importance of using water efficiently and provides pointers to other programme elements and benefits •Costs allow extensive use of product orders •Can reach relatively large numbers of people and assist with them making relatively small savings	0.02	8537.47
HH_E_021	Innovative water saving devices 1 – Installation of flow regulators in supply pipes	Developed during spring 2023 in response to regulator comments on the dWRMP24 and with respect to PR19 PCC target recovery. •Use of sub-contract programmes of installation following successful programmes in SWW in the Colliford and	8.98	32.37

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m^3) (2dp)
		Roadford supply areas •Proven process with good feedback from customers •The programme should be trialled in the Bristol supply area in AMP7 to understand the effect of differences between Bristol and the SWW supply areas implemented so far •Many water companies are now making use of these devices although they are not shown as a specific type of intervention		
HH_E_022	Innovative water saving devices 2 – Installation of flow regulators with meter installation	Developed during spring 2023 in response to regulator comments on the dWRMP24 and with respect to PR19 PCC target recovery. •By the start of AMP8, Bristol Water must still install meters at 15% of households to reach 90% penetration whatever type of meter is to be used; this offers the a lower cost means of installing flow regulators during the same installation visits •This process also needs to be trialled in AMP7 to work out the best means to ensure the same level of acceptability for customers	21.63	18.53
HH_E_023	Innovative water saving devices 3 - Combining installation with home efficiency visits	Developed during spring 2023 in response to regulator comments on the dWRMP24 and with respect to PR19 PCC target recovery. •This is the most comprehensive approach to reducing individual household usage but also the most expensive and so needs to be targeted towards higher usage customers as much as possible, the right-hand side of the distribution in the chart in section 1.1.1. •This a more proven approach and does not depend to the same extent on the need for a trial during AMP7	0.03	14332.81
HH_E_017 (AMI)	Water efficiency programmes targeted at specific groups (e.g. community, religious groups) (AMI)	A focused water efficiency programme at targeted locations across the WCWR area including advertising, education and other outreach work, plus the installation of smart meters aiming to achieve an average consumption across the targeted area This option assumes only 1% of HHs in a company zone are	0.38	7912.15

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
		targeted within a specific community/religious group. Of these 1% an uptake goal of 38% is targeted (in the mid scenario) and assumed to be achieved in 5 years (end of AMP period), e.g. 38% of the 1% of households targeted in the mid scenario all are assumed to establish PCC savings related to behavioural change.		
HH_E_017 (AMR)	Water efficiency programmes targeted at specific groups (e.g. community, religious groups) (AMR)	A focused water efficiency programme at targeted locations across the WCWR area including advertising, education and other outreach work, plus the installation of smart meters aiming to achieve an average consumption across the targeted area This option assumes only 1% of HHs in a company zone are targeted within a specific community/religious group. Of these 1% an uptake goal of 38% is targeted (in the mid scenario) and assumed to be achieved in 5 years (end of AMP period), e.g. 38% of the 1% of households targeted in the mid scenario all are assumed to establish PCC savings related to behavioural change.	0.38	6217.38
HH_M_001 (AMI)	Progressive smart metering - automatic switching over WCWR region (AMI)	Smart meters are installed by water companies at up to 90% of homes. Homes are encouraged to switch to a meter using bill comparisons over a 2 year period. After this period homes are automatically switched. At present only water stressed areas can implement compulsory switching from an unmetered to metered bill. It would require government support. SMART metering is rolled out to all customers over the next 25 years in the region, reaching the uptake goal of 90% of all HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear, i.e. the same number of smart meters installed each calendar year until the uptake target is reached, and it is assumed each HH achieves the same average PCC water savings from the switch (reduced savings when switching from dumb to smart compared to switching from no meter to smart).	5.56	21744.93

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m^3) (2dp)
HH_M_001 (AMR)	Progressive smart metering - automatic switching over WCWR region (AMR)	Smart meters are installed by water companies at up to 90% of homes. Homes are encouraged to switch to a meter using bill comparisons over a 2 year period. After this period homes are automatically switched. At present only water stressed areas can implement compulsory switching from an unmetered to metered bill. It would require government support. SMART metering is rolled out to all customers over the next 25 years in the region, reaching the uptake goal of 90% of all HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear, i.e. the same number of smart meters installed each calendar year until the uptake target is reached, and it is assumed each HH achieves the same average PCC water savings from the switch (reduced savings when switching from dumb to smart compared to switching from no meter to smart).	5.28	8253.24
HH_M_002 (AMI)	Progressive smart metering - voluntary switching over WCWR region (AMI)	Water companies install smart water meters. Homes are encouraged to switch to a meter using bill comparisons over a 2 year period. Switching is voluntary; therefore, this option does not require government support. Companies are still able to meter customers when there is a change in property ownership.	3.48	24326.99
HH_M_002 (AMR)	Progressive smart metering voluntary WCWR switch (AMR)	Water companies install smart water meters. Homes are encouraged to switch to a meter using bill comparisons over a 2 year period. Switching is voluntary; therefore, this option does not require government support. Companies are still able to meter customers when there is a change in property ownership.	3.30	9275.17
HH_M_004 (AMI)	Switch all existing dumb meters to smart meters across the WCWR region (AMI)	All dumb meters are switched across to smart meters. SMART metering is rolled out to all customers currently on dumb meters over the next 25 years in the region, reaching the uptake goal of 90% of dumb metered HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear (i.e. the same number of meters are switched to smart meters each calendar year) and it is assumed each HH achieves the same average PCC	3.79	26863.86

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
		water savings for the dumb to smart meter switch.		
HH_M_004 (AMR)	Dumb meters to smart meters automatic WCWR switch (AMR)	All dumb meters are switched across to smart meters. SMART metering is rolled out to all customers currently on dumb meters over the next 25 years in the region, reaching the uptake goal of 90% of dumb metered HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear (i.e. the same number of meters are switched to smart meters each calendar year) and it is assumed each HH achieves the same average PCC water savings for the dumb to smart meter switch.	3.79	21672.61
HH_M_005 (AMI)	Targeted switching of dumb meters to smart meters across the WCWR region (AMI)	Dumb meters to switch to smart meters are targeted. This could be based on areas with the highest unaccountable water, highest water usage, highest leakage. Could be constrained by communications network. SMART metering is rolled out to a targeted group of customers currently on dumb meters over the next 25 years in the region, reaching the uptake goal of 63% of dumb metered HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear (i.e. the same number of meters are switched to smart meters each calendar year) and it is assumed each HH achieves the same average PCC water savings for the dumb to smart switch.	2.65	26902.60
HH_M_005 (AMR)	Dumb meters to smart meters targeted WCWR switch (AMR)	Dumb meters to switch to smart meters are targeted. This could be based on areas with the highest unaccountable water, highest water usage, highest leakage. Could be constrained by communications network. SMART metering is rolled out to a targeted group of customers currently on dumb meters over the next 25 years in the region, reaching the uptake goal of 63% of dumb metered HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear (i.e. the same number of meters are switched to smart meters each calendar year) and it is assumed each HH achieves the same average PCC	2.65	21711.34

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m^3) (2dp)
		water savings for the dumb to smart switch.		
HH_M_006 (AMI)	Selective/targeted new smart metering installation (AMI)	Smart meters are installed in properties without meters. This could be based on areas with the highest unaccountable water, household high water usage, areas of highest leakage. Could be constrained by communications network. SMART metering is rolled out to a targeted group of customers currently on no meters over the next 25 years in the region, reaching the uptake goal of 63% of unmetered HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear (i.e. the same number of meters are switched to smart meters each calendar year) and it is assumed each HH achieves the same average PCC water savings for the no meter to smart meter switch.	1.22	8664.43
HH_M_006 (AMR)	Non metered to smart metered targeted WCWR switch (AMR)	Smart meters are installed in properties without meters. This could be based on areas with the highest unaccountable water, household high water usage, areas of highest leakage. Could be constrained by communications network. SMART metering is rolled out to a targeted group of customers currently on no meters over the next 25 years in the region, reaching the uptake goal of 63% of unmetered HHs switched by 2050 (in mid scenario). It is assumed that the roll out is linear (i.e. the same number of meters are switched to smart meters each calendar year) and it is assumed each HH achieves the same average PCC water savings for the no meter to smart meter switch.	1.04	5493.87
HH_M_007 (AMI)	Non metered to smart metered at change of occupancy WCWR switch (AMI)	Smart meters are installed in properties without meters upon change of owner/occupier. Uptake governed by "access to those customer". Meter installation on change of occupancy is permitted.	0.15	10602.89
HH_M_007 (AMR)	Non metered to smart metered at change of occupancy WCWR switch (AMR)	Smart meters are installed in properties without meters upon change of owner/occupier. Uptake governed by "access to those customer". Meter installation on change of occupancy is permitted.	0.13	7766.55

ID	Name	Description	Savings in Demand on full implementation (Ml/d) (2 dp)	AIC (p/m³) (2dp)
HH_M_009 (AMR)	Progressive smart metering automatic WCWR switch (HH_A_001) with Watersmart Technology (personalised billing, behavioural changes) (AMR)	This option makes use of customer meter and other data to provide personalised bills and behavioural nudges (e.g. comparisons against local averages). Watersmart is rolled out with the SMART metering roll out. It's assumed it will be offered to all newly metered customers (e.g. 90% of HHs by 2050 in mid scenario), however it is assumed only 50% of customers will take up the service. Expected savings of the option is based on voluntary metering savings estimates from the Artesia Report 2019.	6.44	16031.34

12.7.3 Supply-side options

The 10 supply-side options in **Table 12-5** are varied including, new surface water sources as well as the revival of an existing groundwater source that is not currently used; improvements to water treatment works as well as a landscape scale catchment management option that has already successfully improved water quality over its extent and would be used to help manage the risk from outage due to algal blooms.

Table 12-5: Yield and AIC of supply-side options.

ID	Short description	Estimated yield (Ml/d)	AIC (p/m³) (2 dp)
P08	Increased production at WTW	7	0.06
R014	Direct Effluent Re-use	10	14.41
P06	Catchment Management to manage outage risk from algal blooms	0.7	22.58
R016	Internal transfer	20	0.27
R007	Pumped refill of reservoir	25	0.22
P01-02	Increase performance of existing sources to increase deployable output to near licensed volume	1.59	2.62
R24	Revive existing groundwater source	2.4	7.54
P01-01	Increase performance of existing sources to increase deployable output to near licensed volume	0.7	5.96
R08-03	New river water source	1.1	29.73
R08-02	New river water source	1.4	13.03

12.7.4 Cheddar 2 reservoir

A new reservoir at Cheddar was historically an option for additional resource to serve the Bristol Water area directly. During AMP5 the reservoir obtained outline planning permission, with a high level of approval and engagement from local stakeholders. However, a shift in focus for the company over recent years, to managing leakage and customer demand, means that there is no need for supply options for Bristol Water customers at the present time. This additional reservoir has however been selected as a preferred supply option within the WCWR regional plan following further analysis including the 2022 drought. As the reservoir does not provide a dry year benefit to Bristol water customers, it has been removed from the feasible option list, however it will be developed within Bristol Water's supply area to serve the wider region as part of the RAPID gated process.

The option will be constructed within Bristol Water's supply area and primarily serve the wider needs of the west country region, however it would also provide flexibility to supply high-quality water outside of drought periods to the Bristol Water area, reducing treatment and pumping costs associated with water supplied from the Gloucester & Sharpness Canal, if the need were to arise.

The scheme was also originally promoted as a potential solution to Southern Water's need in Hampshire however, it has not been selected by Southern Water and does not feature in the Water Resources South East (WRSE) plan.

The scheme will involve construction of a second reservoir at Cheddar, filling it from Cheddar springs and the river Axe, under Bristol Water's existing licences. The additional resource and improved connectivity of the region will boost resilience in the whole of the southwest. Specifically, Cheddar 2 will meet the supply deficit in SWWs Wimbleball WRZ involving the potable transfer of up to 20Ml/d from the new reservoir and WTW at Cheddar to provide a DYAA benefit of 13 Ml/d. The potable transfer will be via the supply network in the West of Wessex Water's supply area. Network reinforcement work is required in Wessex Water's supply system to increase capacity and resilience to provide this transfer. Outside of drought periods Cheddar 2 will provide a resilience benefit to Wessex Water.

As the need for the new supply comes from the rest of the region, not Bristol Water, Cheddar 2 reservoir is no longer a supply option for Bristol Water. However, to align with the WRMPs of our regional group partners and in agreement with the Environment Agency, the reservoir is included in our planning tables in Table 3b, lines 5.1FP and 6.2FP. It has no impact on the Bristol Water SDB.

12.8 Constrained Options: Assessment of Environmental and Social Effects

All the constrained options were subject to detailed statutory environmental and social assessment:

- Strategic Environmental Assessment (SEA)
- Habitats Regulations Assessment (HRA)
- Water Framework Directive Assessment (WFD)

Natural Capital Accounting (NCA) and Biodiversity Net Gain (BNG) assessments were undertaken as required by regulators to provide an assessment of ecosystem resilience and a comprehensive understanding of the benefits and costs to the natural environment of plan proposals. In addition, as required by the WRPG, an assessment of the risk of spreading Invasive non-native species (INNS) was undertaken. The options were also evaluated in light of our customer research evidence on water supply services.

These environmental and social assessments were used to inform the subsequent programme appraisal process and decision-making on the preferred plan. Further details on the environmental and social appraisal are provided in **Sections 13 and 14**.

13 Environmental Appraisal

13.1 Methodology Overview

The Water Resources Planning Guideline (WRPG)[65] including supplementary guidelines on Best Value Planning and Environment and Social Decision Making[66], and UK Water Industry Research Ltd (UKWIR) guidance advises that water companies should consider the environmental and social effects (beneficial and adverse) of the options considered for balancing supply and demand and the WRMP24 overall. Additionally, the Environmental Assessment of Plans and Programmes Regulations 2004 (the SEA Regulations)[67] require assessment of the environmental and social effects of the reasonable alternative programmes considered as part of developing WRMP24.

An integrated environmental and social assessment approach for the development of our WRMP24 has been adopted, which has been implemented from the very outset of our planning. We have applied the range of environmental assessment requirements, described further below, to all of the options considered for our WRMP24, from initial screening through to detailed assessment of the options and programmes. The SEA provides the overarching structure of the assessment approach but has been integrated with the parallel statutory assessment requirements for the EU Habitats Directive, EU Water Framework Directive (WFD), Biodiversity Net Gain (BNG) and Natural Capital Assessment (NCA), the results of which inform the SEA.

The WRMP24 decision-making process has been developed following the Environment Agency WRPG and supplementary guidelines. The Supplementary Guidance 'Environment and society in decision making' contains several requirements and recommendations for the scope of WRMP environmental assessment, in particular in relation to SEA, BNG and NCA.

UKWIR has developed several methodologies which support the WRPG. These include an updated guidance document for SEA, Habitats Regulations Assessment (HRA), and new guidance for Water Framework Directive Regulations[68] (WFD) compliance assessment and natural capital accounting (NCA) for strategic water resource plans and drought plans[69]. The specifics of this relevant to each environmental assessment as well as other assessment requirements and key guidance is documented in the respective assessment reports.

The assessment approach takes account of national environmental legislative and associated relevant national guidance. The approach to the SEA has been informed by a review of other policies, plans and programmes.

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[65] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline

[66] Environment Agency, March 2021, Water resources planning guideline supplementary guidance- Environment and society in decision-making.

[67] The Environmental Assessment of Plans and Programmes Regulations 2004 (Statutory Instrument 2004 No. 1633) apply to any plan or programme which relates solely or in part to England

[68] Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (si 2017/407)

[69] UKWIR, 2021. Environmental Assessments for Water Resources Planning. UK Water Industry Research Ltd Report 21/WR/02/15.

The carbon externality assessment for leakage reduction options followed the best practice and steps outlined in Ofwat's guidance *Providing Best Practice Guidance on the Inclusion of Externalities in the ELL Calculation*[70]. This followed a 3 stage assessment identifying externalities and providing a quantitative assessment of externalities. The carbon externalities were derived from an assessment of fuel and energy used in activities relating to leakage management, such as transportation (detection and repair of leaks) and energy used in water treatment and distribution. Emission factors were from Ofwat guidance. For the demand options conversion factors were consistent with leakage options. However, supply chain and emission data were derived from available industry literature.

For supply-side options, an assessment of embodied and operational carbon was carried out. This followed latest government and regulatory guidance and the latest industry methods for carbon assessment. In line with the requirement set out in the latest Water Resources Plan Guidance, embodied and operational carbon emissions and costs for each feasible option were calculated, following guidance from:

- HM Treasury Green Book[71] and carbon costing guidance 2020
- Department of Business Energy and Industrial Strategy (DBEIS) Green Book supplementary guidance for *Valuing Greenhouse Gas Emissions and Energy Use*[72]
- Ofwat guidance on carbon reporting and costing
- UKWIR guidance on assessing embodied[73] and operational carbon, including the latest available UKWIR carbon emissions workbook
- Environment Agency supplementary WRPG24 guidance on environmental valuation

For each of the feasible options, the scope of the assessment was based on BS EN 15978:2011 stages[74].

- Before use stage: A1-A5
- Use stage: B1-B7

Carbon costs were calculated using the latest HM Treasury Green Book supplementary guidance including the latest "Central Scenario" values in Table 3: Carbon values and sensitivities 2020-2100 for appraisal, 2020£/tCO2e of the accompanying data tables. These were provided up to 2050 and were extended to cover the 60-year scheme life.

It should be noted that in the dWRMP24, Cheddar 2 (ref. R005) was assessed but in light of developments in the regional planning process, this has been taken out of the rdWRMP24 and final WRMP24 for Bristol Water. This option is a regional SRO; the benefits of this option will be delivered to other water companies in the region. References to Cheddar 2 in this section are for completeness since it was included in the draft.

[70] Ofwat, 2008. Providing Best Practice Guidance on the Inclusion of Externalities in the ELL Calculation. PROC/01/0075 V08.
[71] Treasury, HM, 2022. *The Green Book: Appraisal and evaluation in central government*.
[72] DBEIS, 2021. *Valuation of energy use and greenhouse gas. Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government.*
[73] UKWIR, 2012. A Framework For Accounting for Embodied Carbon In Water Industry Assets. UK Water Industry Research Ltd Report 12/CL/01/15.
[74] BSI. 2011. BS EN 15978:2011 Sustainability of construction works — Assessment of environmental performance of buildings — Calculation. BSI, London.

13.2 Environmental and Social Assessment Methodologies

13.2.1 Strategic Environmental Assessment (SEA)

The objective of the SEA, according to Article I of the SEA Directive, is: "to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans with a view to promoting sustainable development."

The SEA Directive requires certain plans and programmes to undergo environmental assessment, and likely significant effects on the following issues must be addressed: "…biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including archaeological heritage, landscape and the interrelationship between the above factors."

As explained earlier in Section 3 of this Plan, we have carried out a SEA of our draft WRMP (**Appendix E**). The SEA has been fully integrated with the option appraisal process to inform the selection of the best value options for both our customers and the environment.

SEA incorporates the following generic stages:

- Stage A: Setting the context, identifying objectives, problems and opportunities, and establishing the environmental baseline (scoping)
- Stage B: Developing and refining options and assessing effects (impact assessment)
- Stage C: Preparing the Environmental Report (recording results)
- Stage D: Consulting on the Draft Plan and the Environmental Report (seeking consensus)
- Stage E: Monitoring the significant effects of the plan or programme on the environment (verification)

The assessment methodology was set out in our SEA Scoping Report, which documents Stage A of the SEA process, and was subject to statutory consultation in spring 2022. Following relevant guidance, the assessment methodology took an objectives-led approach, which is a recognised way of considering the environmental effects of a plan and comparing the effects of alternatives. Following consideration of the responses received on the SEA Scoping Report, the assessment methodology was updated. The impact assessment (Stage B of the SEA process) assessed the construction and operational effects of each option against all of the developed SEA objectives (for example those that relate to biodiversity, water quality, climate change and landscape objectives).

The SEA Environmental Report (Stage C of the SEA process) presents an assessment of the likely social and environmental effects of the WRMP and identifies ways in which any adverse effects can be avoided, minimised or mitigated and how positive effects can be enhanced. The SEA has informed the consideration of each option and the programme appraisal process, as well as development of the overall WRMP, which is explained further in **Section 13.3** The Environmental Report is included in the public consultation process for the draft WRMP (Stage D of the SEA process).

13.2.2 Habitats Regulations Assessment (HRA)

Under Regulation 63 of the Habitats Regulations, any plan or project which is likely to have a significant effect on a European site (either alone or in combination with other plans or projects) and is not directly connected with or necessary for the management of the site, must be subject to an assessment to determine the implications for the site in view of the site's conservation objectives.

Therefore, as the competent authority, Bristol Water is required to undertake a Habitats Regulations Assessment (HRA) screening exercise to assess the potential effects on European sites of implementing our WRMP. European sites include National Site Network, as defined by Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, which include those sites designated as Special Areas of Conservation (SAC) under the EU Habitats Directive, Special Protection Areas (SPA) under the Birds Directive; and Ramsar sites under the international Ramsar Convention.

The HRA is reported separately in **Appendix D**. The HRA has also been used to help inform the SEA, particularly the SEA objectives relating to the potential effects of options and the Plan on biodiversity.

For the HRA, the assessment focused on the WRMP supply options; customer demand options and the distribution options were 'screened out' from requiring assessment as both option types are designed to reduce water consumption and these types of activities are considered not to have any risk of leading to negative effects on any European sites. All of the WRMP resource options were subject to the HRA Stage 1 screening assessment and the findings are summarised in **Section 13.4**.

13.2.3 Biodiversity Net Gain and Natural Capital

As part of the WRMP, water companies must demonstrate that they have considered a range of environmental legislation and guidance, including the Environment Bill (2021) and Environment (Wales) Act (2016). Additionally, the EA and NRW have published separate supplementary guidance on Environment and Society in decision-making[75],[76], which provides more detail about the expectation for NCA or ecosystem resilience in England and Wales respectively, and how a Natural Capital Assessment (NCA) and ecosystem resilience can support decision-making. The purpose of this is to allow water companies and Regional Groups to "make decisions that do not devalue and look to enhance the value of the natural world for society benefit"[77] together with supporting water companies to promote plans that have the potential to deliver wider environmental and social benefits.

The requirements for a BNG and NCA of a water company WRMP are outlined in the 2022 WRPG, as shown in **Figure 13-1**.

[75] Environment Agency, 2021. WRPG 2024 Supplementary Guidance - Environment and society in decision-making.
[76] Natural Resources Wales, 2021. WRPG 2024 Supplementary Guidance - Environment and society in decision-making.
[77] Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (si 2017/407)

Figure 13-1: The requirements for a BNG and NCA of a water company WRMP, as outlined in the 2022 WRPG

Section 4.1.1 High-level considerations (from WRPG 2022)

England and Wales

- Ensure your plan contributes to the conservation and enhancement of biodiversity, delivers net biodiversity gain where appropriate, delivers environmental gain and uses a proportionate natural capital approach.
- Consider your duty to conserve biodiversity under section 40 of the Natural Environment and Rural Communities Act (2006) and the list of species and habitats of principle importance set out in section 31 of the Act (England).
- Take a catchment based approach.

In line with this guidance, we have carried out Biodiversity Net Gain assessments using Defra's Biodiversity Metric 3.0 tool, to assess losses of biodiversity as a result of the options[78]. A GIS-based system has been used, using national datasets, to provide comprehensive coverage of habitat data. A proportionate level of assessment has been used at each stage of the WRMP. For supply options in the feasible list, the biodiversity baseline has been calculated, for supply options in the preferred programme Defra's tool will be used to demonstrate how net gain could be achieved on and off-site. The BNG outputs have been used to help inform the SEA, particularly the SEA objective relating to the potential effects of the options on biodiversity.

WRPG Supplementary Guidance states that NCAs in England should include as a minimum the following five ecosystem services:

- Biodiversity and habitat
- Climate regulation
- Natural hazard regulation
- Water purification
- Water regulation

Two additional ecosystem services have also been included:

- Recreation and tourism
- Agriculture.

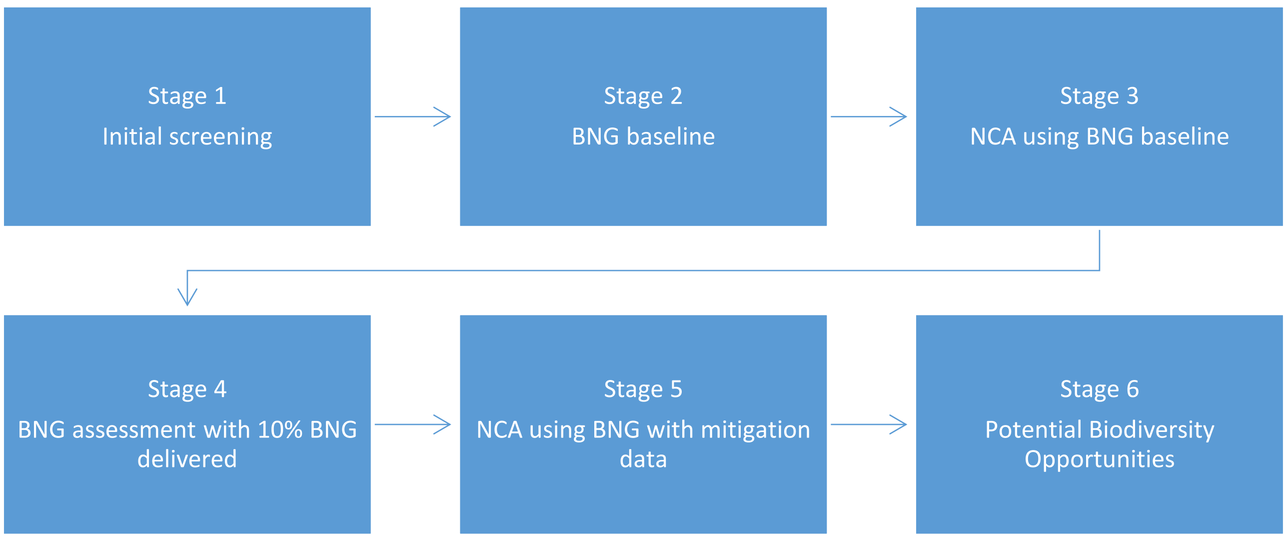
[78] While a newer version of the metric, v3.1, has now been released, v3.0 has been used for these assessments to provide consistency across multiple WRMPs and through the stages of assessment

Sequential Process

Throughout the WRMP process BNG and NCA have been considered in increasing levels of detail, proportionate to the wider WRMP programme. **Figure 13-2** shows the sequential process followed for the assessments. The approach taken for feasible options and consequent programmes of options is as follows:

- Feasible options – Stages 1 to 3 of **Figure 13-2**
- Preferred programme, and any reasonable alternative plans– Stages 1 to 6 of **Figure 13-2.**

Figure 13-2: The sequential process followed for the NC and BNG assessments



The outcomes from Stages 2 and 3 are outlined in **Section 13.5.** Stage 1 outcomes have not been presented here as they were used to inform preliminary stages of assessment and were superseded by subsequent stages of assessment.

A proportionate level of assessment (as recommended in the supplementary guidance 'Environment and society in decision making') was carried out. Therefore, for Stage 4 NCA the supporting text for the quantitative assessment is the qualitative assessment. It was felt another qualitative assessment at this stage would have not aided the assessment. However, where necessary, when a quantitative assessment was not appropriate, for example for water purification, a qualitative assessment was undertaken at Stage 4.

13.2.4 Water Framework Directive Regulations (WFD) Compliance Assessment

In line with statutory requirements and following WRMP regulatory guidance, we have carried out a WFD compliance assessment to assess the potential effects of implementing our Plan on WFD water bodies and Protected Areas. Three core WFD Assessment Objectives have been tested to determine the WFD compliance of each feasible option supply-side within our WRMP and the WRMP as a whole:

1. To prevent deterioration of any WFD element of any water body - in line with Regulation 13(2)(a) and 13(5)(a).
2. To prevent the introduction of impediments to the attainment of 'Good' WFD status or potential for any water body in line with Regulation 13(2)(b) and 13(5)(c).
3. To ensure that the planned programme of water body measures in RBMP2 to protect and enhance the status of water bodies are not compromised.

The WFD compliance assessment is reported separately in **Appendix F**. The WFD report has been used to help inform the SEA, particularly the SEA objectives relating to the potential effects of options and the Plan on biodiversity and the water environment.

WFD compliance was used as a high-level screening tool for the unconstrained list (see **Section 12.3**) to remove any options from progressing in the options appraisal process that have likely WFD compliance risks. Our feasible resource options have been assessed against the three core WFD Assessment Objectives. The assessment for each option comprised three sequential steps:

- Step 1 Screening based on activities.
- Step 2 Screening based on magnitude of hydrogeological/hydrological impact and water body context
- Step 3 Impact assessment.

The outcomes from the WFD compliance assessment are summarised in **Section 13.6.**

13.2.5 Carbon Assessment

The carbon externality assessment for leakage reduction options followed the best practice and steps outlined in Ofwat's guidance[79]. This followed a 3 stage assessment:

- Stage 1 identified all externalities that required valuation and involved a qualitative or simplified quantitative assessment based on minimal data requirements.
- Stage 2 took filtered externalities from Stage 1 and put them through a more detailed quantitative assessment.
- Stage 3 took the final quantitative assessment and applied this within the leakage scenario optimisation assessment.

The carbon externalities were derived from an assessment of fuel and energy used in activities relating to leakage management, such as transportation (detection and repair of leaks) and energy used in water treatment and distribution. Stage 1 of the assessment identified all such inputs and data relevant for the study.

For Stage2, estimated CO_2 emissions (tonnes) for abstraction and distribution for Bristol Water were calculated from energy consumption (kWh), fuel (litres) and the emission factor conversions from the

[79] Ofwat, 2008. Providing Best Practice Guidance on the Inclusion of Externalities in the ELL Calculation. PROC/01/0075 V08.

Ofwat guidance. The total carbon price for Bristol Water was determined by multiplying the estimated CO_2 emissions by the unit price of carbon for 2020.

For the demand options conversion factors were consistent with leakage options. However, supply chain and emission data were derived from available industry literature. For a number of relevant options vehicle movements for device installation were based on two components: a distance travelled to an area, and a distance between sites within an area. An assumption has also been made that fleet vehicles will switch from predominantly petrol vehicles to electric only fleet by 2030.

For supply-side options, an assessment of embodied and operational carbon was carried out. This followed latest government and regulatory guidance and the latest industry methods for carbon assessment. In line with the requirement set out in the latest Water Resources Plan Guidance, embodied and operational carbon emissions and costs for each feasible option were calculated, following guidance from:

- HM Treasury Green Book and carbon costing guidance 2020
- Department of Business Energy and Industrial Strategy (DBEIS) Green Book supplementary guidance for *Valuing Greenhouse Gas Emissions and Energy Use*
- Ofwat guidance on carbon reporting and costing
- UKWIR guidance on assessing embodied and operational carbon, including the latest available UKWIR carbon emissions workbook
- Environment Agency supplementary WRPG24 guidance on environmental valuation

For each of the feasible options, the scope of the assessment was based on BS EN 15978:2011 stages.

- Before use stage: A1-A5
- Use stage: B1-B7

For each scheme, the results of the supply-side carbon assessment were split into:

- A1-A3 Embodied Carbon tCO2e
- B1-B7 Operational Carbon tCO2e/year
- B1-B7 Operational Carbon tCO2e in 60 years, and
- Total Cost of Carbon over 60 Year Design Life; this also assumed replacement carbon in year 60.

Carbon costs were calculated using the latest Treasury Green Book Supplementary Guidance (Autumn 2021) and the latest Central scenario values in Table 3: Carbon values and sensitivities 2020-2100 for appraisal, 2020£/tCO2e of the accompanying data tables. These were provided up to 2050 to cover the 60-year scheme life. For extension of the values beyond 2050, a simple growth function in MS Excel was used based on the data in Table 3, as the guidance provided by BEIS for extending values beyond 2050 is from 2011 and has not been updated since, despite the changes in assumptions and underlying data.

For the embedded and operational carbon assessments for each scheme, details of materials, sizes and capacities, lengths or areas were used as quantified. Where assumptions needed to be made e.g., excavation depths and construction methods, these were aligned with the cost assessment for consistency.

Exclusions were made from the carbon assessment, for details that are unknown at this stage of design. This includes the following which should be included when more information is known:

- Air valves, washout valves and pipe bends
- Roads and access to the pump stations and treatment works
- Employee travel to site during construction and operation
- Site accommodation and welfare during construction
- Mechanical plant during construction for excavation

13.2.6 Invasive Non-Native Species (INNS)

The WRPG states that water companies must review whether current abstraction operations and future solutions will risk spreading INNS or create pathways which increase the risk of spreading INNS. Where there are increased risks, water companies must propose measures to manage that risk. The guidance indicates that all water companies will need to consider:

- Pathways of spread (understanding and reducing the risk from different pathways);
- Preventing spread (controlling, eradicating or managing INNS to prevent spread where this will contribute to WFD prevention of deterioration); and
- Action on INNS to achieve conservation objectives of Sites of Special Scientific Interest (SSSI) and sites protected under the Habitats Directive.

The assessment of the risk of distribution of INNS comprises a two-stage approach. The assessment is composed of the following elements:

Stage 1 - INNS Baseline Review

The baseline data review considered INNS occurrence records stored within the NBN Atlas and NBN Atlas Wales INNS Portal covering a period of 11 years (1 January 2009 - 31 December 2019) of data.

INNS species listed under; Schedule 9 of the Wildlife and Countryside Act, WFD UKTAG Aquatic Alien Species, EU Invasive and Alien Species Regulation, Wales Priority Species for Action, MSFD – UK priority species, WFD UKTAG alarm species, GB NNSS Alert species have been identified from the datasets for consideration.

The purpose of the data review is to establish which species are currently known to be present within the waterbodies/reaches associated with the BW WRMP options. Species records were assessed to identify which species are likely to be facilitated by a raw water transfer by becoming entrained and transported to new sites and/or the associated construction activities of the individual components.

A Kernel Density estimation algorithm was applied to the data captured during the NBN Atlas data review using geographical imaging software (GIS). The algorithm provides a visual representation of occurrence record densities for INNS located within 500 m of the watercourse and associated components. This allows for the identification of regions with a higher density of recorded INNS occurrences based upon the number of records within a 250 m radius of each record.

Stage 2 - SAI-RAT

Following a process of stakeholder review including input from internal experts within Ricardo, the EA released an INNS risk assessment tool for solutions which the EA has indicated should be used at for assessing INNS risks across all solutions. The tool named the "SRO Aquatic INNS Risk Assessment Tool", or SAI_RAT, was developed to account for the diversity of assets and RWTs which may comprise any one solution and uses a single assessment process via a modular approach, to provide a quantitative score of relative risk. The Microsoft Excel-based tool accounts for the diversity of assets and raw water transfers which may comprise any one solution and uses a single assessment process via a modular approach, to provide a quantitative score of relative risk.

The assessment of RWTs using the SAI-RAT takes a pragmatic pathway and source-pathway-receptor model approach, respectively, building upon other assessment tools such as the Northumbrian Water Group (NWG) RWT assessment tool and the Wessex Water asset assessment tool, adopting similar approaches to the quantification of INNS risk. Similar to these tools, an extended functional group mechanism has been incorporated to account for future risks rather than only examining species known to be currently present.

13.2.7 Environmental and Social Metric

In order to provide the programme investment optimisation modelling with information about the environmental and social performance of each WRMP option in the Constrained List, an approach for deriving environmental and social metrics from the SEA option level results was developed, see **Section 14.1**.

The metrics that were derived directly from consideration of the findings of the SEA also incorporated HRA, WFD, NCA, BNG and INNS assessment findings because the SEA itself was informed by these and the SEA framework included objectives that specifically relate to each of these assessments.

In order to avoid "double-counting" of the carbon effects, the SEA objective that relates to carbon emissions was excluded from feeding into the metric scores as these have been included as monetary values in the programme investment appraisal model.

To align with the other metrics in the options appraisal modelling process, the environmental metrics were translated into positive and negative values on a scale of 0 to 100 (or 0 to -100).

13.3 Strategic Environmental Assessment

13.3.1 Options Assessment

The Environmental Report (**Appendix E)** includes a detailed breakdown of the assessment results of all supply and demand management options against all objectives assessed in the SEA.

The assessment concluded that the demand management options would result in some adverse impacts to the environment. Many of them require vehicle movements (to install meters in customers' homes, for example), which would adversely impact upon air quality and greenhouse gas emissions. The creation of new equipment (such as meters) would mean emissions of embodied carbon, and resource use. No adverse impacts on biodiversity, soils, water, human health, cultural heritage or landscape were anticipated for any demand management option. Depending on the anticipated water saving, neutral to moderate beneficial impacts were anticipated for water resources, climate resilience, the economy, and human health & wellbeing, arising from the Bristol Water supply becoming more reliable and less reliant on water extraction.

The assessment concluded that the eleven supply options80 would result in adverse impacts to the environment. Many of them would require construction and new infrastructure within, or in close proximity to, designated wildlife sites, resulting in either moderate or major adverse impacts. Due to new infrastructure being required, these options also often resulted in moderate or major adverse impacts to greenhouse gas emissions. Other objectives that experienced adverse impacts for some options included the spread of INNS, water quality, and the efficient use of material assets.
The assessment concluded that the supply management options would result in beneficial impacts to many objectives within the assessment framework. Many options would improve natural capital, would improve resilience to climate change, promote a sustainable economy, enhance tourism and recreation, and protect human health and wellbeing. They will do this by improving water supply and strengthening its resilience. The extent of the positive impact is predominantly determined by the anticipated deployable output of the option in question.

13.3.2 Environmental and Social Metrics

Based on the SEA findings for each of the Constrained Options, environmental and social metrics were assessed for each option in accordance with the methodology described above in **Section 13.2.7.**

Table 13-1 below sets out the metrics for each option; these metrics were incorporated into our investment programme appraisal model to provide an indication of the environmental performance of each option. The metrics provide a very high level summary of the environmental assessment findings; importantly, these metrics are not a substitute for the more detailed SEA, HRA, WFD, NCA, BNG and INNS appraisal processes - the WRMP programme outputs from the investment appraisal model were subject to detailed SEA, HRA, WFD and NCA assessment to help final decision-making on the preferred plan.

Table 13-1: Metric Results

Option ID	SNR+	SNR-	WAT+	WAT-	HSW+	HSW-
P01-02	5.98125	-19.5	3.17	-13.98	4.34	0
P01-01	7.975	-21	3.17	-13.98	2.17	-2.91
P06	11.9625	-9	15.85	-4.66	6.51	0
P08	7.975	-12	3.17	-16.31	8.68	0
R005	6.835714	-66	9.51	-11.65	21.7	-23.28
R007	7.975	-48.5	6.34	-13.98	19.53	-17.46
R014	7.975	-30.125	3.17	-4.66	10.85	-8.73
R016	7.975	-39.3125	3.17	-11.65	13.02	-14.55
R08-03	5.98125	-30.125	3.17	-9.32	8.68	-17.46
R08-02	5.98125	-30.125	3.17	-11.65	6.51	-11.64

80 It is noted that Cheddar 2 was included in the assessment at draft stage and retained in the SEA

Option ID	SNR+	SNR-	WAT+	WAT-	HSW+	HSW-
R24	5.98125	-22.5	3.17	-6.99	6.51	-20.37
C016	0	0	6.34	0	4.34	0
C019	0	-1.5	6.34	0	2.17	0
HH_A_001	1.99375	-9	6.34	0	10.85	-2.91
HH_A_002	0	-7.5	6.34	0	8.68	-2.91
HH_A_003	0	-9	6.34	0	10.85	-2.91
HH_A_004	0	-7.5	6.34	0	10.85	-2.91
HH_A_005	0	-7.5	6.34	0	0	-2.91
HH_CM_001 (AMI)	0	-1.71429	6.34	0	6.51	-2.91
HH_CM_001 (AMR)	0	-1.71429	6.34	0	6.51	-2.91
HH_E_001	0	-3	6.34	0	2.17	0
HH_E_002	0	0	6.34	0	0	0
HH_E_004	0	-4.5	6.34	0	4.34	-2.91
HH_E_005	0	-1.5	6.34	0	6.51	0
HH_E_006	0	-1.5	6.34	0	6.51	0
HH_E_008	0	-3	6.34	0	8.68	0
HH_E_009	0	-6	6.34	0	6.51	-5.82
HH_E_010	1.99375	-9	6.34	0	10.85	-2.91
HH_E_013	0	0	6.34	0	0	0
HH_E_016	0	0	6.34	0	8.68	0
HH_E_020	1.99375	0	6.34	0	0	0
HH_E_021	0	-4.5	6.34	0	4.34	-2.91
HH_E_022	0	-4.5	6.34	0	0	0
HH_E_023	0	-4.5	6.34	0	0	-2.91
HH_E_017 (AMI)	0	0	6.34	0	0	0
HH_E_017 (AMR)	0	0	6.34	0	0	0
HH_I_001	0	-3	6.34	0	10.85	-2.91
HH_I_004	0	0	6.34	0	0	0
HH_M_001 (AMI)	0	-1.71429	6.34	0	15.19	-2.91
HH_M_001 (AMR)	0	-1.71429	6.34	0	15.19	-2.91
HH_M_002 (AMI)	0	-1.71429	6.34	0	8.68	-2.91
HH_M_002 (AMR)	0	-1.71429	6.34	0	8.68	-2.91
HH_M_004 (AMI)	0	-1.71429	6.34	0	10.85	-2.91
HH_M_004 (AMR)	0	-1.71429	6.34	0	10.85	-2.91
HH_M_005 (AMI)	0	0	6.34	0	8.68	-2.91
HH_M_005 (AMR)	0	0	6.34	0	8.68	-2.91
HH_M_006 (AMI)	0	-1.71429	6.34	0	6.51	-2.91
HH_M_006 (AMR)	0	-1.71429	6.34	0	6.51	-2.91
HH_M_007 (AMI)	0	-1.71429	6.34	0	2.17	-2.91
HH_M_007 (AMR)	0	-1.71429	6.34	0	2.17	-2.91
HH_M_009 (AMI) Baseline	1.99375	-7.5	6.34	0	8.68	-2.91
HH_M_009 (AMI) Enhancement	1.99375	-7.5	6.34	0	8.68	-2.91
HH_M_009 (AMR)	0	-1.71429	6.34	0	15.19	-2.91
HH_N_002	1.99375	-3	9.51	0	2.17	-2.91
HH_N_003	0	-3	9.51	0	0	-2.91
HH_N_004	0	-7.5	9.51	0	6.51	-2.91
HH_P_001	1.99375	0	6.34	0	4.34	0
HH_P_002	1.99375	0	19.02	0	13.02	0
HH_P_003	0	0	6.34	0	8.68	0

Option ID	SNR+	SNR-	WAT+	WAT-	HSW+	HSW-
HH_P_004	1.99375	0	6.34	0	4.34	0
HH_P_005	1.99375	0	6.34	0	8.68	0
HH_T_001 (AMI)	0	0	6.34	0	0	0
HH_T_001 (AMR)	0	0	6.34	0	0	0
HH_T_006	0	0	6.34	0	0	0
HH_T_008	0	0	6.34	0	0	0
HH_W_001	1.99375	0	6.34	0	0	0
NHH_A_001	0	0	6.34	0	4.34	0
NHH_A_003 & NHH_A_006	0	0	3.17	0	0	-2.91
NHH_A_004 (AMI)	2.278571	-1.71429	6.34	0	2.17	-2.91
NHH_A_004 (AMR)	2.278571	-1.71429	6.34	0	2.17	-2.91
NHH_E_001	0	0	6.34	0	0	0
NHH_E_002 (AMI)	0	0	6.34	0	0	0
NHH_E_002 (AMR)	0	0	6.34	0	6.51	0
NHH_I_001	0	0	6.34	0	0	0
NHH_M_001 (AMI)	0	-1.71429	6.34	0	4.34	0
NHH_M_001 (AMR)	0	-1.71429	6.34	0	4.34	0
NHH_M_002 (AMI)	0	0	6.34	0	2.17	-2.91
NHH_M_002 (AMR)	0	0	6.34	0	2.17	-2.91
NHH_N_001	0	-1.5	9.51	0	0	0
NHH_N_002	0	0	9.51	0	0	0
NHH_N_003	0	0	9.51	0	0	0
NHH_T_003	0	0	6.34	0	0	0
HH_CM_002 (AMI)	0	-1.71429	6.34	0	15.19	-2.91
HH_CM_002 (AMR)	0	-1.71429	6.34	0	15.19	-2.91
131 Linear 50	0	-4.5	9.51	0	13.02	-2.91
133 04 Linear 30	0	0	9.51	0	4.34	-2.91
135 02 Frontloaded	0	0	9.51	0	4.34	-2.91
136 02 Frontloaded SM	0	0	9.51	0	8.68	-2.91
134 05 SM Linear 30	0	0	9.51	0	8.68	-2.91
132 06 SM Linear 50	0	0	9.51	0	15.19	-2.91
138 Linear 45	0	-4.5	9.51	0	13.02	-2.91

13.4 Habitats Regulations Assessment (HRA)

The HRA report (**Appendix D**) includes detailed findings of the assessments on demand management options and water supply side options.

The assessment concluded that none of the demand management options included in our WRMP24 would have a likely significant effect on any European site, either alone or in combination with other options, programme or plans. However, the screening assessment concluded that nine out of eleven water supply options81 would have likely significant effect on one or several European sites, either alone or in combination with other options, programme or plans.

Table 13-2 summarises the findings of the screening assessment for the water supply side options.

81 It is noted that Cheddar 2 was included in the assessment at draft stage and retained in the HRA.

Table 13-2: Summary of HRA Screening Assessment

Option No	HRA Screening Assessment outcome	European designated sites requiring appropriate assessment
P01_01	LSE	Mendip Limestone Grasslands SAC North Somerset and Mendip Bats SAC Severn Estuary SAC, SPA and Ramsar
P01_02	LSE	Mells Valley SAC North Somerset and Mendip Bats SAC Severn Estuary SAC, SPA and Ramsar
P08	LSE	Severn Estuary SAC, SPA and Ramsar
R005	LSE	Chew Valley Lake SPA Chilmark Quarries SAC Mells Valley SAC Mendip Limestone Grasslands SAC North Somerset and Mendip Bats SAC Severn Estuary SAC, SPA and Ramsar Somerset Levels and Moors SPA and Ramsar
R007	LSE	Bath and Bradford on Avon Bats SAC Chew Valley Lake SPA
R08_02	LSE	Bath and Bradford on Avon Bats SAC Severn Estuary SAC, SPA and Ramsar
R08_03	LSE	Wye Valley & Forest of Dean Bat Sites SAC Wye Valley Woodlands SAC Severn Estuary SAC, SPA and Ramsar
R014	LSE	River Wye/Afon Gwy SAC Severn Estuary SAC, SPA and Ramsar
R016	LSE	Mendip Limestone Grasslands SAC Mendip Woodlands SAC North Somerset and Mendip Bats SAC Severn Estuary SAC, SPA and Ramsar Somerset Levels SPA and Ramsar
R24	LSE	Mendip Limestone Grasslands SAC North Somerset and Mendip Bats SAC Severn Estuary SAC, SPA and Ramsar Somerset Levels and Moors SPA and Ramsar
P06	No LSE	-

The HRA Screening assessment concluded that nine of options would have a likely significant effect on a European site, including:

- P01_01: Charterhouse
- P01_02: Forum
- R005: Cheddar Reservoir
- R007: Pumped Refill of Chew Valley Reservoir
- P08: Alderley WTW
- R08_02: Bathford
- R08_03: Frome at Frenchay
- R014: Avonmouth WWTW Direct Effluent Reuse
- R016: Huntspill Transfer

- R24: Honeyhurst.

Should any of these options be selected through programme appraisal for the preferred plan further assessment through an Appropriate Assessment would be required.

13.5 Biodiversity Net Gain and Natural Capital Assessment

The NCA and BNG report (**Appendix G**) includes detailed findings of the assessments of water supply side options. Here an overview of results from Stage 2 and 3 have been presented.

Table 13-3 presents the summary data from conducting Stage 2 of assessment, here the temporary and permanent habitat loss has been presented. Total habitat units lost are also presented, these are important as they demonstrate how losing a small area of habitat with high value could potentially be worse for biodiversity compared to losing a large area of habitat with a lower value. **Table 13-3** shows that R016 has a significant amount of habitat units lost in relation to the area lost, this is due to the temporary loss of a significant amount of Floodplain Wetland Mosaic (CFGM), a high value habitat. This loss is severe but only temporary and therefore a significant long-term impact is not expected in relation to construction of this option.

Table 13-3: Stage 2, NCA with BNG baseline outcomes82

	Temporary area lost (ha)	Total units lost (ABHU)	Permanent area lost (ha)	Total units lost (ABHU)
P01_01	0.94	-4.44	0.02	-0.04
P01_02	0.42	-1.98	0.06	-0.06
P08	2.33	-19.08	0.02	0
R007	46.37	-176.85	0.19	-0.51
R014	23.83	-102.08	4.14	-9.01
R016	57.91	-563.14	0.95	-12.49
R08_02	49.8	-163.09	0.57	-3.05
R08_03	41.8	-149.91	0	0
R24	12.11	-43.41	0	0
P06	0	0	0	0
R005	171.63	-764.85	102.5	-599

Table 13-4 presents the summary data for the monetised metrics in relation to the temporary loss of the schemes. **Table 13-5** presents the summary data for the monetised metrics in relation to the permanent loss of the schemes. Finally, **Table 13-6** presents a brief summary of the qualitative water purification assessment results. Table 13-4Table 13-5Table 13-3 Options carried through to the preferred plan will have assessment Stages 4 to 6 conducted (mentioned in **Figure 13-2)**, these assessments will demonstrate the impact of the scheme after BNG has been delivered.

[82] R005 was included in the draft WRMP and retained in the NCA and BNG assessment for reference although this option has now been removed from the feasible list; the design has changed such that the water is delivered to other water companies.

Table 13-4: Stage 3 assessment results showing the temporary impacts of the schemes in relation to the ecosystem services studied.

WRMP24 Ref.	Biodiversity Ha	Climate Regulation £2019/year	Natural Hazard Regulation £2019/year	Recreation and Tourism £2019/year	Agriculture £2019/year
P01 01	-0.93572	-£208.82	-£67.54	£0.00	£0.00
P01 02	-0.42273	-£5.46	£0.00	£0.00	-£59.04
P08	-2.32669	-£417.69	-£187.37	£0.00	-£15.14
R007	-46.365	-£1,771.45	-£444.84	-£215,868.13	-£13,765.63
R024	-11.971	-£80.94	-£43.49	-£65,441.79	-£2,155.19
R06	na	na	Na	Na	na
R08 02	-49.797	-£2,019.19	-£610.56	-£145,638.04	-£13,129.96
R08 03	-41.802	-£1,178.80	-£507.20	-£241,149.39	-£12,059.72
R14	-23.043	-£677.71	-£539.39	-£127,097.54	-£1,137.60
R16	-57.909	-£1,167.54	-£2,068.78	-£280,635.16	-£3,681.91
R005	-171.634	-£3,153.18	-£718.67	-£310,165.02	-£50,569.00

Table 13-5: Stage 3 assessment results showing the permanent impacts of the schemes in relation to the ecosystem services studied.

WRMP24 Ref.	Biodiversity Ha	Climate Regulation £2019/year	Natural Hazard Regulation £2019/year	Agriculture £2019/year
P01 01	-0.01801	-£0.46	£0.00	£0.00
P01 02	-0.0636	-£0.22	£0.00	£0.00
P08	-0.02117	£0.00	£0.00	£0.00
R007	-0.193	-£1.26	-£6.08	-£58.86
R024	0	£0.00	£0.00	£0.00
R06	na	na	na	na
R08 02	-0.566	-£3.07	-£59.39	-£143.55
R08 03	0	£0.00	£0.00	£0.00
R14	-4.136	-£118.45	-£241.95	£0.00
R16	-0.951	-£25.58	-£6.55	£0.00
R005	-102.538	-£1,068.40	-£246.52	-£27,558.49

Table 13-6: Water purification assessment summary

WRMP24 Ref.	Water purification assessment
P01 01	Option does not intersect any WFD waterbodies. Water purification services are currently offered by woodland and grassland habitats. Construction of feature (pump upgrade) will have a moderate impact on water purification services.
P01 02	Option does not intersect any WFD waterbodies. There are no surrounding habitats providing water purification services which the scheme (WTW upgrade) will impact.
P08	Option does not intersect any WFD waterbodies, however one is in close proximity. Water purification services are currently offered by woodland habitats. Construction of feature (WTW upgrade) will have a moderate impact on water purification services.

WRMP24 Ref.	Water purification assessment
R007	Option does not intersect any WFD waterbodies. Water purification services are currently offered by woodland and grassland habitats. Construction of feature (pipeline) will have a temporary moderate impact on water purification services. Option does not intersect any WFD waterbodies. Water purification services are currently offered by woodland and grassland habitats. Construction of feature (upgrade of sewage treatment works) will have a moderate impact on water purification services.
R024	Water purification services are currently offered by woodland/grassland/ grazing marsh habitats. Construction of feature (pipeline) will have a temporary moderate impact on water purification services.
R06	Water purification services would be improved under this option, natural capital benefits could arise from a farmed wetland being created. Other catchment management solutions within this scheme would not provide a natural capital benefit, such as installation of trackways etc, as while these options will improve water quality, they are not naturally provided. Scheme is likely to have a moderately good impact.
R08 02	Water purification services are currently offered by woodland/ grassland habitats. Construction of feature (pipeline) will have a temporary moderate impact on water purification services
R08 03	Water purification services are currently offered by woodland/ freshwater habitats. Construction of feature (pipeline) will have a temporary moderate impact on water purification services.
R14	Water purification services are currently offered by woodland, salt marsh, grazing marsh habitats. Construction of feature (pipeline) will have a temporary severe impact on water purification services. Water purification services are currently offered by woodland habitats. Construction of feature (storage reservoir) will have a moderate impact on water purification services.
R16	Water purification services are currently offered by grassland/ wetland/ grazing marsh habitats. Construction of feature (pipeline) will have a temporary moderate impact on water purification services.
R005	Option does not intersect any WFD waterbodies, however it is near a water body. Water purification services are currently offered by grazing marsh and grassland habitats. Construction of feature (reservoir) will have a significant impact on water purification services.

13.6 Water Framework Directive Regulations Compliance Assessment

The WFD Regulations compliance assessment report (**Appendix F**) includes detailed findings of the assessments of resource options in the feasible list of our WRMP and of the WRMP as a whole. The level of detail in this assessment is proportionate to the requirements of a WRMP[83] noting that it is not a definitive statement on the WFD compliance of a scheme. For schemes we progress with, further WFD compliance assessment will be undertaken at the appropriate point such as planning application and abstraction licence application. All customer demand options and distribution management options included in our feasible list of options are considered to be compliant with WFD Regulations.

13.6.1 Options Assessment

Table 13-7 summarises the outcomes of the WFD Regulations compliance option level assessments. It is noted that scheme R024 *Bring Honeyhurst source back into supply* has been subject to more detailed assessment through our AMP7 WINEP water resources WFD no deterioration investigation.

[83] As set out in the Water Resources Planning Guideline (Environment Agency/ Natural Resources Wales/ Ofwat, 2021) following guidance from Environmental Assessments for Water Resources Planning (UKWIR, 2021)

Table 13-7: Summary of the WFD compliance assessment for WRMP24[84]

Option Name	WRMP24 Ref.	Outcome of WFD Regulations compliance assessment for WRMP24
Increase performance of existing sources to increase DO near to licensed quantity	P01-01	Non-compliant (low confidence)
Increase performance of existing sources to increase DO near to licensed quantity	P01-02	Uncertain
Cheddar 2 Source and Transfer SRO	R005	Non-compliant (low confidence)
Catchment Management of the Mendip Lakes (Chew, Blagdon and Cheddar) to manage outage risk from algal blooms	P06	Compliant (high confidence)
Pumped Refill of Chew Valley Reservoir	R007	Compliant (medium confidence)
Increase performance of existing sources (Alderley WTW) to increase deployable output	P08	Non-compliant (low confidence)
New water sources within Bristol Water CAMS area for the location Middle River Avon at Bathford	R08-02	Compliant (high confidence)
New water sources within Bristol Water CAMS area for the location Frome at Frenchay	R08-03	Compliant (high confidence)
Avonmouth WWTW Direct Effluent Re-use	R014	Compliant (high confidence)
Huntspill transfer	R016	Compliant (low confidence)
Bring Honeyhurst source back into supply	R024	Compliant (medium confidence)

For the three options assessed as not compliant with WFD Regulations there is low confidence in this assessment at present without further information on data or design information at this stage. We have not excluded any of these options from the constrained list of options for consideration in plan development on the basis of WFD.

13.7 INNS

The INNS assessment report (**Appendix H**) includes detailed findings of the assessments of resource options in the feasible list of our WRMP (see Section 12.4) and of the WRMP as a whole. The level of detail in this assessment is proportionate to the scheme design detail provided at this stage of the WRMP. For schemes we progress with, further INNS assessment will be undertaken at the appropriate point such as planning application and abstraction licence application. All customer demand options and distribution management options included in our feasible list of options are not considered to present an INNS transfer risk.

[84] It is noted that Cheddar 2 was included in the assessment at draft stage and retained in the WFD assessment for reference

13.7.1 Options Assessment

Stage 1 – Baseline review

Table 13-8 summarises the outcomes of the INNS occurrence baseline review. INNS occurrence records within 500m of the scheme's infrastructure have been compiled and summarised. Further detail with regards to operational specifications, pipeline routes and treatment process will provide additional detail which may impact risk and mitigation requirements during construction and operation.

Table 13-8: Baseline review of recorded INNS occurrences within 500m of scheme infrastructure[85]

Option No	Summary of INNS occurrence records within 500m of the scheme infrastructure.
P01_01	No INNS of interest were recorded within 500m of the scheme infrastructure during the baseline period
P01_02	No INNS of interest were recorded within 500m of the scheme infrastructure during the baseline period within the NBN atlas.
P08	No INNS of interest were recorded within 500m of the scheme infrastructure during the baseline period within the NBN atlas.
R005	A total of 3 INNS of interest were recorded within 500m of the scheme infrastructure during the baseline period within the NBN atlas. Both terrestrial and aquatic INNS species are recorded within the area. the most common INNS found was Nuttall's waterweed *Elodea nuttallii*.
R007	A total of 22 INNS of interest were recorded during the baseline period within the NBN atlas. A multitude of terrestrial and aquatic species are recorded within the study area. The most common INNS found was the terrestrial plant species Himalayan Balsam (*Impatiens glandulifera)* followed by Japanese Knotweed (*Fallopia japonica*).
R08_02	A total of 16 INNS of interest were recorded during the baseline period within the NBN atlas. The most common INNS found was Himalayan Balsam *Impatiens glandulifera.*
R08_03	A total of 19 INNS of interest were recorded during the baseline period within the NBN atlas. A multitude of terrestrial and aquatic species are recorded within the study area. The most common INNS found was the terrestrial plant species Himalayan Balsam (*Impatiens glandulifera*) and Butterfly bush (*Buddleja davidii*). A number of aquatic animal and plant species are also recorded in the study area including New Zealand Mudsnail (*Potamopyrgus antipodarum*) and Canadian Pondweed (Elodea canadensis).
R014	A total of 23 INNS of interest were recorded during the baseline period within the NBN atlas. A multitude of terrestrial and aquatic species are recorded within the study area. The most common INNS found was the terrestrial plant species Butterfly Bush (*Buddleja davidii*) and Common Cord-grass (*Spartina anglica*). A number of aquatic animal and plant species are also recorded in the study area including New Zealand Mudsnail (*Potamopyrgus antipodarum*) and Canadian Pondweed (*Elodea canadensis*).
R016	A total of 5 INNS of interest were recorded during the baseline period within the NBN atlas. Terrestrial and aquatic INNS are recorded within the study area. The most common INNS found was the aquatic plant species Nutall's waterweed (*Elodea nuttallii*) and the terrestrial species Himalayan Balsam (*Impatiens glandulifera*).
R24	A total of 3 INNS of interest were recorded during the baseline period within the NBN atlas. Terrestrial and aquatic INNS are recorded within the study area. The most common INNS found was the aquatic plant species Nutall's waterweed (*Elodea nuttallii*) and the New Zealand Mudsnail (*Potamopyrgus antipodarum*).

[85] It is noted that Cheddar 2 was included in the assessment at draft stage and retained in the INNS assessment for reference.

Stage 2 – SAI-RAT

Table 13-9 summarises the outcomes of the SAI-RAT RWT assessments. Several options do not constitute a RWT due to the source type or treatment process involved prior to transfer and therefore have not been assessed using the SAI-RAT RWT risk assessment and are therefore marked "N/A" within the table below. The options have been assessed based upon the options design at this stage. Further detail with regards to operational specifications, pipeline routes and treatment process will provide additional detail which may impact risk scoring in later assessments.

Table 13-9: Summary of the INNS assessment for WRMP24

Option Name	WRMP24 Ref.	Outcome of SAI-RAT risk assessment (%)
Increase performance of existing sources to increase DO near to licensed quantity	P01-01	24.70
Increase performance of existing sources to increase DO near to licensed quantity	P01-02	NA
Cheddar 2 Source and Transfer SRO	R005 (Cheddar Springs to Cheddar 2 transfer)	33.13
	R005 (River Axe to Cheddar 2 transfer)	40.63
	R005 (Cheddar 2 to Honeyhurst WTW transfer)	31.85
Catchment Management of the Mendip Lakes (Chew, Blagdon and Cheddar) to manage outage risk from algal blooms	P06	NA
Pumped Refill of Chew Valley Reservoir	R007	34.60
Increase performance of existing sources (Alderley WTW) to increase deployable output	P08	NA
New water sources within Bristol Water CAMS area for the location Middle River Avon at Bathford	R08-02	32.58
New water sources within Bristol Water CAMS area for the location Frome at Frenchay	R08-03	32.20
Avonmouth WWTW Direct Effluent Re-use	R014	NA
Huntspill transfer	R016	34.35
Bring Honeyhurst source back into supply	R024	28.08

13.8 Carbon Assessment

Embodied and operational carbon emissions were calculated in tonnes of CO_2 equivalent (tCO_2) for each option in accordance with the relevant water industry and government guidance. The carbon emission values were converted to carbon costs (in £) in accordance with the UK government carbon calculation methods using the Green Book Supplementary guidance (2021)[86] and carbon values data tables[87]. **Table 13-10** provides a summary of the carbon emission (tonnes CO_2) and carbon cost values (£) for each feasible option (optimal leakage scenario).

Table 13-10: Feasible options, carbon assessment

Option ID	Option name	Embodied carbon emissions (tCO2 equivalent)	Average operational carbon emissions (tCO2 equivalent per annum)	Total carbon cost (£m)
131 Linear 50	Compiled results from SoLow run Data 131 Linear 50	69281.59454	2279.662647	61.62
138 Linear 45	Compiled results from SoLow run Data 138 Linear 45	65798.82246	2281.41737	60.80
C016	Water saving devices - waterless urinals	272.416	0	0.06674192
C019	Water Butts (Bristol Water subsidy)	2889.620583	0	0.707957043
HH_A_001	Home efficiency visits (HEV) - Targeted water efficiency audit with free water efficient device installation - In person.	46123.10961	62.64885232	11.68388607
HH_A_002	Home efficiency visits (HEV) - water efficiency audit with free water efficient device installation - metered	21495.15999	31.68462363	5.460382517
HH_A_003	Home efficiency visits (HEV) - water efficiency audit with free water efficient device installation - New meter	10057.42066	73.17827084	2.912284971
HH_A_004	Virtual Home efficiency visits (VHEV) - water efficiency audit with free water efficient devices	18351.52122	28.81315813	4.672603292
HH_E_001	Appliance subsidies (rebates for water	25349.52704	0	6.210634125

[86] Defra, 2021. Valuation of energy use and greenhouse gas.
[87] Carbon values data tables

Option ID	Option name	Embodied carbon emissions (tCO2 equivalent)	Average operational carbon emissions (tCO2 equivalent per annum)	Total carbon cost (£m)
	efficient devices and appliances)			
HH_E_002	Pay per use appliances (e.g. Miele bundles subscription)	4753.965	0	1.164721425
HH_E_004	Leaky Loos' Wastage Fix: large scale targeted fixes	0	4.110024947	0.025173903
HH_E_005	Eco branding water efficiency programme	573.5	0	0.1405075
HH_E_006	Distribution of household water efficiency kits for self-installation - via the water company of WCWR website.	2280.8715	0	0.558813518
HH_E_008	Partnerships/targeting of large/small developers to install water efficient devices	0	0	0
HH_E_009	Home Efficiency Visits (HEVs) - water efficiency audit - local authorities, housing associations, corporate landlords)	23384.3928	37.34468946	5.957912459
HH_E_010	Home Efficiency Visits (HEVs) - water efficiency audit - combined with energy efficiency audits	31886.83872	50.92170967	8.124170958
HH_E_013	School visits water efficiency programme	0	0.46177873	0.002828395
HH_E_016	Media campaigns to influence water use	0	0	0
HH_I_001	Targeted incentives scheme - Individual customer/community reward (e.g. Greenredeem) - New metered customers	0	0	0
HH_I_004	Community competition	0	0	0
HH_M_009 (AMI) (15) (Baseline)	Progressive smart metering automatic WCWR switch with Watersmart Technology (personalised billing, behavioural changes) (AMI) (Baseline)	4966.076041	1.420632237	1.225390002
HH_M_009 (AMI) (15) (Enhancement)	Progressive smart metering automatic WCWR switch with	14661.26731	8.894514856	3.646489395

Option ID	Option name	Embodied carbon emissions (tCO2 equivalent)	Average operational carbon emissions (tCO2 equivalent per annum)	Total carbon cost (£m)
	Watersmart Technology (personalised billing, behavioural changes) (AMI) (Enhancement)			
HH_N_002	Home retrofit of rainwater harvesting	8719.81	0	2.13635345
HH_N_003	Rainshare - Communities direct harvested rainwater into a centralised shared resource	102920.475	0	25.21551638
HH_N_004	Grey water recycling retrofitting to existing properties.	8806.165	0	2.157510425
HH_P_001	Change WC standards	0	0	0
HH_P_002	Water labelling - with minimum standards	0	0	0
HH_P_003	Water labelling - with no minimum standards	0	0	0
HH_P_004	New development standards - water neutrality	0	0	0
HH_P_005	New home standards - mandatory	0	0	0
NHH_A_001	Business Efficiency Visits (BEV) - water efficiency audit - in person audit, fix and retrofit, targeted at specific sectors/businesses	2406.2321	0.001030354	0.589533175
NHH_A_003 & NHH_A_006	Business Efficiency Visits (BEV) - leakage detection - in person (NOT targeted at specific sectors/businesses) & Business Efficiency Visit (BEV) - water efficiency audit/leakage detection - in person targeted at leisure sector (golf)	3140.62512	1.34316766	0.777680056
NHH_E_001	Sector specific water efficiency advice e.g. partnerships with holiday rental companies Airbnb.	0	0	0
NHH_E_002 (AMI)	SMART Online - Water smart online tools and resources (AMI)	539.586	0.206636437	0.133464218

Option ID	Option name	Embodied carbon emissions (tCO2 equivalent)	Average operational carbon emissions (tCO2 equivalent per annum)	Total carbon cost (£m)
NHH_I_001	Rewards to water retailers for business water use savings.	0	0	0
NHH_N_001	Rainwater harvesting is included in new developments to meet planning conditions - commercial/public sector developments -single or multiple	14.4553	0	0.003541549
NHH_N_002	Rainwater harvesting feasibility assessment and/or subsidised installation - target large water users	68.0798	0	0.016679551
NHH_N_003	Rainwater harvesting - target large water users	126.3673	0	0.030959989
NHH_T_003	Benchmarked rising block business tariffs	0	0	0
P01-01	Increase performance of existing sources (Charterhouse) to increase deployable output to near licensed volume	180.50425	1398.831504	4.127063864
P01-02	Increase performance of existing sources (Forum) to increase deployable output to near licensed volume	345.1695	833.1243373	2.603736505
P06	Catchment Management of the Mendip Lakes (Chew, Blagdon and Cheddar) to manage outage risk from algal blooms	19381.48764	0	5.039186786
P08	Alderley WTW (increased production)	93.5	33.0331716	0.230956877
R007	Pumped Refill of Chew Valley Reservoir	5256.634016	6303.006172	19.26850529
R014	Avonmouth WWTW Direct Effluent Re-use	1296.874972	875.812636	2.999984404
R016	Huntspill transfer	1537.210975	38.48977195	0.568622515
R08-02	New water sources within Bristol Water CAMS area for the location Middle River Avon at Bathford	2231.628528	3631.831534	10.19284894
R08-03	New water sources within Bristol Water CAMS area	4819.808245	284.3366206	2.525113531

Option ID	Option name	Embodied carbon emissions (tCO2 equivalent)	Average operational carbon emissions (tCO2 equivalent per annum)	Total carbon cost (£m)
	for the location Bristol Frome at Frenchay			
R24	Bring Honeyhurst source back into supply	382.7286547	14.414361	0.182238763
HH_W_001	Resource West Campaign	0	0	0
HH_A_005	Home efficiency visits (HEV) - HEV/retrofit visits during flow regulator installation visit.	9760.8775	18.31786959	2.503611939
HH_E_020	Communication and awareness campaign	0	0	0
HH_E_021	Innovative water saving devices 1 – Installation of flow regulators in supply pipes	2931.643	0.975746388	0.724228982
HH_E_022	Innovative water saving devices 2 – Installation of flow regulators with meter installation	8300.435	0	2.033606575
HH_E_023	Innovative water saving devices 3 - Combining installation with home efficiency visits	2578.433	0.861092073	2.004266184

13.9 Customer Preference in Relation to WRMP Options

As detailed in **Section 2.1.1**, we have undertaken a wide range of research on customers views and preferences in the development of this WRMP. However, more is required before we are able to test our options against customer preferences through our assessment framework. This section details what we know to date about what customers think about key topic areas that will inform the options. These topic areas include leakage reduction, water efficiency, metering, catchment management, and resource development (reservoirs, river abstractions, taking more water from the environment).

Leakage is consistently ranked in the top five customer priorities for household customers, and they continue to consider us to be performing well in this area. Customers have told us that leakage reduction is a top priority in the context of it being a core area of responsibility for Bristol Water and not because of poor performance. However, business customers prefer to maintain the current level of repair and maintenance over an enhanced programme. See **Section 7.3.2** for a full summary of customer research on leakage.

Our household customers have indicated a strong preference for support on water efficiency. The majority of household customers try to actively manage and reduce their water usage at home. In contrast over half of non-household participants stated that their business would struggle to use less water. They all perceive water use restrictions as difficult to cope with and generally unacceptable. See **Section 7.4.1** for a full summary of customer research on water efficiency.

Our customers have mixed views on metering, where some are strongly in favour and others are concerned that it would lead to higher bills and the effects this would have on those already struggling with bills. The potential for higher bills, and the idea of feeling restricted in the use of water is a significant concern for many in the context of the cost-of-living crisis. Respondents have told us that Bristol Water should be doing more to educate customers on the benefits of water meters and incentivise them to have them installed voluntarily. See **Section 7.2.1** for a full summary of customer research on metering.

We will require more research to better understand customers views on catchment management and resource development. We often engage with customers on environmental matters such as protecting water bodies and wildlife and resilience planning. These topics often implicitly involve these practices, but consultation specific to these areas is lacking.

We do however have some insight into resource development from research conducted by WCWRG. Within the qualitative strand of their research, protecting the environment was a driving factor for participants across household and business customers alike. Participants showed strong support for improving the environment in the context of water resources. Participants were introduced to four best value planning factors in developing the regional plan. They considered them all to be important but overall, improving the environment was ranked second, and this factor included reducing the amount of water taken from environmentally sensitive water sources. From the quantitative strand of the research, we know there is strong support from both household and non-household respondents for measures that will reduce the dependency of the water supply system on surface and groundwater abstractions, particularly from sensitive catchments.

13.9.1 Options Compatibility with Customer Preferences

As part of the public consultation process for our dWRMP24 we actively consulted with our customers to understand their views and preferences on the options put forward in our WRMP, and the strategy by which we are planning to secure customer water supply in the context of sustainable abstraction into the future. Although our preferred plan does not include supply options and delivers long-term resilience through management of demand, this consultation and research will continue to be relevant for development of future Water Resource Management Plans.

14 Programme Appraisal

14.1 Overview

We have examined all the potential options and combinations of options, using a fully flexible decision-making framework which allows a range of metrics against which to optimise. At the heart of this framework is an optimisation algorithm which follows a weighted sum optimisation (WSO) methodology to derive our preferred plan. The approach adopted for this submission is suitable for our decision-making problem which was classified as low level of concern derived from our formal problem characterisation.

The modelling tool that was developed by HR Wallingford to implement the above optimisation, has a high degree of automation, which has allowed for a strong and in-depth audit process where options, and associated inputs and outputs, are stored and can be reviewed by external parties.

When the outputs have been assembled they have been subjected to additional scrutiny by an expert panel to test and confirm that overarching objectives of our customers are retained front and centre in the decision-making process, in particular through reference to our customer research findings.

14.2 Programme Appraisal and Optimisation

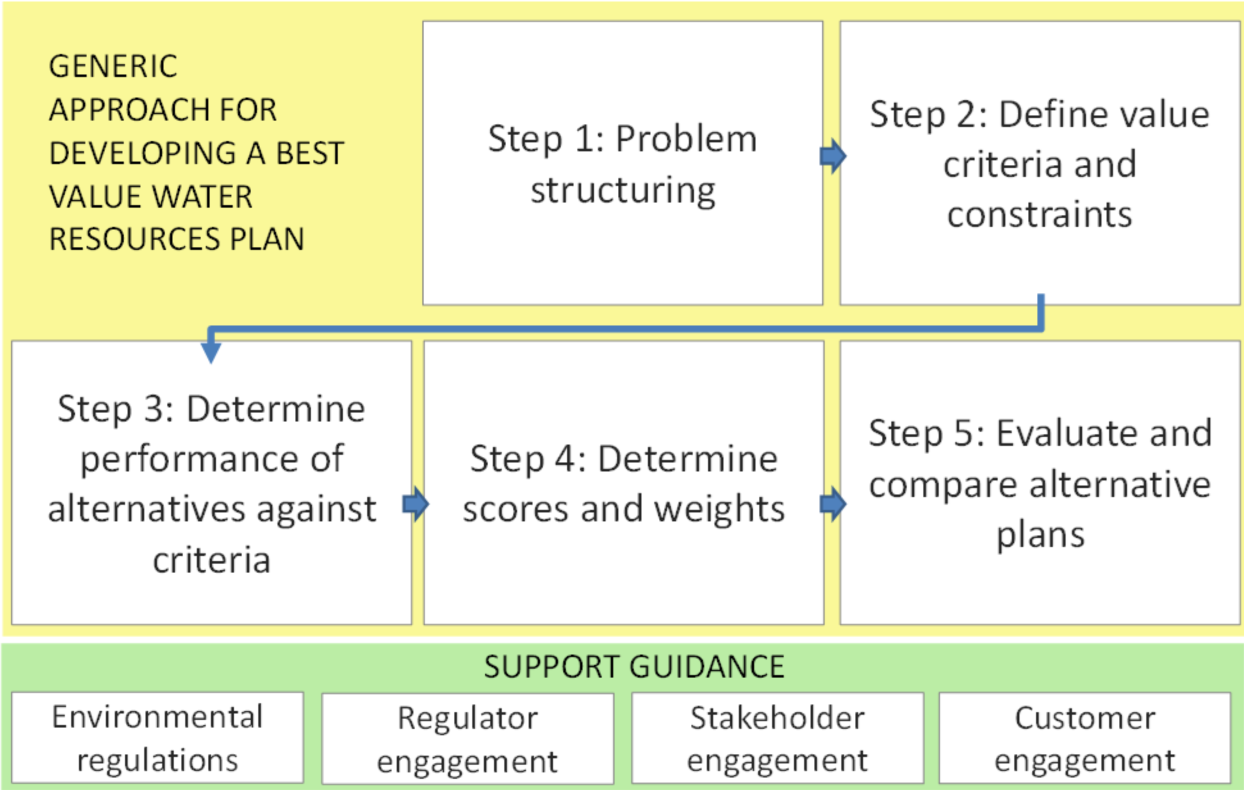
We have followed the guidance provided by the Environment Agency (EA) in the Water Resources Planning Guideline (WRPG)[88] and other relevant documents such as UKWIR's *Best Value Planning* (BVP)[89] report. Following an initial problem characterisation activity carried out by HR Wallingford, it was decided that, in addition to the AIC and the EBSD approaches, a pragmatic optimisation-based approach in which various objectives[90] and the corresponding metrics[91] can be combined to identify a BVP, is most suitable to solve Bristol Water's supply-demand imbalance. This approach has been adopted and used by other water companies in England and Wales and is specifically aligned with the approach taken by other water companies of the WCWR.

14.2.1 Approach and Methodology

We have followed UKWIR's BVP framework for the decision-making process proposed for Bristol Water's WRMP24. There are 5 steps in the BVP framework, which are followed by our decision-making framework – see **Figure 14-1**.

[88] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[89] UKWIR, 2020. Deriving a Best Value Water Resources Management Plan. UK Water Industry Research Ltd Report 20/WR/02/14.
[90] Objectives are high level deliverables such as 'increasing resilience' (Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline)
[91] Metrics are measurable indices for best value which relate to the objectives (Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline)

Figure 14-1: Best Value Planning framework[92]



Step 1, Problem Structuring is evaluated using the previous steps described in this plan; taking note of the legal requirements, including identification of statutory requirements and non-legally binding government and policy guidance. Changes since the previous WRMP are evaluated through the drought vulnerability assessment, demand forecasting, and uncertainty analysis. Finally, the planning scenarios and planning horizon of interest are defined.

The second step defined the high-level objectives, including water resources, environmental, social, policy, cost, and carbon cost objectives.

Next, in the third step, we identified how the performance against each objective could be measured. The results of this stage are reported in **Sections 12** and **13.**

In step 4, we determined scores and weights for the criteria which will be used in the next step to interpret obtained plans. This quantifies the performance of each option against different metrics. Weights are used to define relative importance/significance of different metrics.

Scoring, weighting and value criteria were determined during a workshop held in May 2022 by HR Wallingford, with a number of attendees from across the Bristol Water business. During the workshop, the attendees answered questions on the weights, values and scoring approach, providing feedback

[92] UKWIR, 2020. Deriving a Best Value Water Resources Management Plan. UK Water Industry Research Ltd Report 20/WR/02/14.

anonymously. The feedback was collated and responses analysed to provide the results required for the weights, values and scoring mechanism for metrics to be used in the decision-making process.

Metrics

The metrics used are summarised as follows in **Table 14-1**.

Table 14-1: Summary of metrics used in decision-making modelling.

Metric type	Metric	Sub-metric (objective)	Description
Monetary	Cost	N/A	Total NPC based on Capex (initial and replacement) and Opex (fixed and variable).
Monetary	PWS drought resilience	N/A	Supply-demand balance change at 1 in 500 level.
Monetary	Carbon cost	N/A	Total NPC of monetised carbon cost.
SEA	Water (WAT)	1. Flood risk	Qualitative assessment from SEA converted to a linear scale.
		2. Multi-abstractor benefits	Water quality and quantity, and water resources from SEA converted to a linear scale.
		3. Climate change	Maximise resilience to the threats of climate change.
SEA	Human and social wellbeing (HSW)	1. Human health and socio-economics	Maximise promoting a sustainable economy and maintaining and enhancing the economic and social well-being of local communities; Maximise tourism and recreation; and maximise enhancing human health and wellbeing.
		2. Air Quality	Maximise air quality.
		3. Cultural heritage	Maximise conservation and enhancement of historic assets and other cultural heritage and their settings, including archaeologically important sites.
SEA	Sustainable natural resources (SNR)	1. Climate change	Minimise greenhouse gas emissions and embodied carbon.
		2. Biodiversity, flora and fauna	Maximise protection and enhancement for sites that are designated, both nationally and internationally for their nature conservation value; Minimise reduction in natural capital assets, and maximise opportunities for biodiversity net gain, where possible; Maximise protection for priority habitats and species; And minimise further spread of invasive, non-native species
		3. Soil, geology, and land use	Maximise the appropriate and efficient use of land and maximise protection and enhancement of local geomorphology, soil quality and geodiversity.
		4. Landscape and visual amenity	Maximise conservation and enhancement landscape and townscape character and visual amenity.

Several assumptions had to be made, including:

1. Each sub-metric equally impacts the metric it belongs to.
2. Construction and operation periods equally impact the measurement of the performance of an option against a given metric.
3. Negative and positive impacts from each metric will be captured separately in the scoring but, the relative importance (i.e., weights) of negative and positive impacts is deemed equal.
4. Monetary metrics are of equal importance to one another.
5. Although environmental metrics are labelled as SEA, they include wider definitions covering NCA, HRA, BNG, and WFD.

Weights and value functions

The main outputs of the workshop were the weights and the value functions. Weights are obtained for all metrics, but value functions are specific to SEA metrics. The value functions are defined to express the level of nonlinearity of the SEA scores as well as providing a mechanism for translating qualitative assessment of options against SEA metrics into numerical counterparts. There are four steps when calculating the final (total) score of each option. An example is provided in **Table 14-2** for a hypothetical option which is scheduled for operation as of 2040 in a preferred plan. In the first step, raw scores (qualitative scores for the SEA metrics in the form of +++ for major positive impact to - - - for major negative impact) are translated into numerical scores (in the scale of +100 for +++ to -100 for - - - with 0 showing a neutral impact of an option) using the value functions obtained from the workshop (see **Figure 14-2**). Next, the numerical scores are turned into monetary values by multiplying each metric's numerical score by its weight. It should be noted that the weights serve two purposes: 1) they express the relative significance of metrics; and 2) they are used to turn non-monetary metric scores into monetary values. The third step is to calculate the net present cost (NPC) of each metric's monetary value by applying a discount factor based on the year each option is scheduled for. The last step is to aggregate the discounted NPCs of all metrics to form the total NPC which will be minimised during the optimisation modelling.

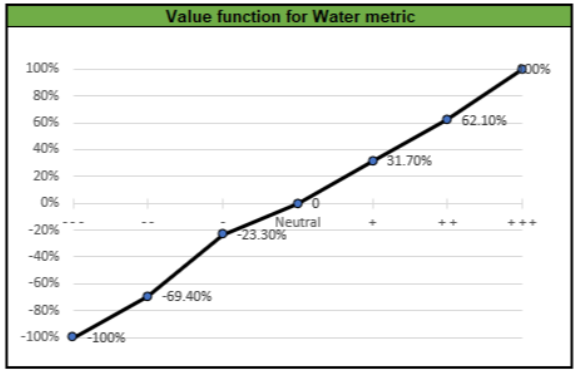
The decision-making framework uses a tool developed by HR Wallingford that is based on the best value plan framework. It uses a weighted sum optimisation method to incorporate the various metrics described in **Table 14-1**, as required by the WRPG. The decision variables of the optimisation routine are the selection of options and their scheduling. Constraints can be included in the optimisation routine. For instance, in addition to supply-demand balance-related constraints, some options can be mutually exclusive/dependent, some options cannot be activated earlier than a fixed time, and some options might require ratchet constraints (i.e. the option can only start a certain number of years after another option is activated).

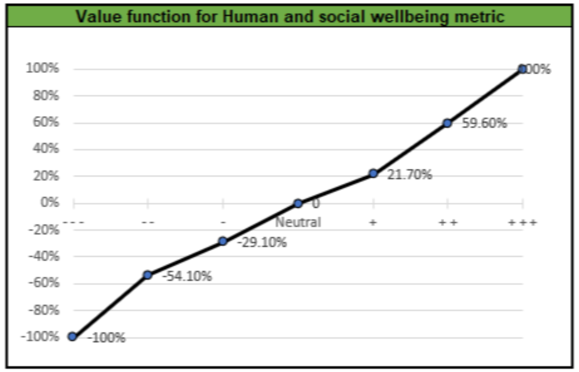
The same options with the same weights and scores will be optimised against several different pathways to identify, review and test potential alternative plans under different futures. This is further described in **Section 14.4.**

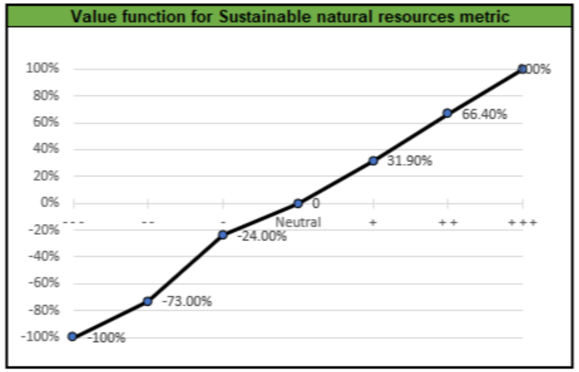
Table 14-2 Worked example of turning monetary and non-monetary assessment results into Net Present Value for optimisation.

Metric name	Cost (£m)	PWS drought resilience	Carbon cost (£m)	WAT +	WAT -	HSW +	HSW -	SNR +	SNR-	Comments
Weight	1	1	1	0.251	0.251	0.168	0.168	0.275	0.275	Weights determined during workshop
Score (raw)	14.5	0	1.8	++	---	+	0	+++	-	Raw monetary and SEA scores
Score (un-discounted)	14.5	0	2.3	62.1	-100	21.7	0	100	-24	Scores for SEA metrics are turned into 0 to 100 for positive metrics and -100 for 0 for negative metrics, using value functions.
Score (£m; un-discounted)	14.5	0	2.3	15.602	-25.1232	3.652662048	0	27.468032	-6.59232768	Numerical scores (row above) are multiplied by their weights to create monetary score for each metric.
Score (£m; NPV)	8.36215	0	1.32641	8.9974	-14.4885	2.106490203	0	15.84081405	-3.801795373	Monetary scores (row above) are multiplied by a discount factor based on the anticipated year of selection to create the Net Present Cost (NPC) for each metric.
Total NPC score (£m) of Option X for the plan based on being scheduled for 2040 (discount factor=0.5767):									1.034	Sum of metric NPC. This value is minimised in the optimisation model.

Figure 14-2: Value functions for SEA metrics.







14.3 Programme Appraisal and Decision-making

Our programme appraisal optimisation approach was used to investigate a range of alternative strategies to delivering the leakage and demand reduction policy requirements set out in the Government Expectations for Water Resource Planning (April 2022), a well as address a small forecast supply demand deficit post 2050.

The preferred plan for WRMP24 is not based solely upon the requirement to solve the supply-demand balance deficit but also to deliver leakage levels as indicated in the Public Interest Commitment (PIC) to 2030 and National Infrastructure Commission's (NIC) challenge to 2050; and, to reduce per capita consumption (PCC) to 110 litres per head per day by 2050 as outlined by the National Framework for Water Resources (Environment Agency, 2020). As a result of this, there are several steps to identifying the preferred plan under the different scenarios outlined in **Section 14.4**. The steps are as follows:

1. Identify the most preferential leakage scenario based upon the cost, carbon cost and environmental scores.
2. Optimise the demand-side options relating to per capita consumption against the targets up to 110 l/h/d by 2050.
3. Optimise demand-side, non-household options against the non-household demand reduction targets of 9% reduction in non-household consumption by March 2038 and 15% reduction in non-household consumption by 2050 based upon the cost, carbon cost and environmental scores.
4. Use steps 1-3 to calculate the remaining SDB deficit profile for the planning period and use this to guide the selection of supply-side options if required.

During the development of this approach, the optimisation tool has been run with various combinations of the options. Whilst these runs do not form part of the preferred plan, they do provide some useful contextual information:

- Metering programmes, relative to the supply-side options, are expensive. Without the explicit policies to aim for, the metering options are not selected if the other demand-side and supply-side options are available.
- Least cost and best value plans to reduce PCC and non-household demand are the same i.e. the environmental impacts of demand-side measures are small, such that they do not influence the selection.
- Without the demand-side options that relate to policy and/or Government-led initiatives, a per capita consumption figure of 133l/h/d by 2029/30, 122l/h/d by 2038/39 and 110l/h/d by 2050 are unlikely be achieved, using the options identified in this process. Any programme that is developed in the absence of Government-led initiatives will certainly be significantly more expensive, with greater customer bill impacts than our final plan.

14.4 Adaptive Pathways

The Environment Agency Water Resources Planning Guideline (2021) sets out the circumstances under which water companies should consider applying an adaptive planning approach to their WRMP development. These are:

- If there is significant uncertainty at any stage in the planning period, particularly in the first 5 to 10 years of your plan.
- If there is a strategic decision in the plan's medium terms, which has a long lead-in time,
- And if there is large long-term uncertainty which might lead a company to consider different preferred options.

Our baseline supply demand balance shows that we remain in surplus for the first 17 years of the planning period. Therefore, there is not significant uncertainty within the early years of our plan. Our plan also shows that by implementing the options required to meet the policy targets for leakage and PCC reduction by 2050, additional resilience is built into the supply demand balance, and therefore no strategic decisions are needed in the plan's medium term, which require a long lead-in time. Finally, we have tested our plan against the long-term uncertainties, and it is resilient to these within the statutory 25-year planning period, therefore we do not need to consider different preferred options within this timeframe. These outcomes are aligned with our problem characterisation status identified in **Section 4**.

Based on the evidence outlined above, we have not developed a formal adaptive planning approach whereby multiple preferred programmes or options are considered and decision points identified. We have, however tested our plan via scenario assessment to understand the likely effects of the biggest uncertainties that could influence the plan. In doing this we have aligned the scenarios assessed with those set out in the Environment Agency WRPG and the Ofwat common reference scenarios[93].

[93]Ofwat, 2021. PR24 and beyond: Long-term delivery strategies and common reference scenarios.

15 Final Water Resources and Demand Strategy

15.1 Section Overview

This section provides information on the preferred plan that we propose for WRMP24.

15.1.1 What drives us to do something different from the last plan?

We are now planning to a higher level of resilience against severe drought than in our last plan, and since early 2020 we have experienced a significant change in the way that our customers use water in the home because of societal changes following the COVID-19 pandemic. Household per capita consumption is higher, and our plan reflects this by taking a more cautious approach on PCC (assuming higher consumption per person at the start of the planning period) than we did in previous plans, while at the same time we have a more stringent set of targets to work to, with a goal to help customers not only reduce consumption to 110 litres per person per day by 2050 but also now to meet the 2038 target of 122 litres per person per day.

Government targets (draft Environment Act targets) require a 50% level of leakage reduction from 2017/18 levels by 2050 and a 20% reduction in the use of public water supply by 2037 against a 2019/20 baseline, which assumes a 31.3% reduction in leakage from the 2017/18 baseline - our plan delivers these target requirements.

For resilience to a 1 in 500-year drought, we have chosen to prepare our system for this risk from 2025.

As well as new requirements on resilience and a change in the society we serve, we are now part of a broader planning process on regional water resource management and our WRMP24 aligns with the developing regional plan for water. This means that consideration of larger options such as the new reservoir at Cheddar have been reviewed as we have transitioned from draft to the revised draft plan, to ensure that water in the West Country region is managed in the best possible way.

15.1.2 How did we choose the options we have selected?

In line with government targets, our plan delivers options to reduce leakage by 50% and reduce PCC to 110 litres per person per day (and to achieve interim targets as well). We have used a weighted sum optimisation approach with all the options scored in relation to a selection of metrics with weights applied to each metric, following decision-making workshops within the business using consultancy support to ensure we consider the widest range of key issues. Options chosen to deliver this demand reduction have been selected based on their cost, wider benefits, customer preference, and environmental impacts as described in the Options section of this plan, and the investments required in each AMP to 2050 are listed below in **Table 15-1**.

Table 15-1: Enhancement investments required in each AMP to 2050 (base year 2020-21)

Leakage	£29.1	£53.9	£52.2	£71.3	£96.8
Water efficiency (HH+NHH)	£1.2	£6.6	£6.0	£5.4	£5.4
Metering (HH+NHH)	£25.3	£26.0	£27.2	£0.0	£0.0
Supply schemes	£0.0	£0.0	£0.0	£0.0	£0.0
TOTAL	£55.6	£86.5	85.4	£76.7	£102.2

15.1.3 What are the options selected?

As shown in **Table 15-1**, our plan focuses on leakage reduction, water efficiency (PCC reduction and non-household demand reduction) and metering (which provides benefits to both leakage and PCC). The specific options selected in our preferred plan are shown below, together with the costs of these options.

Leakage reduction

A least cost approach to leakage would see investment reach a 50% reduction in leakage front-loaded within the WRMP planning period. Front loading to achieve target reductions by 2040 creates a programme that would be unacceptable to our customers and stakeholders. This approach would have a significant upfront cost and customer disruption due to the high levels of asset renewal required. If leakage interventions are delayed, back loading to later in the investment period, then unfair costs are pushed to future customers. We discussed at our pre-draft WRMP meetings with Ofwat and the Environment Agency the concept of an “intelligent pathway” of steady progress on leakage from our frontier position in 2025.

Our best value planning approach assumes a progressive reduction in leakage between 2025 and 2050, which has been termed the optimal scenario. The resulting leakage levels and percentage reductions from the 2017/18 baseline are given in **Table 15-2** and **Figure 15-1**.

Table 15-2: Leakage level and percentage reductions from the 2017/18 baseline resulting from the best value planning approach.

	2017/18 baseline	2021/22 actual	2024/2525	2036/3737	2044/45	2049/50
Leakage level (ML/d)	43.9	35.65	32.1	25.32	23.20	21.96
Percentage reduction on 2017/18 baseline	-	18.8%	26.9%	42.3%	47.1%	50.0%

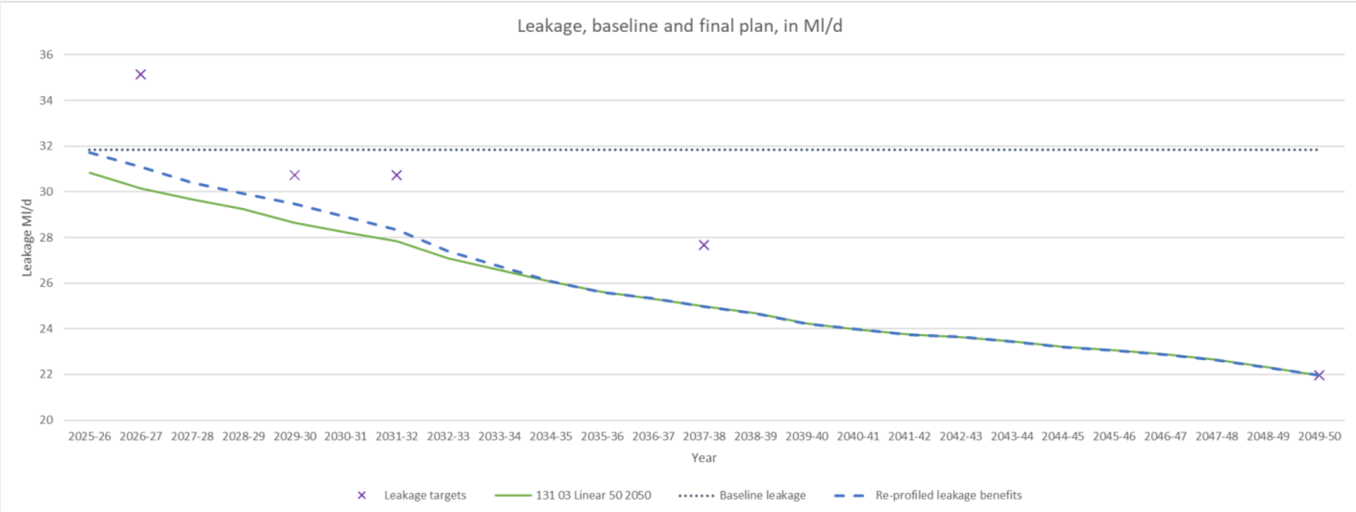


Figure 15-1 Preferred plan leakage profile demonstrating the aim to achieve leakage reduction targets.

To assess the optimal way to deliver this leakage reduction from the low level currently in the Bristol Water system, we have worked with RPS using their proprietary SoLow model. This model optimises a user specified level of leakage reduction over a specified timeframe using a range of leakage reduction activities to identify the overall programme of activities that is the most efficient; it is the optimised programme of activities for each of the different scenarios leakage reduction that are presented in our planning tables. It reflects the optimised programme of activities required to achieve the leakage reduction targeted. We have used our own costs where available and industry costs where these are more representative of future costs to reduce leakage. Where data have not been available, a combination of historic data and industry values provided by RPS have been used.

In our plan, asset renewal is required at a higher rate than in previous planning periods at a rate of 68 km in AMP8 – ~0.25% of mains replaced each year, rising to 0.55% p.a. for AMP9 and beyond. This rate of asset renewal is the most effective way to tackle the background leakage level, which must be addressed due to Bristol Waters low leakage levels. The capex cost for Bristol Water to reduce leakage is high at £29.1m for AMP8 and £274.2m for AMP9 to AMP12, due to the current leakage position of Bristol Water. We consider it will be very important to test with customers regarding the willingness to pay for this long-term reduction in leakage, compared with other lower-cost options such as new supply options providing the same or greater benefit at a higher level of certainty. The cost here reflects the marginal cost beyond our 100km per AMP current baseline, although the full cost is shown in the option cost in tables 4 and 5a-c.

Our optimal route to a 50% reduction in leakage by 2050 also outperforms the 30% by 2030 and 37% by 2038 national targets. From the range of profiles available, we have selected a reduction rate in leakage, as described in **Table 15-2**, from 2024/25 to 2049/50 that delivers the leakage reduction we need across the planning period. We consider that this programme of leakage reductions will be challenging to plan and carry out and therefore, we have been conservative with the benefits we expect to see in AMP8 (see **Figure 15-1**, blue dashed line).

We have undertaken extensive testing in delivering the target leakage reductions across different glide paths. This has included scenarios with higher and lower leakage reductions, different glide path durations, and different leakage reduction profiles (front-loaded, back-loaded). Some of these scenarios have planned to deliver leakage levels lower than the required reduction levels or achieving the 50% reduction target by 2055. Through this testing, it has been established that a 50% leakage reduction by 2050 represents the best value solution.

Two key investments are seen in this scenario: asset renewal at an average of 28.9km mains replacement per year and smart metering. Smart metering can provide benefits both in demand reduction and leakage reduction through effective use of the data this technology makes available. The leakage benefits from smart metering have been considered in the development and optimisation of the leakage activities. Smart metering costs have been excluded from leakage reduction scenarios described here and are only included in relation to PCC reduction and water efficiency options.

Table 15-3: Summary of leakage reduction scenario optimisation for the period 2024/25 to 2049/50. Note total costs include maintenance costs.

Scenario	Leakage reduction (Ml/d)	Direct leakage reduction costs (£m)	Carbon Cost (£m)	Cost of Water (£m)	25yr undiscounted cost (£m)	25yr discounted cost (£m)
No reduction	-	-	10.44	29.32	213.23	138.49
Reduction to 50% by 2049/50 (with smart metering)	9.89	290.31	26.79	23.18	494.12	326.17

Table 15-4: Optimised leakage reduction programme 2024/25 to 2049/50 (underpinning the option ID 131 Linear 50)

Leakage reduction activities	Leakage Reduction (Ml/d)	Undiscounted Cost over Glide Path (£m)
D001 - PM	0.35	0.73
D002 – Main	5.92	300.35
D005 - CSP	-	-
D006.1 – DMA ALC/L&S Transition	-	-
D006.3 –iALC	0.13	0.15
D006.4 – TM ALC	-	-
D007.1 - PAL	-	-
D007.2 -DMA Subdivision	-	-
D007.3- Monitoring	-	-

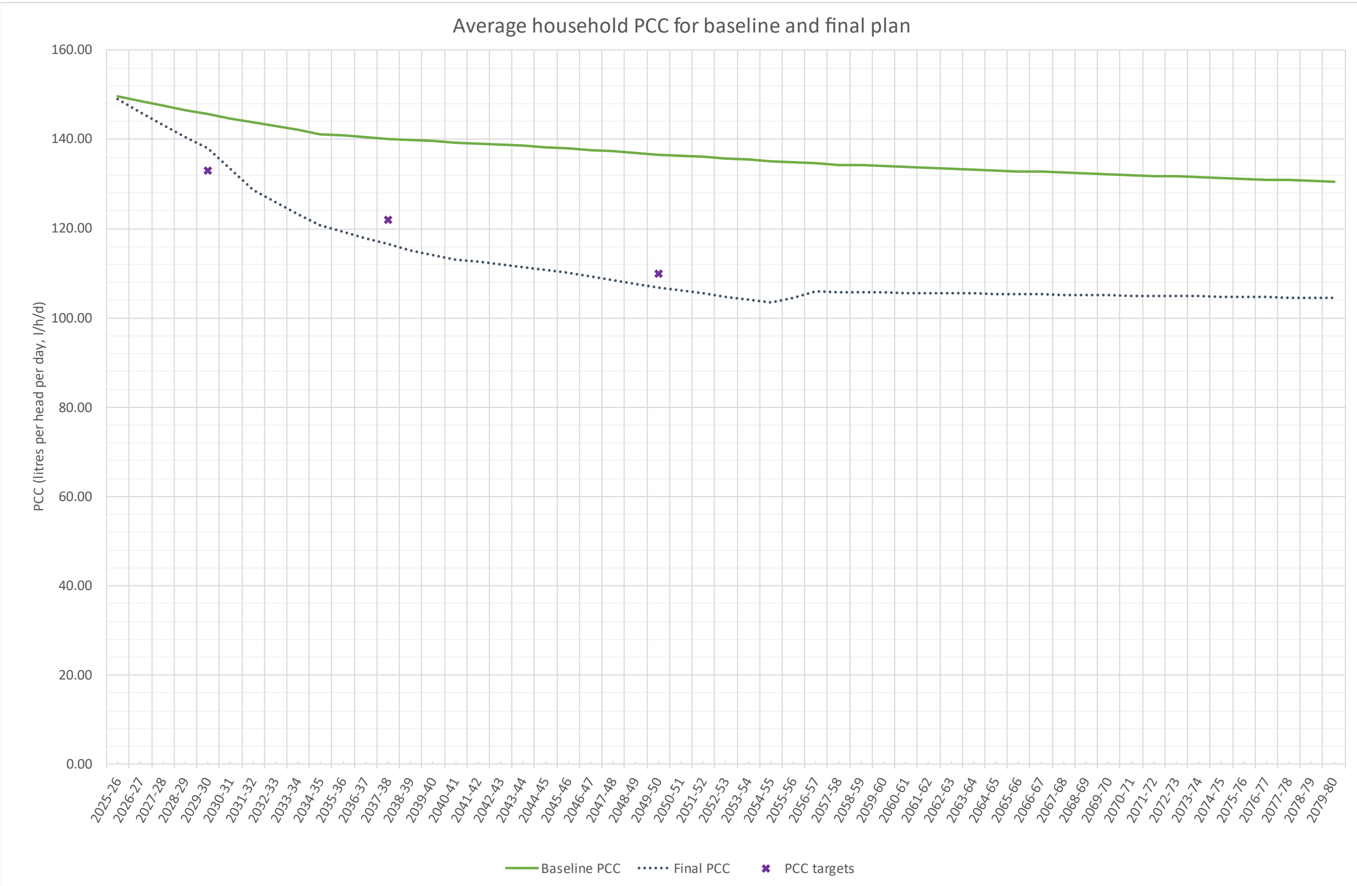
D009 - Smart Metering	3.49	2.05
D010.1 – ALC Innovation	-	0.5
D010.2 – AR Innovation	-	0.5
D23 – TM AR	-	-

Further information on the costs and benefits of the leakage activities considered and additional narrative on our leakage investment strategy is available in Appendix I.

PCC reduction and non-household water efficiency

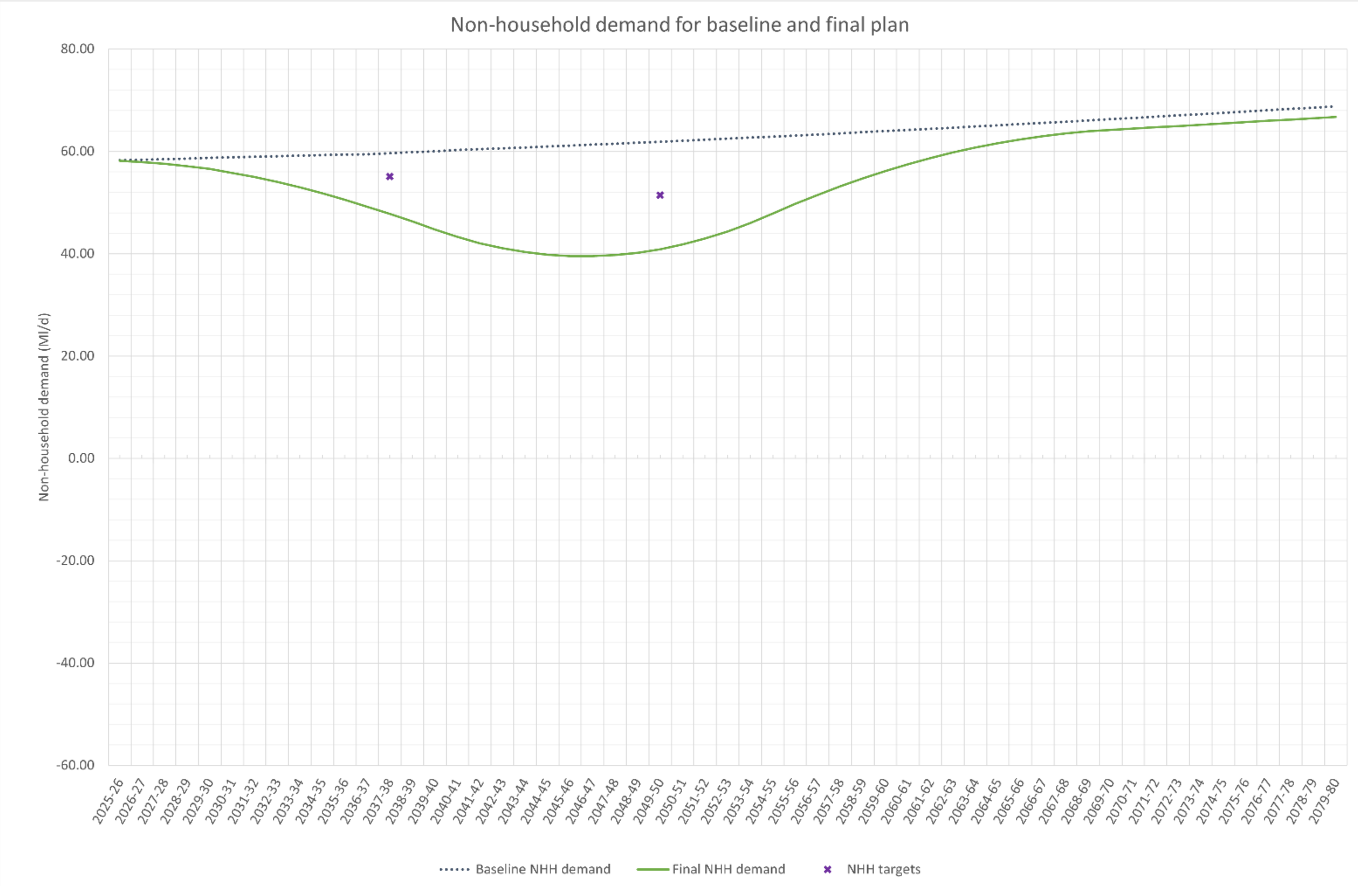
We have identified a large range of possible activities as described in the Options section of this plan, helping customers to reduce their water use. To deliver a PCC target of 110 l/h/d we anticipate it will be necessary to implement a number of these actions. The main areas of focus will be on smart metering and customer engagement through apps and other social media, with targeted mass media awareness and behaviour change campaign. We also plan to engage more with non-household customers in their water use, supporting these customers through site audits, targeted support on rainwater harvesting and water efficient options such as waterless urinals. **Figure 15-2** demonstrates the anticipated PCC reduction profile over the planning period, demonstrating our intention to achieve the government-led targets for PCC reduction.

Figure 15-2 Preferred plan PCC reduction profile demonstrating the aim to achieve Government targets in 2038 and 2050.



At £1.2m for non-households in AMP8, we anticipate a significant increase in expenditure beyond AMP8 in this area during the planning period, compared with our historical support for customers on metering and water efficiency, to help drive down PCC to the target level of 110 litres per person per day by 2050 and improve non-household efficiency with a view to the 9% reduction target in 2038. Figure 15-3 demonstrates our aim to achieve the reduction targets associated with non-household demand reduction. As demand from non-households increases after 2050, we will need to evaluate how to manage the water use. We intend to do this through the usual water resources planning process.

Figure 15-3 Non-household demand reduction profile, demonstrating the aim to achieve the targets for non-household demand reduction over the planning period.



Key to delivering this long-term goal will be new standards in household water efficiency and the efficiency of water-using appliances such as washing machines, showers and toilets. We have not assumed any significant cost associated with these regulatory changes but they are an important part of the mechanism for delivering reduction in PCC.

We considered two different water labelling options within our plan as feasible. The savings are defined by the Defra consultation 2020[94]. Our decision-making process identified the water labelling option with minimum standards (HH_P_002) to be the most optimal solution of the two options. However, the benefits of this option after 25 years are large and we felt these were unrealistic. Hence, the benefits of this option are limited to an annual saving of 7.34Ml/d from 2034/2035. Following feedback from Defra

[94] DEFRA 2020 Water efficiency labelling consultation (EST) Annex F

in early 2024, we have tested the impact of the water labelling option without minimum standards (HH_P_003) on our final plan. In this option, the annual benefits accumulate more slowly than the option in our final plan however, in 2049/50, the annual benefit of water labelling without minimum standards is 17.22 Ml/d rather than the 7.34M/d we have assumed. We estimate that both options would allow us to meet the 2038 and 2050 PCC targets however, the one selected for our plan would better support the reduction in PCC in the short-term and we hope that by curtailing the annual benefit from 2034/35 that we are being precautionary in the level of reliance we have on either of these options.

We are aware that as this aspect of our plan is outside our direct control, there is an increased risk that this reduction may not be delivered within the planning period so we have alternative options available if this regulatory support is not forthcoming. Following the governmental support of water labelling we believe that support for these initiatives will continue and provide PCC reductions.

Metering

Our customers recognise that metering is the fairest way to pay, and our stakeholders call for us to increase meter penetration at an increased rate. Metering not only provides customers with an incentive to use water carefully, but also provides us with better data to monitor and run our network. Our data shows that universal metering (on an area-by-area basis) is the most cost-efficient way to meter. However, as our supply zone is not classified as an area of water stress, we cannot compulsorily bill on the meters that we install until our customers opt-in or move house. We will heavily promote the benefits of metering to our customers, continue to run 'no regrets' switching campaign and lobby the government for a change in legislation to permit compulsory metering in our supply area.

We have extensively tested different meter delivery programmes. We have considered back- and front-loaded meter installation programmes, different delivery years for the 90% smart meter penetration target, and programmes with focuses of different types of meter installations. From this, we have found that a universal smart metering programme over 15 years from 2025 is the most cost-effective means of installing meters to reach effective full meter penetration by 2040 (90%).

The optimised least cost plan in the dWRMP suggested smart metering would not be required until 2037. Following the development of new options to install flow regulators and additional method to undertake home efficiency visits, smart metering would not necessarily need to be carried out at all to ensure the supply demand balance.

However, this would not provide sufficient confidence that we could meet both leakage (due to lack of monitoring data) and PCC targets. Delay to smart metering would reduce future options and resilience. Justification of alternative supply options (although not required should the targets be met but tested as a scenario) would be difficult to make without the additional information on demand and leakage from smart metering.

This will improve the information available to target supply options and will support regional planning of supply schemes, given the uncertainty associated with future water resource resilience across the region. This is a relatively high-cost option requiring a total expenditure of £73.4m across the planning period for household alone, but this approach aligns with government expectations for increased smart meter usage and will also provide significant benefits on leakage reduction and broader understanding of the water supply network. The scheme will include installation of new smart meters at unmetered properties and replacement of existing meters with new smart meters. Smart metering will also provide customer side leakage benefits.

Our plan is to make use of "advanced metering infrastructure" (AMI) smart meters rather than AMR metering, as these can provide highly granular data. This will enable full delivery of demand and leakage reductions, as well as enable monitoring of the effectiveness of other water efficiency and demand reduction options. The cost of AMI metering has decreased greatly in recent years, and as such the risks associated with selecting an AMI programme instead of AMR are much lower.

Table 15-5: Smart meter and meter penetration up to 2050

	AMP8	AMP9	AMP10	AMP11	AMP12
Meter penetration (%)	80.31	85.74	90.00	92.68	94.73
Smart meter penetration (%)	33.43	63.15	90.00	92.65	94.73

For non-household customers there is support from the Environment Agency for additional smart metering to drive improved consumption data and support demand reductions. We have assumed a highly targeted programme of NHH AMI metering within our best value plan.

The estimated total cost of the metering programme is given below in **Table 15-6**.

Table 15-6: Estimated total cost of the enhancement metering programme.

Totex £m	AMP8 (£m)	AMP9 (£m)	AMP10 (£m)	AMP11 (£m)	AMP12 (£m)
Households	23.7	24.3	25.3	0.0	0.0
Non-households	1.5	1.7	1.9	0.0	0.0

Project management costs are included under the Watersmart costs and maintenance costs. Costs associated with risk are included in the AMI meter installation costs as contractors include a risk allowance as part of their delivery costs for installations. On-costs (additional costs associated with putting the meter in the ground) are included within the AMI cost as appropriate with some additional costs within the Watersmart element of the option.

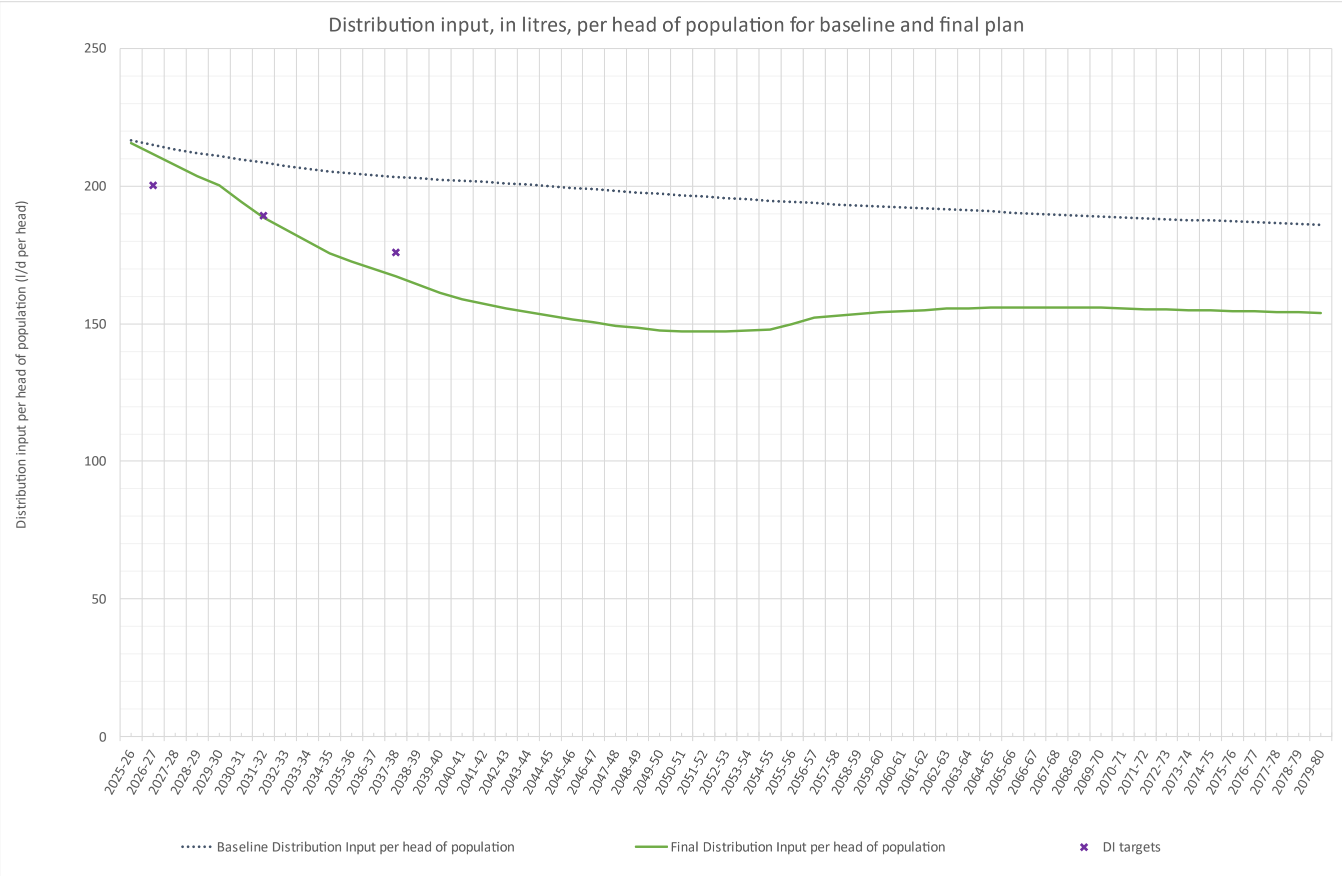
Table 5a-c shows the calculation of financing costs and NPC. We have amended the standard calculation in the worked example provided in the guidance to reflect that capital expenditure on our options, particularly demand reductions such as mains replacement, occurs in each year. The capex each year is added to the opening RCV and the asset-life based depreciation rate applied to the opening RCV plus capex in the year. This reflects RCV operation rather than being precisely straight-line depreciation. At the end of the asset life, we amended the calculation to take the financing cost forward – a calculation simplification as, for instance for mains replacement with an 80-year life, at the end of the period there would need to be continued mains replacement to maintain leakage at that (lower) level.

Distribution input reduction targets

The EIP requires overall distribution input to be reduced. The requirement is to *"Reduce the use of public water supply in England per head of population by 20% from the 2019 to 2020 baseline reporting figures, by 31 March 2038, with interim targets of 9% by 31 March 2027 and 14% by 31 March 2032"*. Despite aiming to achieve the reductions for leakage, PCC reduction and non-household demand reduction, we estimate that we will not be able to meet a 9% reduction in distribution input, per head of population, by 31st March 2027. More importantly, we do not believe that it is technically feasible for us to make this level of reduction in the first two years of the planning period.

The company has decided that pursuing a trajectory to be confident in achieving a 14% reduction in DI by 31 March 2032 does not reflect affordability for our customers. As demonstrated in , our preferred plan should enable us to achieve, and surpass, the final DI reduction target.

Figure 15-4 Distribution input reduction profile demonstrating which targets will be achievable.



Review and transition to final plan.

Demand management measures are not necessarily the lowest-cost option to meet a supply-demand deficit, and they are also less certain of success than an equivalent volume of water supply, particularly where this is achieved through water storage where water can be saved from one year to the next.

The bill impact of our preferred plan will be calculated by the PR24 business plan. Affordability of the plan has been at the forefront of what the Company is aiming to achieve for its customers. Initiatives such as our smart metering programme and the Government-led options that we have selected offer a route to reducing customer bills by managing usage whilst keeping the bill impact as low as possible. If we were to select a purely lowest-cost plan, this would be more likely to select Government-led initiatives followed by cheaper but more short-term demand options including the installation of flow regulators and media campaign schemes. Supply options such as treatment works upgrades, reintroduction of small water sources and effluent re-use also offer potentially more affordable options to closing any future deficits although these do not deliver demand reduction. Our plan seeks to balance delivery of Government targets while creating long-term resilience for customers at affordable cost, and due to the iterative nature of the WRMP process we will continue to take a fresh view of the best plan at each opportunity presented through the planning process.

15.2 Final Planning Supply Demand Balance

Our approach to securing a supply-demand balance over the 55-year planning period to 2080 is focused on delivering the leakage reduction and demand reduction policy targets to achieve a 50% reduction in leakage by 2050 (against 2017/18 levels) and reducing customer demand to an average of 110 l/h/d by 2050 and non-household demand by 15% by 2050. This strategy has been fully tested with our customer during the public consultation process for our WRMP24, particularly regarding the extent of leakage and demand reduction in the context of our overall supply demand position.

The options we are proposing to implement are summarised in **Table 15-7**, and the final supply demand balance associated with delivery of these options is presented in **Figure 15-5**.

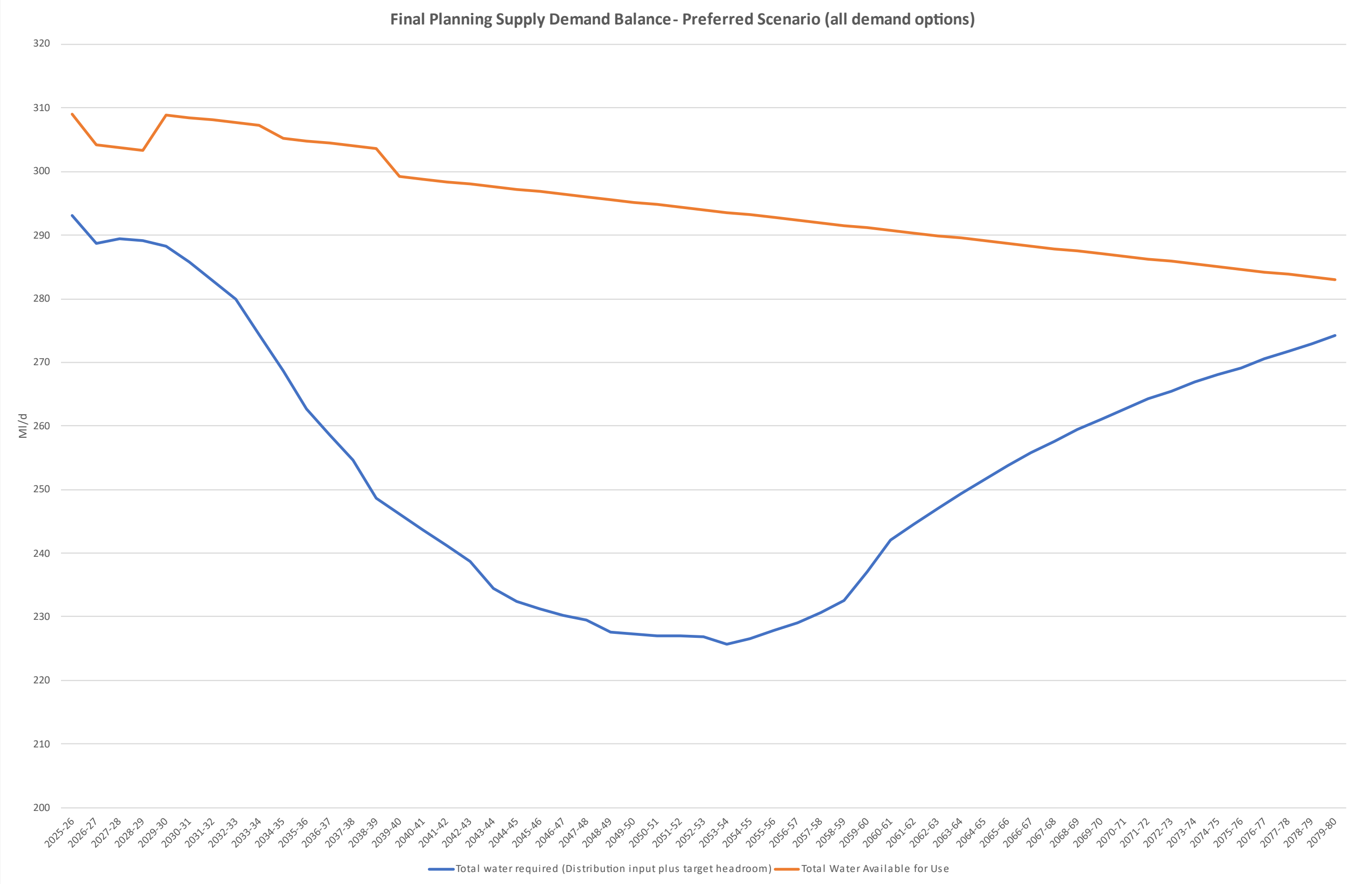
Table 15-7: Final planning options and implementation dates

Option ID	Type of option	Option Name	Year of implementation
131 Linear 50	Leakage control	D001: Pressure management	2025
	Leakage control	D002: Asset Renewal	2025
	Leakage control	D006.3: Intensive ALC	2025
	Leakage control	D009: Smart Metering	2025
	Leakage control	D010.1: ALC Innovation – to drive ALC repair efficiency	2025
	Leakage control	D010.2: AR Innovation – to drive Asset Renewal efficiency	2025
HH_E_016	Water efficiency customer education/awareness	Media campaigns to influence water use	2030

Option ID	Type of option	Option Name	Year of implementation
HH_M_009 (AMI) (15) (Baseline)[95]	Water efficiency customer education / awareness	Progressive smart metering automatic WCWR switch with Watersmart Technology (personalised billing, behavioural changes) (AMI) (Baseline)	2025
HH_M_009 (AMI) (15) (Enhancement)	Metering and water efficiency customer education/awareness	Progressive smart metering automatic WCWR switch (HH_A_001) with Watersmart Technology (personalised billing, behavioural changes) (AMI) (Enhancement)	2025
HH_P_002	Water efficiency customer education/awareness	Water labelling - with minimum standards	2026
HH_P_001	Retrofitting indoor water efficiency devices	Change in WC Standards	2030
HH_P_005	Water efficiency	New home standards	2030
NHH_A_001	Non-household water audit	Business Efficiency Visits (BEV) - water efficiency audit - in person audit, fix and retrofit, targeted at specific sectors/businesses	2025
NHH_E_002 (AMI)	Water efficiency	SMART Online - Watersmart online tools and resources (AMI)	2025
NHH_N_002	Rainwater harvesting	Rainwater harvesting feasibility assessment and/or subsidised installation - target large water users	2025
C016	Water efficiency	Water saving devices – waterless urinals	2025
NHH_T_003	Tariffs	Benchmarked rising block business tariffs	2030

[95] Note that the distinction baseline versus enhancement reflects the way in which the costs are treated in the business plan.

Figure 15-5: Final planning supply demand balance position.



In view of our positive supply demand position, and the likely continuation of this if the leakage and PCC policy targets are delivered, we have not included any supply side options in our preferred plan. Similarly, we have not included any water trading options in our plan. However, if we are confident in the delivery of our leakage and water efficiency programmes, our surplus may allow for the consideration of trading options where appropriate, particularly within the West Country region.

Our preferred plan is our best value plan. It takes account of the environmental and social effects of the options available to deliver the policy targets and we have selected those that deliver the targets with minimum environmental impact and are aligned with the expectations of our customers. We will implement a pro-active programme of smart metering from 2025. Bristol Water has not been classified as a water stressed area by the Environment Agency under their latest classification[96], we are not, therefore allowed to implement a compulsory metering programme. Under our pro-active smart metering strategy, we will therefore install meters, but not bill customers against them unless they request it.

[96] Environment Agency/ Defra, 2021. *Water stressed areas – 2021 classification*.

15.2.1 Level of Service and Annual Risks of Water Use Restrictions

In developing our water resources strategy, we have ensured that we at least continue to meet our planned levels of service for water use restrictions and have demonstrated that we can maintain supplies in a 1 in 500-year drought event.

We have assessed the actual (modelled) level of service associated with each level of demand restrictions as an average annual percentage risk over the planning period. This has been carried out as an indicative assessment using the historic hydrological record and then applying an adjustment factor to align it to the likely impact from a 1-in-500-year event. The results of this assessment are reported in water resource planning table 2f (WC Level DYAA Levels of Service final planning) and summarised on an AMP by AMP basis in **Table 15-8.**

Table 15-8: Actual levels of service per 5 year period across the 25-year planning horizon (using demand + target headroom) and at 2080.

	AMP8		AMP9		AMP10		AMP11		AMP12		2080	
	2025/26–2029/30		2030/31-2034/35		2035/36-2039/40		2040/41-2044/45		2045/46-2049/50		2080	
Demand + Target Headroom (end of AMP)	**311.18 Ml/d**		**307.53 Ml/d**		**301.49 Ml/d**		**299.51 Ml/d**		**297.48 Ml/d**		**285.29 Ml/d**	
Demand restrictions	Actual LoS	% annual risk	Actual LoS	% annual risk	Actual LoS	% annual risk	Actual LoS	% annual risk	Actual LoS	% annual risk	Actual LoS	% annual risk
TUBS	1 in 100 yrs.	1.0	1 in 100 yrs.	1.0	1 in 100 yrs.	1.0	1 in 100 yrs.	1.0	1 in 100 yrs.	1.0	1 in 100 yrs.	1.0
Drought Permits	< 1 in 100 yrs.	<1.0	< 1 in 100 yrs.	<1.0	< 1 in 100 yrs.	<1.0	< 1 in 100 yrs.	<1.0	< 1 in 100 yrs.	<1.0	< 1 in 100 yrs.	<1.0
Drought Order (NEUB)	< 1 in 100 yrs	<1.0	< 1 in 100 yrs	<1.0	< 1 in 100 yrs	<1.0	< 1 in 100 yrs	<1.0	< 1 in 100 yrs	<1.0	< 1 in 100 yrs	<1.0
Emergency Drought Order	1 in 500yrs.	0.50	1 in 500 yrs.	0.50	1 in 500 yrs.	0.20	1 in 500 yrs.	0.20	1 in 500 yrs.	0.20	1 in 500 yrs.	0.20

Following the review and update of our hydrological data and information, both in terms of the historic data and the stochastic data sets, we are currently working with the Canal & River Trust to better understand the resilience of the Gloucester and Sharpness Canal to droughts and drought restrictions on the River Severn. We will re-assess our actual (modelled) level of service in the context of this work for subsequent WRMPs.

In parallel to the DO modelling work completed for this WRMP24 submission, we have been undertaking a review of reservoir control curves (which drive drought trigger actions). As part of this work, we have set up a modelling optimisation framework in Aquator to allow assessment of the trade-offs between different future potential control curves. The work so far has allowed us to understand the level of influence the control curves and associated actions have on reservoir drawdown behaviours and identified potential opportunities to refine the curves as part of future Drought Plan updates.

Whilst work will continue towards our next Drought Plan, the work so far has shown refinement of the curves is possible without impinging upon Level of Service or DO, adding confidence to WRMP24. Any formally revised trigger curves will feed into modelling at WRMP29.

15.2.2 A Social and Environmental-Focused Strategy

Each of the WRMP options has been assessed for the potential effects on society and the environment as detailed in **Section 13** and associated appendices. The preferred programme of options involved a reduction in treated water leakage, as well as significant demand reduction. Therefore, there are no increases to current abstraction rates via increased production or the development of new resources. As a result, the overall environmental effects are considered to be low or negligible.

15.2.3 SEA of the Preferred Programme

The preferred programme of options were reviewed (individually and cumulatively) to ensure that the effects of Bristol Water's WRMP24 has been identified, described and evaluated. The WRMP24 preferred plan is set out in **Table 15-9** and shows the assessed performance against each of the SEA objectives. These results are summarised below, full details of the SEA and its findings are presented in **Appendix E**.

Assuming the implementation of reasonable mitigation measures and the use of good construction practice the potential for negative effects regarding objectives associated with the Biodiversity, Flora and Fauna SEA topic are generally considered neutral. This includes the assessment regarding the risk of spreading INNS, which is considered neutral due to the characteristics of the leakage reduction and demand policy delivery based options which do not present an INNS transfer risk.

Similarly, because the plan is largely focused on demand reduction and involves options with limited potential for wider environmental effects, objectives associated with the SEA Topics Cultural Heritage and Landscape & Visual Amenity have been assessed as neutral assuming the implementation of reasonable mitigation measures and the use of good construction practice.

The Catchment Management of the Mendip Lakes option, unlike the leakage and demand reduction options, would provide a wider range of environmental effects, for example regarding nutrient management, soil management and water resources. This will result in positive, localised, effects with respect to the Biodiversity, Flora and Fauna SEA topic and the Soil, Geology and Land Use SEA topic.

Table 15-9: Preferred Programme (combination of options) Assessment

SEA Topic	SEA Objective		Construction Effects Negative	Construction Effects Positive	Operational Effects Negative	Operational Effects Positive
Biodiversity, Flora and Fauna	1.1	To protect and enhance sites that are designated, both nationally and internationally, for their conservation value	0	0	-	++
	1.2	To avoid a reduction, and contribute to an enhancement where possible, in natural capital assets, and to provide opportunities for biodiversity net gain, where possible	0	0	0	0
	1.3	To protect priority habitats and species	0	0	0	++
	1.4	To reduce the spread of invasive, non-native species	0	0	0	0
Soil, Geology and Land Use	2.1	To ensure the appropriate and efficient use of land and protect and enhance local geomorphology, soil quality and geodiversity	0	0	0	+
Water	3.1	To protect and improve the quality of surface water and groundwaters	0	0	-	++
	3.2	To protect flows and resource levels of surface waters and groundwaters	0	0	-	++
	3.3	To reduce or manage flood risk whilst accounting for climate change	0	0	0	+/?
	3.4	To meet WFD objectives	0	0	0	++
Air Quality	4.1	To protect and enhance air quality	0	0	-	0
Climate Change	5.1	To minimise greenhouse gas emissions and embodied carbon	---	0	---	0
	5.2	To adapt and improve resilience to the threats of climate change	0	0	0	+++
Human Health and Socio-Economics	6.1	To promote a sustainable economy and maintain the economic and social wellbeing of local communities	0	+++	0	+++
	6.2	To maintain and enhance tourism and recreation	0	0	0	+
	6.3	To protect and enhance the human health and wellbeing	0	0	0	+++
Material Assets	7.1	To promote the efficient use of resources and minimise waste	--	0	0	+
Cultural Heritage	8.1	To conserve and enhance the significance of designated and non-designated heritage assets and their settings, including archaeologically important sites	0	0	0	0
Landscape & Visual Amenity	9.1	To conserve and enhance landscape and townscape character and visual amenity	0	0	0	0

Key:

Effect	Description
+++	Major Positive
++	Moderate Positive
+	Minor Positive
0	Neutral
-	Minor Negative
--	Moderate Negative
---	Major Negative
?	Uncertain

The only potential for significant negative effects were those identified regarding greenhouse gas emissions (Objective 5.1). This includes those arising from embodied carbon associated with the materials involved as well as greenhouse gas emissions associated with the use of vehicles. This is true for several of the options involved, for example the leakage reduction activities. The increase in vehicle movements also has implications regarding air quality. However, the significance of effect regarding emissions to air and air quality depends on the type of vehicles utilised (petrol/electric).

Assuming at the start of the implementation period vehicles will be petrol, the effects on air quality (Objective 4.1) are anticipated to be minor considering the geographic extent of the Bristol Water supply area, the fact that vehicles will be dispersed across this area and the programme of implementation is over a long duration. The significance will reduce to neutral after 2030 when it is assumed that electric vehicles will be used.

A number of options in the preferred programme would together result in an increase in resource use and construction waste (Objective 7.1). However, in operation the reduction in leakage and demand, and increased water efficiency resulting from the options involved, will together result in positive effects against this objective. These are associated with savings from the reduced treatment and pumping of water (e.g. chemical usage). Positive effects are also identified with respect to improving resilience to climate change in relation to the reduction leakage and demand and resulting additional resource.

Moderate to major positive effects are identified with respect to objectives associated with the Human Health and Socio-Economics SEA topic. This includes major positive effects to economic growth (Objective 6.1), relating to the significant work involved associated with achieving the reductions in leakage. It is noted that there is some uncertainty regarding this effect as detailed information regarding effects on employment opportunities etc. are currently unknown. In operation, the improved continuity of supply and efficiency achieved by the options in the preferred programme, is expected to have a major positive effect on economic and social wellbeing in local communities.

Based on the timing of implementation of the options in the preferred programme (spread between 2025 and 2050) the cumulative impact of any noise/vibration disturbance and nuisance resulting from installation or transportation associated with the options involved are not expected to result in any significant negative effect on human health. In operation the reduction in leakage and demand achieved by the preferred programme of options will ensure continuity of supply of safe and secure drinking water. In light of this a moderate to major positive effect on human health and wellbeing.

None of the options in the preferred programme will have any adverse effects on our duties under the Natural Environment and Rural Communities Act 2006 to conserve biodiversity. No significant impacts have been identified with respect to cumulative effects with other of other relevant programmes, plans and strategic projects.

15.2.4 HRA

Bristol Water's constrained option list was subject to Stage 1 Screening as part of the HRA process. This identified that a number of the options would require further assessment through Stage 2 Appropriate Assessment because of impact pathways to European sites or offsite functionally linked habitat. However, the WRMP preferred programme only involves leakage and demand policy delivery-based options which are not considered to result in adverse effects to European sites given the type and scale of activity, and therefore no further assessment work is required.

15.2.5 Biodiversity Net Gain and Natural Capital Assessment

It is confirmed that the WRMP preferred programme only involves leakage reduction and demand policy delivery-based options and that no supply side options are included. As such, no further biodiversity net gain and natural capital assessments are required beyond what is needed for the feasible option assessments, as stipulated within the WRPG.

15.2.6 WFD Assessment

It is confirmed that the WRMP preferred programme only involves leakage reduction and demand policy delivery-based options and that with no supply side options included in the WRMP, no WFD assessment is required of the preferred plan as the options fall out of the scope of the WFD assessment. The preferred plan is therefore assessed as WFD compliant.

15.2.7 Overview

This revised draft WRMP sets out the best value approach to delivering policy targets relating to leakage and demand reduction by 2050, in the context of increased resilience to a 1 in 500 year drought. In delivering these targets via this programme, we increase the supply surplus within the Bristol Water resource zone without taking additional water from the environment.

We will test the customer acceptability of this draft plan via the public consultation process and look forward to engaging with customers and stakeholders to understand their thoughts on the options we are proposing and the level of resilience we are aspiring to, amongst other considerations such as the synergies with other statutory and long term investment plans.

We regard the provision of high-quality drinking water as our top priority in planning for the service we provide and none of the options in our preferred plan would lead to any deterioration in water quality. In addition, our proposals for options which could need to be implemented in different scenarios would also allow for provision of safe high quality drinking water with no deterioration from the high standards that our customers rightly expect.

16 Testing the WRMP

16.1 Overview

Our preferred plan sets out our approach to delivering the policy targets and resilience requirements based on our best understanding of the future supply and demand position. However, the future is uncertain. We have therefore tested our plan to the biggest areas of uncertainty and in line with the scenarios set out in both the Environment Agency Water Resource Planning Guideline[97], and the Ofwat common reference scenarios[98]. This scenario testing process demonstrates how our plan is resilient to a range of risks.

It reflects the "intelligent pathway", recognising for leakage that steady progress would be attractive from an efficiency, reputation and consumer perspective rather than a step change, which would also reflect a sensitivity around the timing of delivery of long term PCC targets.

We have tested these uncertainties across the planning period to understand whether risks are likely to manifest soon, or later in the planning period.

Table 16-1 summarises the scenarios we have assessed and which element of guidance they align to. Details of each of the assessments are then presented in the subsequent sections.

Table 16-1: Summary of the scenarios used to test the Bristol Water WRMP.

Scenario Ref	Scenario Name	Climate change assumption	Other assumptions	Alignment with guidance
1	Least cost (policy targets)	PB6.0 (Mid)	Delivers leakage reduction of: - 20% by 31st March 2027 (EIP) - 30% by 31st March 2030 (PIC) - 30% by 31st March 2032 (EIP) - 37% by 31st March 2038 (EIP) - 50% by 31st March 2050 (NIC) Compared to 2017/18 levels; and, PCC reduction of: - 122 l/h/d by 31st March 2038 - 110 l/h/d by 31st March 2050	EA Guidance and Ofwat requirement
2	Climate change – adverse	PB8.5 (High)	Delivers leakage and PCC reductions as above and in context of high climate change scenario	EA Guidance – climate change and Ofwat High climate change CRS
3	Climate change - benign	PB2.6 (Low)	Delivers leakage and PCC reductions as above and in context of low climate change scenario	Ofwat Low climate change CRS
4	Low demand scenario	PB6.0 (Mid)	Delivers leakage and PCC reductions as above and in context of the ONS population and household projections	Ofwat Low demand scenario

[97] Environment Agency/ Natural Resources Wales/ Ofwat, 2021. Water Resources Planning Guideline
[98] Ofwat, 2021. PR24 and beyond: Long-term delivery strategies and common reference scenarios.

Scenario Ref	Scenario Name	Climate change assumption	Other assumptions	Alignment with guidance
5	High demand scenario (Ofwat)	PB6.0 (Ml/d)	Delivers leakage and PCC reductions as above and in context of the Local Authority population and household projections and no change building regs and product standards to 2050	Ofwat High demand scenario
6	High demand scenario (EA)	PB6.0 (Mid)	Delivers leakage and PCC reductions as above and in context of a higher population forecast than in the Preferred plan.	EA Guidance – population growth
7	Environmental Ambition scenario	PB6.0 (Mid)	Delivers leakage and PCC reductions as above and demonstrates the difference between our preferred plan and the plan if unconfirmed environmental targets were not included.	EA Guidance (baseline assumptions) Ofwat High abstraction reductions scenario
8	Plausible worst case climate change and demand	PB8.5 (High)	Leakage and PCC targets not delivered in context of high climate change scenario.	EA Guidance resilience test
9	Low technology scenario (Ofwat)	PB6.0 (Mid)	Delivers leakage and PCC targets using more conventional, less hi-tech means e.g., AMR meters and mains renewal.	Ofwat Low technology scenario
10	High technology scenario (Ofwat)	PB6.0 (Mid)	Delivers leakage and PCC targets using more hi-tech means e.g., AMI meters	Ofwat High technology scenario

These scenario tests covered all the Ofwat common reference scenarios quantitatively with the exception of the technology scenarios, due to their complexity and detailed links to the options are more qualitatively assessed.

16.2 Scenario 1 – Least Cost (Policy targets)

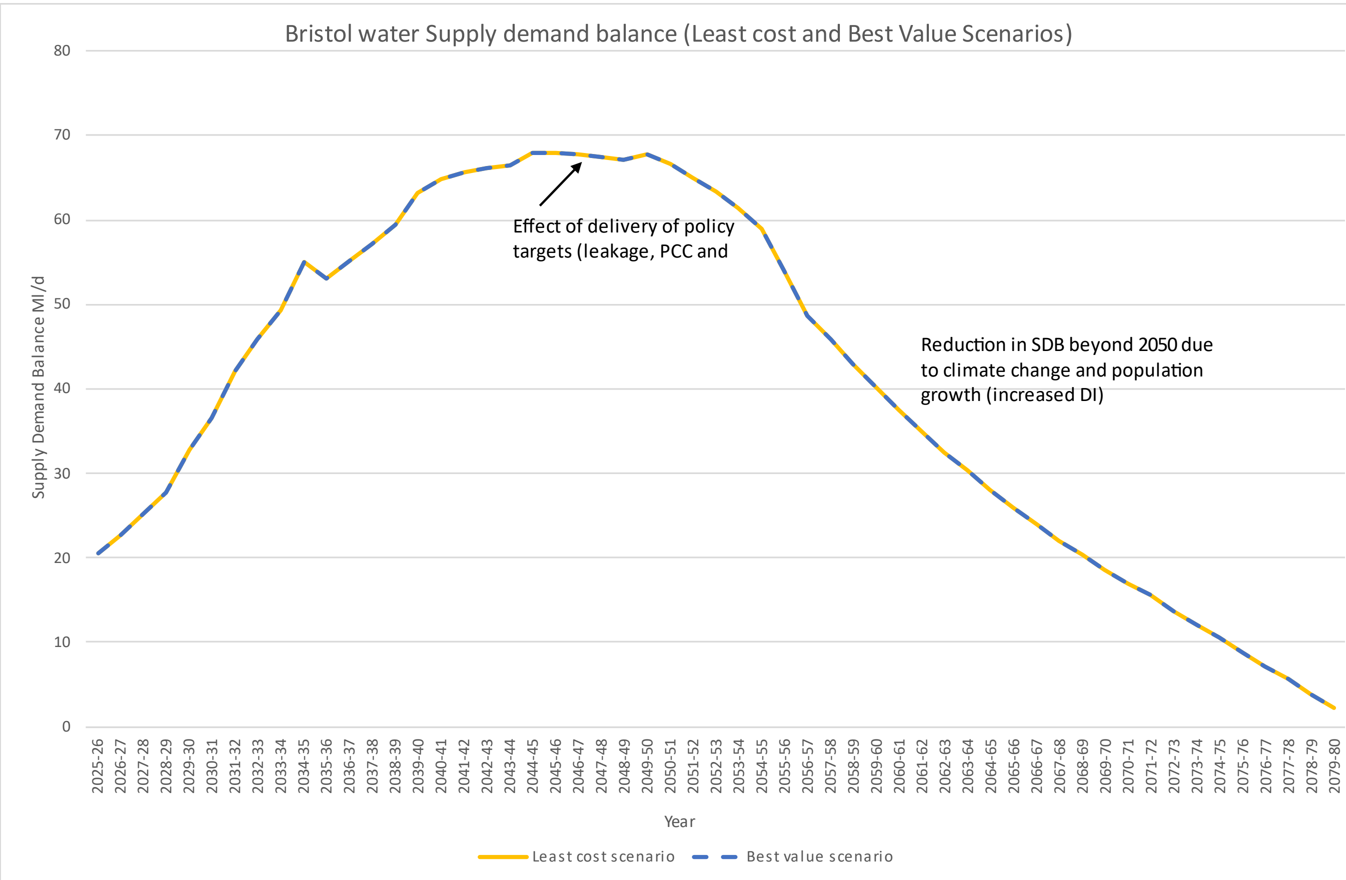
The Environment Agency WRP Guideline requires us to present a least cost scenario as a benchmark against which our Best Value plan can be assessed. The least cost programme was developed in line with our statutory requirements and to meet the policy targets set out in the Government direction and expectations. It was informed by the SEA and HRA where appropriate.

Due to Bristol Water being in a supply demand surplus position at the beginning of the planning period in 2025, and the implementation of the leakage and PCC reduction targets, in line with South West Water's strategic view on smart metering, the assessments showed that there was no difference between the least cost and the best value programme. In both programmes, smart metering is started in 2025 to support the leakage strategy and help better understand the customer water use. This brings the cost of smart metering forward to AMP8, but better supports the delivery of increased meter penetration.

WRP Table 7 sets out the Adaptive programmes and the data for our programmes is presented here. This includes the associated supply and demand data (Table 7a and 7b).

The graph in Figure 16-1 shows the least cost supply demand balance against the best value supply demand balance; assuming 1-in-500 level of resilience from the start.

Figure 16-1 Least cost and best value plans are equal.



Meeting our AMP7 PCC targets

Our WRMP performance for PCC has been modelled and profiled to meet Government targets. These will form the basis of performance commitment levels, noting that as discussed with Ofwat and EA during consultation meetings (5th April 2023 and 23rd March 2023 respectively), in order to reduce risk to customers we feel it is appropriate to acknowledge that AMP7 targets for PCC will not be met in the timeframes initially hoped, and to reflect this in the WRMP baselines. Whilst this is not what we hope for in our last WRMP, the Covid-19 pandemic greatly influenced household water use and how far those impacts may be felt or how they may change over time, is unknown.

Our final plan is based upon our smart metering programme and the Government-led inventions. Our approach would not differ had we met the targets set out in AMP7 within the time intended. Smart metering is required, not only to help our customers manage their water use, but also to help identify leaks and better understand how this precious resource is used; smart metering is part of the UK water industry's future. Reducing our water use as a society is not solely the responsibility of water companies, everyone has their part to play. The interventions we have identified that Government can lead on are water labelling, WC standards and housing standards. These are an integral part of our plan and its potential for success.

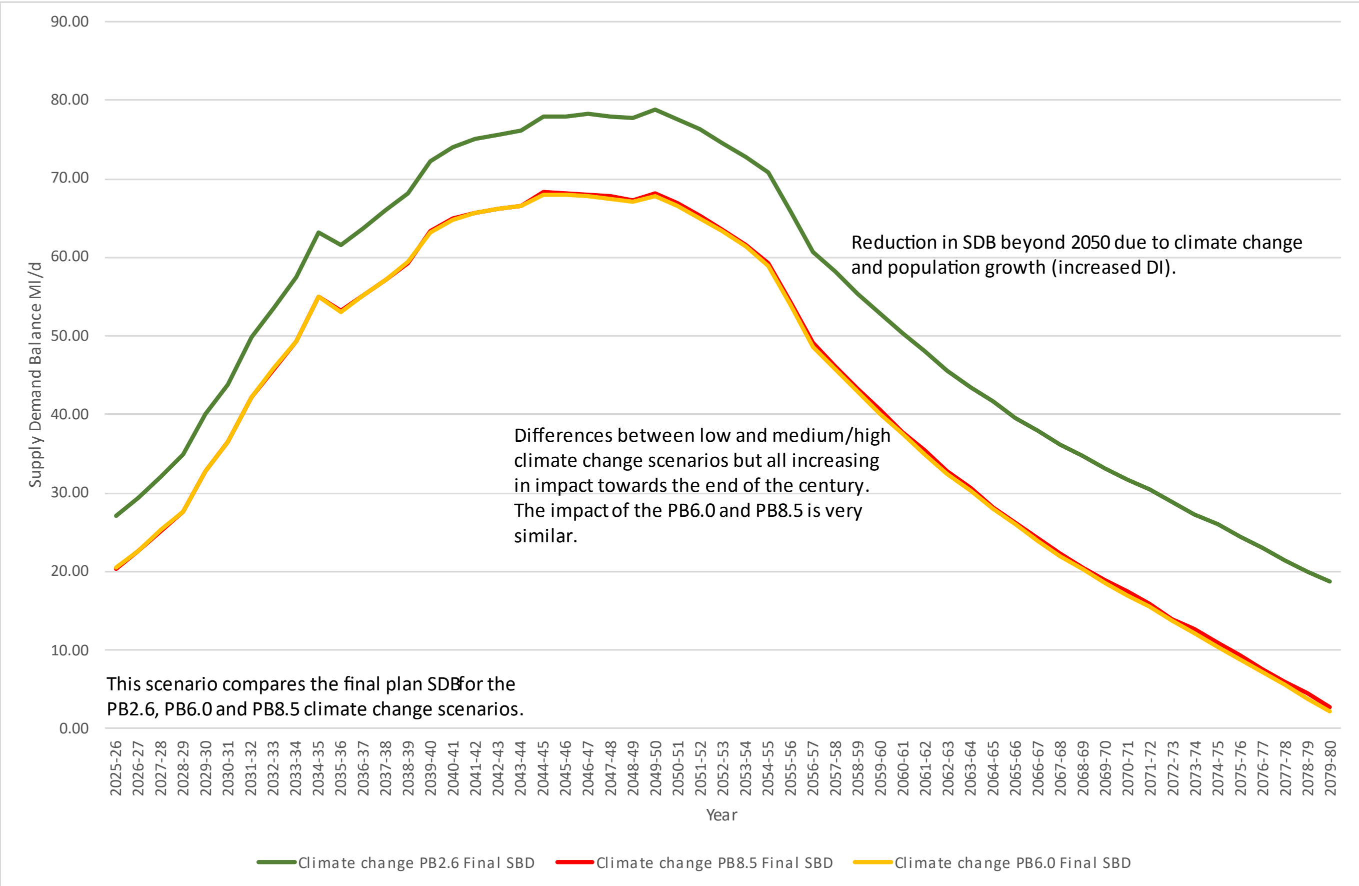
16.3 Scenario 2 & 3 – Sensitivity to Climate change assumptions

Scenarios 2 and 3 assess the envelope of climate change uncertainty and whether this would trigger any change to the options selected within the WRMP. These align to the Ofwat common reference scenarios 'Low' and 'High' climate change. Due to the policy target driven nature of this WRMP, there would be no difference to the options selected under the low or high climate change scenarios because no matter what the level of climate change, we would still be delivering the policy targets.

Under the high climate change scenario, the supply demand surplus developed because of the delivery of the leakage and PCC related targets is eroded more quickly than under the low scenario. However, the demand reductions associated with the delivery of the leakage and PCC policy targets still result in an overall supply demand surplus throughout the planning period to 2080, although under the high climate change scenario this surplus has eroded to 2.75Ml/d by 2080. Scenarios 2 and 3 have a different headroom uncertainty to the other scenarios tested. The headroom uncertainty has been adjusted to reflect the climate change uncertainty distribution of PB2.6 and PB8.5, respectively.

The graph in **Figure 16-2** shows the supply demand balance for the low, medium and high climate change scenarios.

Figure 16-2: Climate change scenario assessment



16.4 Scenarios 4, 5 & 6 – Sensitivity to changes in Demand.

Scenario 4 considers a demand scenario that is lower than the Preferred Plan to align with the Ofwat common reference scenario 'Low demand scenario'. This scenario is represented by the demand forecast resulting from the ONS derived population forecast and is deemed our trend-based scenario. We have therefore tested what the supply demand balance would look like if this lower demand scenario occurred. The supply demand balance that results from this assessment is shown in **Figure 16-3** (orange line).

Our preferred plan already assumes the options for new water labelling with minimum standards being implemented from 2025 and WC standards and new development standards (water neutrality) being implemented from 2030. With respect to water neutrality, the standards we mention are not to be developed by Bristol Water, rather these are options that would be enacted by Government, which would help to support us in maintaining our supply-demand balance. The supply demand balance that results from this assessment is shown in **Figure 16-3** (blue line).

The Ofwat common reference scenario for high demand aligns with our preferred plan in that it uses the local authority growth forecasts in line with the Environment Agency water resource planning guidelines and is therefore, our plan-based scenario. However, our preferred plan does select options relating to building regulations and product standards before 2050 to be able to deliver the PCC policy target of 110 l/h/d by 2050 and the intermediate 2038 target. We have therefore assessed a scenario where these option would not be available, and the significant negative effect this would have on our SDB (**Figure 16-3** red line).

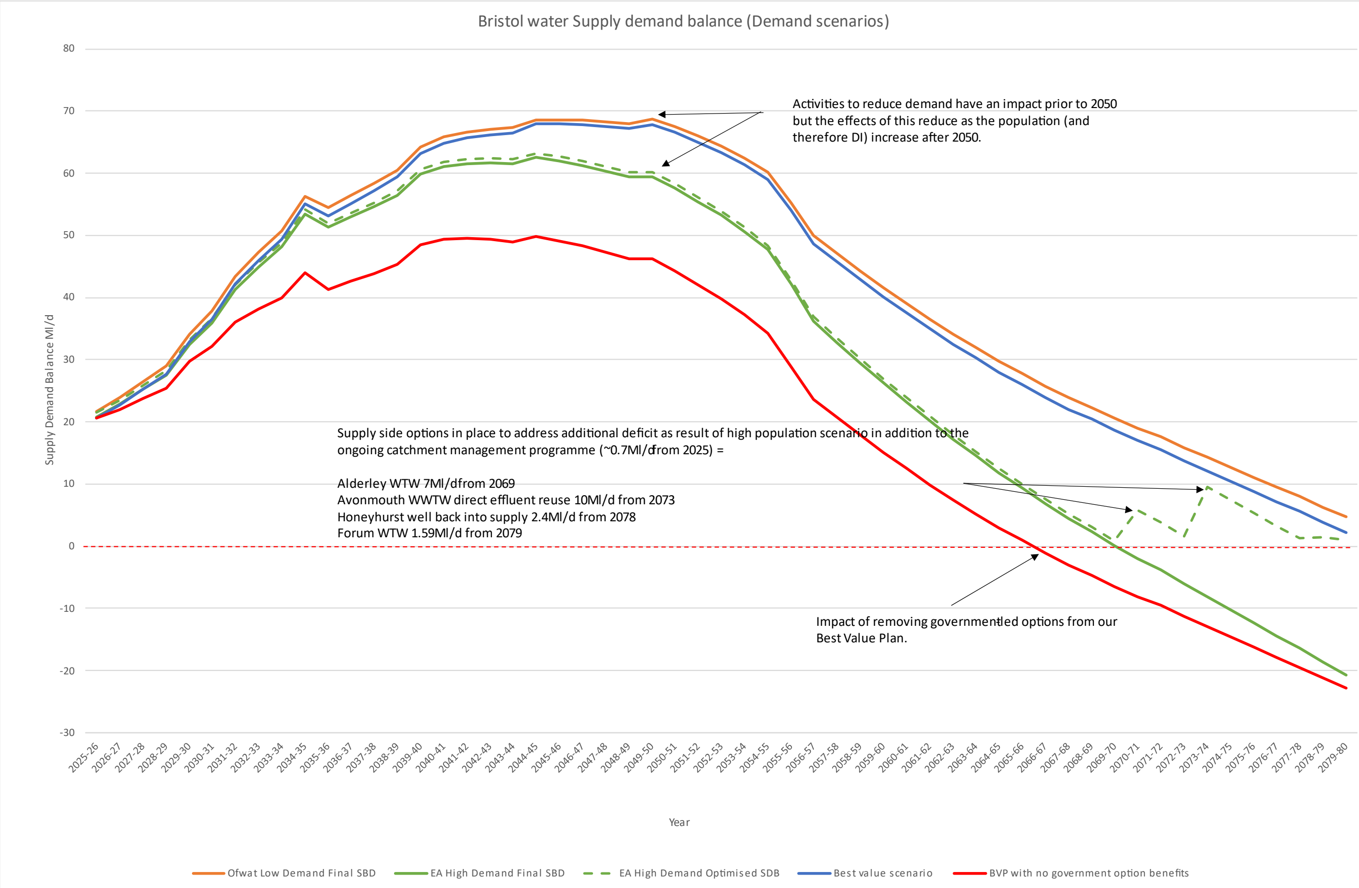
The Environment Agency guidance also asks us to test a high population growth scenario. This is higher than the local authority growth forecasts used in our baseline supply demand assessment. We have therefore tested our plan against a higher population scenario developed by consultants Experian to look at the effects of higher long-term net migration. This scenario results in an erosion of the supply demand surplus from 2050 onwards, resulting in the need for supply options by 2070 (**Figure 16-3** green line). The options that are likely to be required under this scenario are summarised in **Table 16-2** (green dashed line) and this assumes that our catchment management programme continues.

As this is not until beyond the statutory 25-year planning period, our preferred plan is not anticipated to change in terms of supply side options within the first 25 years, and we will monitor this position via the statutory process of WRMP annual reviews and the 5 yearly review and updates of our plan.

Table 16-2: Supply side options that could be required under an EA high population growth scenario

Option ID	Option Name	Yield	Year of implementation
P06	Catchment Management of Mendip Lakes	0.7Ml/d	2025
P08	Alderley WTW (increased production)	7Ml/d	2070
R014	Avonmouth WWTW direct effluent reuse	10Ml/d	2073
R24	Bring Honeyhurst Well source back into supply.	2.4Ml/d	2078
P01-02	Forum WTW capacity improvements	1.59Ml/d	2079

Figure 16-3: Scenarios testing sensitivity to changes in demand.

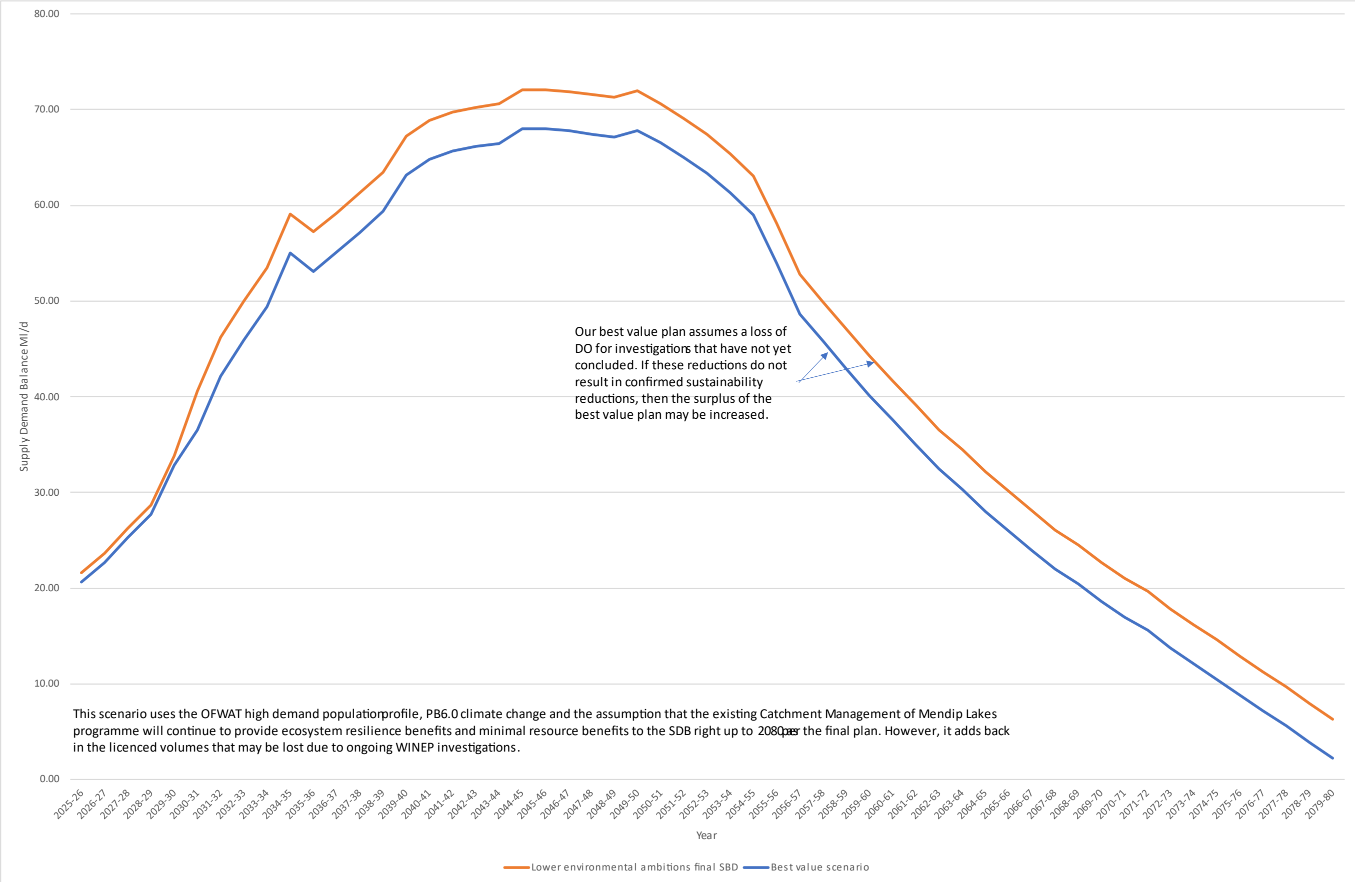


16.5 Scenario 7 – Environmental Ambition scenario

Our final planning supply demand balance takes account of any known abstraction reduction requirements up to 2050. We also consider 4.1Ml/d of potential risk to licence reductions in our final supply demand balance. Following discussions with Environment Agency during consultation on the dWRMP, we have agreed that potential risk to deployable output is 1Ml/d dependent on outcomes of the Winscombe and Chelvey investigations, which would arise in AMP8, and a further 3.1Ml/d is at risk dependent on outcomes of the planned AMP8 WINEP investigations, which would arise in AMP9 (see Section 8.3 for more information). This is assessed as a reduction of 1 Ml/d from 2025-2030, increasing to a 4.1Ml/d in total from 2030 onwards. Our final planning assumptions bring in the environmental ambition reductions in 2030 despite the low level of likely licence reductions currently identified for the BAU+ (or enhanced) scenario. This is assessed as a reduction of 3.28Ml/d from 2030. As the ongoing WINEP investigations have not yet concluded, the estimated licence reductions have not been modelled to estimate the zonal level impact given other constraints or the way in which our system operates. These values should be considered approximate at this time.

The results of this assessment are shown in the graph at figure 16-4 and show that with the successful delivery of the leakage and PCC policy targets, the supply demand balance is resilient to the potential additional reduction in deployable output associated with sustainability changes and environmental ambition uncertainty. Without such changes to our licensed abstractions, our surplus throughout the planning period would be higher.

Figure 16-4: Sustainability Changes and Environmental Ambition Scenario



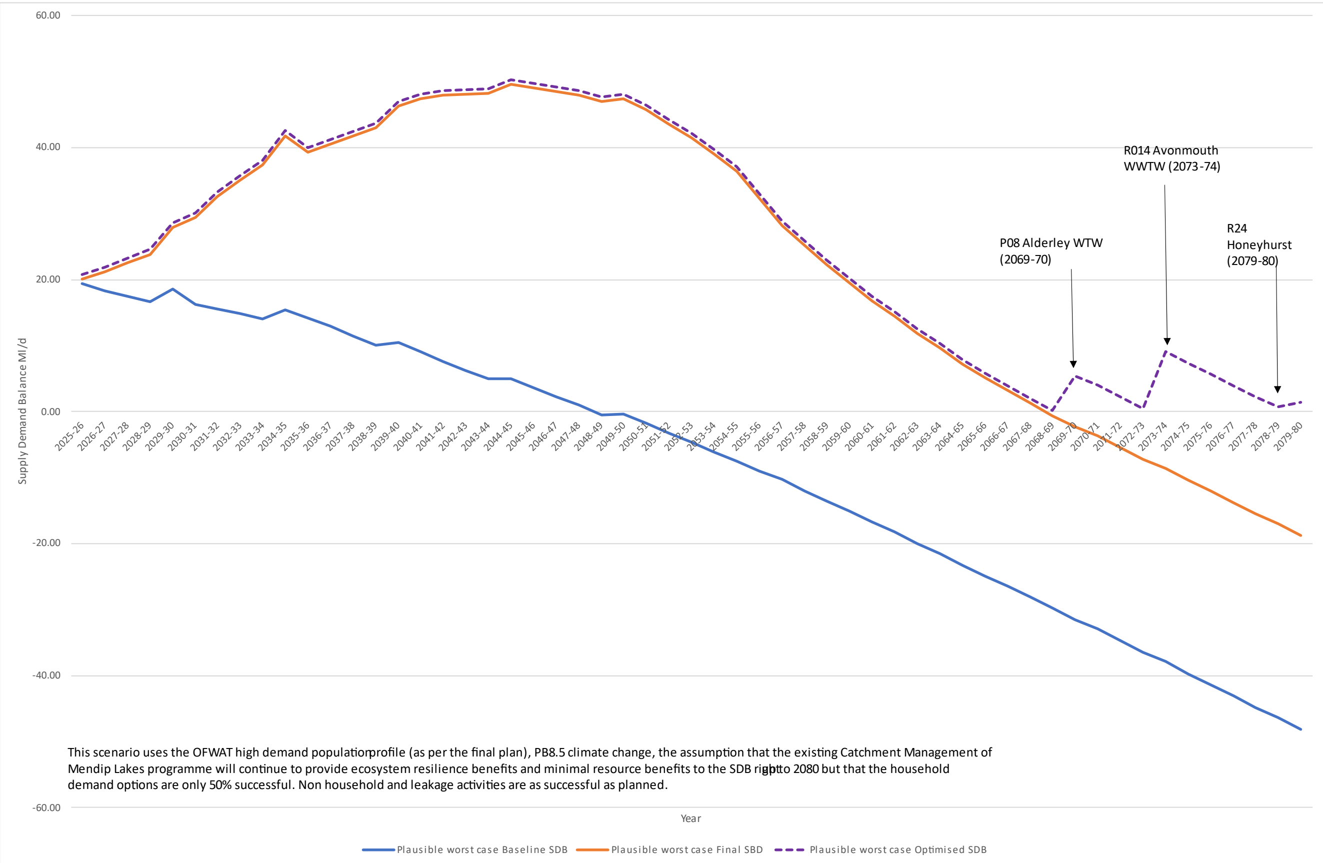
16.6 Scenario 8 – Plausible worst-case

We have tested our plan against a 'plausible worst case' scenario, which is represented by a future under which we experience the high climate change scenario, resulting in less water available in the environment, and we are unable to deliver the leakage and PCC reduction targets by 2050 (assume that 50% delivery of the target is achieved). This scenario results in us needing supply options by 2068 to meet an additional supply demand deficit of 18.73 Ml/d by 2080. As this is not until beyond the statutory 25-year planning period, our preferred plan is not anticipated to change in terms of supply side options within the first 25 years, and we will monitor this position via the statutory process of WRMP annual reviews and the 5 yearly review and updates of our plan. The options that are likely to be required under this scenario are summarised in **Table 16-3** and **Figure 16-5**.

Table 16-3: Supply side options that could be required under a plausible worst-case scenario

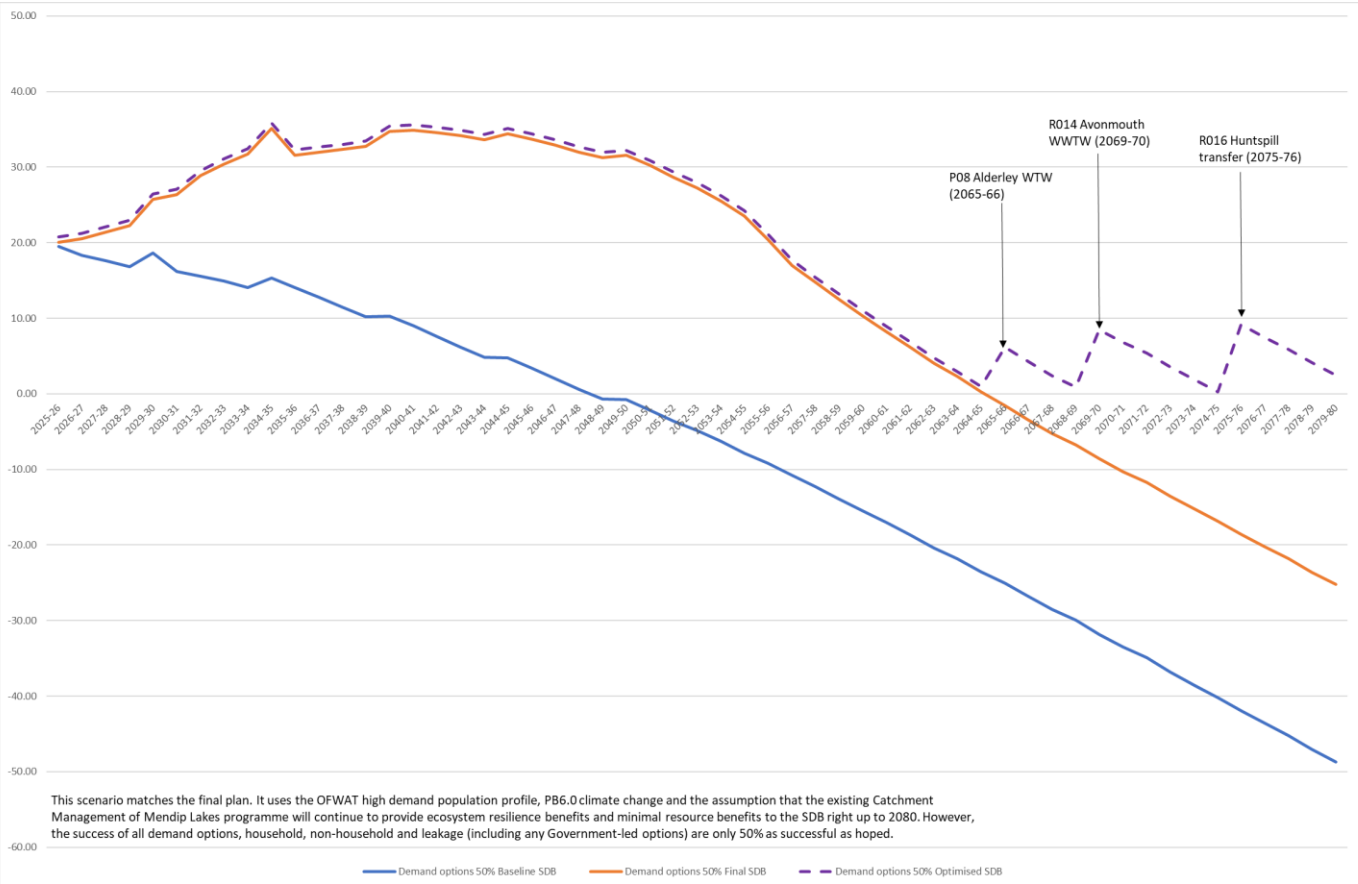
Option ID	Option Name	Yield	Year of implementation
P06	Catchment Management of Mendip Lakes	0.7 Ml/d	2025
P08	Alderley WTW (increased production)	7 Ml/d	2068
R014	Avonmouth WWTW direct effluent reuse	10 Ml/d	2073
R24	Bring Honeyhurst Well source back into supply.	2.4Ml/d	2079

Figure 16-5 Plausible worst-case scenario



To align to regional planning activities, we have also tested two other scenarios to ensure the robustness of our plan that are similar to our “plausible worst case.” The first assumes the OFWAT high demand population profile, PB6.0 climate change and the success of all demand options, household, non-household and leakage (including any Government-led options) is 50% of the benefits we have planned for. The second assumes the OFWAT high demand population profile, PB6.0 climate change and the success of all demand options, household, non-household and leakage (including any Government-led options) is 75% of the benefits we have planned for. The first scenario is the most severe and is shown in Figure 16-6. As there is little difference between the medium and high climate change scenarios, the resultant sensitivity test is similar to the plausible worst case scenario.

Figure 16-6 Scenario test assuming demand management benefit equals 50% of benefits planned for.



16.7 Scenario 9 and 10 – High and Low technology scenarios (Ofwat)

Our plan is reliant on high technology in several key areas, notably with respect to smart metering, delivery of full smart meter penetration and the associated data network by 2040 and with respect to the decarbonisation of the company; company policy is for carbon neutrality by 2030.

Smart metering is key to the success of the plan. Failure of the smart metering programme due to technological challenges is likely to result in the failure to meet near-term PCC targets. However, the final plan also includes the use of less high technology devices, such as flow regulators to help drive down demand. So, in this respect it is hoped that diversity in the activities to reduce demand provides resilience.

Fortunately, as part of the Pennon Group, Bristol Water now has access to the emerging smart network and experience of South West Water with respect to smart metering and the associated economies of scale. The smart metering option selected for the WRMP is nearly 30% more beneficial, in terms of l/h/d savings over the period 2025-2050 than the average of the AMR metering options in the draft plan. This is in large part down to the use of more modern technology; as part of the bigger company, the price changes mean that this is now also more cost effective.

With respect to the whole life costs of low-carbon construction materials, these are unlikely to have a significant impact on Bristol Water in the short term because our plan does not include the construction of supply options. In the longer term, low-carbon technologies will have hopefully come down in price, reducing the potential cost impact of this on our future WRMPs.

In other areas, there is less reliance on high technology interventions. The leakage programme is reliant on asset renewal in the first AMP period especially, due to the companies relatively low levels of leakage. This profile of interventions was selected as it is most optimal in terms of water benefits and costs however, it also allows additional time for innovative technologies to arrive in the marketplace.

16.8 Monitoring and managing uncertainty

For this plan, we have chosen not to undertake a fully adaptive pathway approach. However, we have tested our plan to a range of uncertainties and acknowledge that there are a number of risks that may drive how our plan develops in the future. In Table 16-4 below is a summary of the key risks associated with our plan and possible mitigations. This aligns with the monitoring plan and risk assessment in South West Water's plan.

Table 16-4 Summary of our monitoring plan and risk assessment, including review stages.

Uncertainty	What is the risk?	How might the risk be mitigated?	Review point
Uncertainty in scale of environmental destination	The scale of licence capping impacts and environmental destination reductions is not known until the AMP 8 investigations are complete.	Studies affecting our abstractions will be carried out in AMP 8, informing future licence arrangements, feasibility of	Reviewed and reported on annually through our WRMP annual return.

		supply options and magnitude of licence changes needed	
Demand management is less effective than planned	We have included an ambitious plan of demand reductions driven by leakage, metering and water efficiency activity. If these are less successful than planned we may have lower surplus or residual deficits in our supply demand balance later on in our plan.	Demand management benefit monitoring. Update every forecast every 5 years as part of WRMP planning cycle.	Demand management benefits reviewed and reported on annually through our WRMP annual return.
Population growth is higher than expected	Our planned demand growth is based on local authority plans in line with WRMP guidance. If actual growth is significantly higher than assumed in our baseline, we may have lower surplus or residual deficits in our supply demand balance later on in our plan.	Population growth monitoring, better insight into usage driven by our smart metering program.	Population growth assumptions reviewed and reported on annually through our WRMP annual return.

Our monitoring plan review points are linked into the regulatory planning cycle, meaning that decisions on our plan's future will happen in 2028 to inform WRMP29. Note that it is likely that for WRMP29, Bristol Water will form one water resource zone within South West Water's WRMP.

During AMP8 we will monitor and assess the effectiveness of our demand strategy, and report on our progress through the WRMP annual return. As part of the preparation of our WRMP29 and WRMP34 we will update our forecasts for population growth, non-household demand and climate change. We will also have completed the major WINEP investigations to inform our assumptions on license capping and environmental destination. We will use the outputs of the WINEP investigations to drive our assumptions for WRMP29.

Monitoring our plan will allow us to be agile and determine if, when, how, where and why our future plan may change.

Table 16-5 sets out our monitoring framework for WRMP24.

Table 16-5 Monitoring framework for WRMP24

Component of the plan	Type of uncertainty	Tracking activities and assessments	Frequency of reporting
Demand side	Population growth	Reporting of population growth against WRMP assumptions. Annual update of growth forecasts through the WRMP cycle to inform	Annually as part of WRMP annual return. As part of the regulatory planning cycle in WRMP 29 and beyond

		AMP8 and WRMP29. Engage industry experts to further understand non-resident population impacts on the Bristol area going forward.	
	Demand-side benefits realisation	Monitor and report on the benefits of demand management interventions against the assumptions in the WRMP24. Delivery updated on leakage, smart metering, water efficiency options selected in BVP.	Annually as part of WRMP annual return. As part of the regulatory planning cycle in WRMP 29 and beyond
	Performance against demand side targets	Reporting performance on leakage, PCC, NHH consumption and DI reduction targets.	Reported annually as part of WRMP annual return
	Policy and support for water efficiency	Engage with stakeholders and policy makers on government support for water efficiency activities such as water labelling, targets on new housing developments and innovations such as rainwater harvesting.	Reported annually as part of WRMP annual return
Supply-side	Impact of Licence Capping and Environmental destination	Assess the outcomes of AMP8 WINEP investigations against the planning assumption in the WRMP24	Reported annually as part of WRMP annual return Informing supply forecast assumptions WRMP29
	Climate change impacts our security of supply	Update and refine our modelling of climate change impacts on supply every year to ensure we capture the effect of the recent more extreme years. Monitor and engage with stakeholders to review key environmental indicators, such as river levels, for climate change impacts and work with those stakeholders to understand implications for our water resource planning.	As part of the regulatory planning cycle in WRMP 29 and beyond

17 Future Developments

17.1 Introduction

Water resources planning is an iterative process that makes use of a steadily growing understanding of supply and demand for water. New technologies, changes in social behaviours around water use, climate change and environmental constraints mean that in order for long-term water management plans to be fit for purpose, we must both look long-term and address change through a responsive approach. This is now more apparent than ever in the context of the effects of the COVID-19 pandemic on demand and water use behaviours regarding the preference for home working, and the dry weather/drought situation that affected much of England and Wales in 2022 and 2023. These major events have occurred since the development of our WRMP19, and are ongoing, so will require ongoing review and monitoring of their effects on our supply and demand position.

During the development of our WRMP24, and in the context of the effects of COVID-19 and recent heatwaves and drought, several opportunities for improvement to our technical methods and approaches have been identified for implementation between our draft and final WRMP24. These are detailed in Section 17.2.

With the development and publication in early 2025 of the Regional Plan for the West Country Water Resources Group, we are committed to continuing to work across the West Country region to better understand the water resources needs and manage them in a sustainable way into the future. This will include the development of any strategic regional options that can support water resource requirements across the region and beyond, if required.

17.2 Future Technical Improvements to WRMP

Our current development and technical improvement plans are set out in the table below:

Technical Area	Development/ improvement proposals
Supply analysis	**Reservoir control curve and/or drought trigger optimisation:** We have developed a control curve optimisation framework in Aquator to allow us to readily optimise both operational and drought control curves to inform future curve design. We are at the stage of consolidating the outputs and conclusions from our first review, which will inform our revision of the control curves in the next Drought Plan. Now that the modelling framework has been set up, we are able to refine and reapply the process reasonably easily in future. This will allow us to sensitivity test outcomes in future under alternative environmental scenarios, and also account for future revisions to base datasets prior to WRMP29. We will continue our work towards the next Drought Plan, which will in turn feed into WRMP29. Following revision of other model data inputs and updates outlined in this table, we will also be able to reaffirm operational level control curves prior to WRMP29 to ensure ongoing robust DO estimation, taking account of the latest hydrological datasets etc., and ensure control curves remain optimal to meet the needs and challenges of the future (including the incorporation of any new supply-side schemes and/or transfers).
	River Severn and Gloucester & Sharpness Canal yield assessment: We are working with the Canal and River Trust to better understand the yield of the canal under certain flow conditions, including the effect of the River Severn Drought Order. The outputs from this work will not be included in the final WRMP24

Technical Area	Development/ improvement proposals
	unfortunately due to delays in the technical work however, we intend this work to feed into future WRMPs.
	Groundwater yield assessment: We undertook groundwater yield assessment, to verify the deployable output of our groundwater sources for this WRMP. Although the assessments are complete for the major sources and show that baseline values, impacts, and seasonal impacts are small, they highlighted the need to improve baseline data and knowledge of potential influence of climate change. We shall follow the advice from these assessments and seek to update our water level data with a particular focus on elevation datums and ensure we have sufficient manual dip measurements to help validate our monitoring from automated data loggers.
	Update any relevant assumptions in the context of the current dry weather and drought experiences: The dry weather and drought of 2022 presented significant challenges across the West Country Region and the UK as a whole. We are pleased to report that the Bristol Water system proved fully resilient to the combination of high demand, extremely warm weather and low rainfall during this period, and as a result we were able to maintain a "business as usual" management of the system without having to trigger any actions in our Drought Plan other than the "normal dry weather" management of increased use of Sharpness water rather than maximising the use of low-cost Mendip water. This experience gives us confidence that our WRMP24 will allow us to continue this high level of customer service and environmental protection in the WRMP24 planning period .
	Strategic Schemes review: Consider the need to develop any of the strategic schemes identified for the WCWRG in the context of both the water company WRMP's and the WCWRG Regional Plan and any lessons learned from the current drought. This will include an appraisal of the Cheddar 2 Reservoir scheme insofar as it interacts with Bristol Water's system directly.
	Engagement with WCWR group: We will continue to work with WCWR group and our neighbouring water companies to ensure that any surplus in Bristol Water's area is used in the most efficient and best value way to the benefit of the environment and drought resilience in the West Country.
	Transfer options to Wessex Water: In the context of our WRMP24 SDB we have reviewed the feasibility of varying the transfer of water to Wessex Water via Newton Meadows to increase availability during peak demand periods. This transfer has been altered in discussion with Wessex Water directly.
Demand forecasting	**Population & Property forecast update:** We have reviewed our population and household estimates in the context of the Census 2021 data which was released in June 2022 (too late for inclusion in our draft WRMP). Given the small changes in the data, we do not deem it necessary to update our work for the WRMP.
Environmental Ambition	**Environmental Ambition programme of work**: We have agreed with the Environment Agency that as part of our WINEP proposed for PR24, we will deliver Environmental Destination investigations across all of our abstraction catchments. These will complement WFD driven abstraction sustainability investigations as part of a wider reaching WINEP. The Environmental Destination WINEP investigations will give us an improved understanding of how our sources and their deployable outputs will be impacted by climate change, taking into account environmental requirements for water. This understanding will inform future WRMPs.
	Uncertainties surrounding the environmental impacts of existing water management activities: We will continue to work the Natural England to better understand the uncertainties associated with our WRMP HRA and SEA to ensure cumulative and in combination effects are well understood ahead of WRMP29. Our AMP8 WINEP programme will support this through continuing investigations into our existing abstractions and operations. We will also work via WCWR to develop our regional SROs to understand how these will work in combination with Bristol Water's system and the water environment.
Scenario Assessment	**Ofwat Common Reference Scenario for technology:** We have assessed this scenario to support both the development of our final WRMP24 and the PR24 Business Plan submission, see Section 16.

18 National Security and Commercial Confidentiality

The published version of the final Water Resources Management Plan 2024 is required to exclude any matters of commercial confidentiality and any material contrary to the interests of national security. There were no matters of commercial confidentiality. In order to maintain the security of the water supply to our customer and in compliance with national security requirements as described in the Water Industry Act 1991 section 37(B) and the guidance provided by Defra in Advice Not 11 edition 5 "The Control of Sensitive Water Company Security Information" dated February 2016, some minor details have been removed (or redacted) from the Water Resource Management Plan documents we have published on our web site. This information is mainly about site names.

Annex 1: Water Resource Planning Tables Assumptions (by exception)

As required, we have completed a set of Water Resource Planning Tables (WRP Tables) to accompany our WRMP24 technical report. These tables have been completed in line with the Environment Agency and Ofwat technical guidance '*Water Resources Planning Tables – Instructions v5'* (revised February 2022). For some of the technical information we have had to make assumptions when completing the tables. The table below sets out where we have made these assumptions and what they are.

Table A1- Assumptions applied to completing the WRP Tables.

Table & line ref.	Commentary/ assumption
1 DYAA Deployable output	The DYAA DO presented in column H has been derived to calculate the overall conjunctive use DO only and is not representative of actual DO of source. This is due to the table formatting not allowing cells in column H to be merged. Bristol Water's system is a conjunctive use system and deployable output is modelled for the whole resource zone, not individual sources.
2d 5BLW Total Leakage	Clarification guidelines state that the pre-plan figures in this table should reflect the outturn data held by Ofwat rather than normal year forecast data. However, this isn't consistent with Table 2d that specifies DYAA figures to be used for each of the components.
4 (column U: Gains in WAFU)	For unconstrained options we have not included an estimated gain in WAFU. Given the nature of unconstrained options it was felt that to provide a value here could be misleading as in the majority of cases the options identified at this level in the options appraisal process have not been developed to the stage at which a clear understanding of WAFU benefit has been identified.
4 (column V: Option benefit lead in time)	For all demand side options (including leakage and metering) we have assumed 0 years for lead in time, as options benefits start as soon as action is taken. All supply side options have lead in times based in the difference between start of action (i.e. construction) and point at which benefit is seen.
5a	The guidance requires all options to be listed in this table (not just the preferred plan) therefore it is not possible/logical to present options against a specific start year if they are not in the preferred list (as they are not being implemented). We have therefore presented all options on the same basis in this table whereby the start year is assumed to be year 1 of the option. If the options are not implemented until 2030, then this is taken as year 1.
5a (Cost Metric (£m)	Financing costs and Net Present Cost (NPC): We have amended the standard calculation in the worked example provided in the guidance to reflect that capital expenditure on our options, particularly demand reductions such as mains replacement, occurs in each year. The capex each year is added to the opening RCV and the asset-life based depreciation rate applied to the opening RCV plus capex in the year. This reflects RCV operation rather than being precisely straight line depreciation. At the end of the asset life, we amended the calculation to take the financing cost forward – a calculation simplification as, for instance for mains replacement with an 80 year life, at the end of the period there would need to be continued mains replacement in order to maintain leakage at that (lower) level.
5b	This has not been completed as there are no resource/supply options that are >£100m (feasible and preferred). Based on the breakdown of the metric information required (structures, pipework, etc) it was assumed that this was the intention of this table. Some demand options may beach the £100k threshold, but they have not been included here as they cannot be broken down into the metrics listed on the table.
5c (Column D: Asset Life)	The approach to identifying asset life was based on expert judgement and is consistent across the different types of options assessed as follows:

Table & line ref.	Commentary/ assumption
	• Water efficiency options (behavioural) = 5 years • Water efficiency options (device installed) = 10 years • Water efficiency metering options = 15 years • Metering options = 40 years • Resource options (Not new reservoirs) = 60 years • Resource options (New Reservoirs) = 200 years • Leakage option = 80 years
Table 7c	Totex increases (base) and Totex savings (base) only able to be presented for least cost scenario and reflect that under this scenario the start of smart metering programme is delayed from 2025 until 2030. Totex total (base) – We have not presented a formal adaptive plan due to the WRZ being in surplus and the outcomes of our Problem Characterisation assessment. Therefore, we have not developed a full alternative programme.
Table 7d	Our least cost and Ofwat core scenarios do not vary significantly from our Preferred plan due to the policy driven nature of our plan and not being in deficit. There is therefore no enhancement expenditure associated with the alternative programmes, different to the preferred scenario.
Table 8	The following assumptions were made when completing Table 8: • The first year that demand reductions occur is the first year that expenditure is incurred • In Table 5a to Table 8 we have profiled the expenditure by the years identified above • We have summarised the expenditure annually for 2025-26 to 2029-30 and 5-yearly 2031 to 2080 as per the Ofwat format • Demand reductions have been summed annually for 2025-26 to 2029-30 and 5-yearly 2031 to 2080 as per the Ofwat format • Table 8c has been interpreted in a way which ensures all enhancement metering components are captured. References C1-C3 present the expenditure of Unmetered to smart meter households (optants), C4-C6 has been inputted as Unmetered to smart meter households (non-optants), C7-C9 takes the expenditure from the non-household SMART Online option which uses watersmart online tools and resources, C10-C16 comprise of expenditure for Dumb meters switched to smart meters (non-end of life). • In Table 8e, benefits from new AMI meter installations (household) (reference E5.3), is taken as the benefits from the enhanced metering programme. Benefits from replacing (or upgrading) existing basic or AMR meters with AMI meters, for household and non-household respectively (E5.5 and E5.7), is taken as the baseline metering programme and the non-household metering programme, respectively.

Glossary of Terms and Abbreviations

Abstraction	The removal of water from any source, either permanently or temporarily.
Abstraction licence	The authorisation granted by the Environment Agency to allow the removal of water from a source.
Abstraction point	The top of a borehole for borehole abstraction; the river intake for a river abstraction to direct supply or bankside storage; the draw-off tower for a direct supply reservoir.
ADPW	Average Day Demand Peak Week
AISC	Average Incremental Social Cost
AMP	Asset Management Plan (AMP7 covers April 2020 to March 2025; AMP8 covers April 2025 to March 2030)
Annual average	The total demand in a year, divided by the number of days in the year.
Available headroom	The difference (in Ml/d or percent) between water available for use (including imported water) and demand at any given point in time.
Aquator	Water resources computer modelling system.
Baseline Demand Forecast	A demand forecast which reflects a company's current demand management policy but which should assume the swiftest possible achievement of the current agreed target for leakage during the forecast duration, as well as implementation of the company water efficiency plan, irrespective of any supply surplus.
Base Year	The first year of the planning period, which forms the basis for the water demand and supply forecast in future years
BVA	Basic Vulnerability Assessment
CAMS	Catchment Abstraction Management Strategies
Canal and River Trust	A charitable organisation playing a protective role for waterways in England and Wales
Catchment	The area from which precipitation (rainfall/snow) and groundwater naturally collect and contribute to the flow of a river
CDF	Cumulative Distribution Function
Compensation flow/ release	Stored water released from a reservoir to ensure a continuous flow in the downstream watercourse.

Critical Period	The length of time between a reservoir being full and the reservoir reaching minimum storage during the worst drought on record.
Defra	Department for Environment, Food and Rural Affairs
Demand management	The implementation of policies or measures which serve to control or influence the consumption or waste of water (this definition can be applied at any point along the chain of supply).
Deployable Output (DO)	The output of a commissioned source or group of sources or of bulk supply as constrained by: Environment • Licence, if applicable • Pumping plant and/or well/aquifer properties • raw water mains and/or aquifers • transfer and/or output main • treatment • water quality
District Meter Area (DMA)	The area where the supply to it is continuously monitored and there is a defined and permanent boundaries.
Distribution input	The amount of water entering the distribution system at the point of production.
Distribution losses	Made up of losses on trunk mains, service reservoirs, distribution mains and communication pipes. Distribution losses are distribution input less water taken.
Droughts	A prolonged dry period potentially leading to scarcity of water.
Drought order	An authorisation granted by the Secretary of State under drought conditions, which imposes restrictions upon the use of water and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.
Drought permit	An authorisation granted by the Environment Agency under drought conditions, which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.
Drought Plan	A statutory document written every 5 years, detailing company strategy to maintaining water supplies during periods of drought.
DRS	Drought Responsibility Surface
DVA	Drought Vulnerability Assessment
DVF	Drought Vulnerability Framework
DWI	Drinking Water Inspectorate
DWSPs	Drinking Water Safety Plans
Dry Year	In water resources modelling, a period of low rainfall from which future demand is forecast.
Dry Year Annual Average (DYAA)	The annual average value of demand, deployable output or some other quantity over the course of a dry year

Dry Year Annual Average Unrestricted Daily Demand	The level of demand, which is just equal to the maximum annual average, which can be met at any time during the year without the introduction of demand restrictions. This should be based on a continuation of current demand management policies. The dry year demand should be expressed as the total demand in the year divided by the number of days in the year.
Dry Year Critical Period (DYCP)	The time in a dry year when demand is greatest, often taken to be the peak week. Commonly known as the Summer Peak Period
DCWW	Dŵr Cymru Welsh Water
Environment Agency (EA)	One of our regulators. The Environment Agency (EA) is a non-departmental public body, established in 1995 and sponsored by the United Kingdom Government's Department for Environment, Food and Rural Affairs (Defra), with responsibilities relating to the protection and enhancement of the environment in England.
EVA	Extreme Value Analysis
Final Planning Demand Forecast	A demand forecast, which reflects a company's preferred policy for managing demand and resources through the planning period, after taking account of all options through economic analysis.
Final planning scenario	The scenario of water available for use and final planning demand forecast which constitute the company's best estimate for planning purposes, and which is consistent with information provided to Ofwat for the Periodic Review.
GIS	Geographic Information System
GPD	Generalised Pareto Distribution
Habitats Directive	The European Union Habitats Directive (92/43/EC) is the instrument through which Member States must identify and protect as 'Special Areas of Conservation' (SAC) certain sites that are representative of specified habitats for specific species which are of European importance. It also covers 'Special Protection Areas' (SPA) but none are identified as being affected by United Utilities abstractions
Hands off flow	A hands off flow (also known as a prescribed flow) is normally associated with a river abstraction and is the flow above which abstraction can occur. The purpose of a hands off flow is to ensure a given flow of water continues in the river prior to abstraction.
Headroom	Headroom is defined as "a planning allowance that a prudent water company should take into account when developing plans to balance supplies and demands and to deliver its desired Level of Service". The allowance is called "target headroom" and is designed to cater for specified uncertainties in both demand side and supply side uncertainties.
HRA	Habitats Regulations Assessment is a process for identifying the implications of the drought plan options for European designated sites

	(SAC, SPA, and Ramsar). If likely significant adverse impacts are predicted, then a detailed Appropriate Assessment of the option is required
INNS	Invasive Non-Native Species have been introduced into areas outside their natural range through human actions and are posing a threat to native wildlife
IR	Inverse Ranking
Meter optants	Properties in which a meter is voluntarily installed at the request of its occupants.
Micro-component analysis	The process of deriving estimates of future consumption based on expected changes in the individual components of customer use.
Ml/d	Megalitres per day Megalitres = one million litres (1,000 cubic metres)
Natural England (NE)	A non-departmental public body in the United Kingdom sponsored by the Department for Environment, Food and Rural Affairs. It is responsible for ensuring that England's natural environment, including its land, flora and fauna, freshwater and marine environments, geology and soils, are protected and improved.
Natural Rate of Rise in Leakage (NRR)	The natural rate of rise in leakage relates to the underlying rate at which leakage increases within a system.
NRW	Natural Resources Wales
Net Present Value (NPV)	The difference between the discounted sum of all of the benefits arising from a project and the discounted sum of all the costs arising from the project.
NIC	National Infrastructure Commission
Non-households	Properties receiving potable supplies that are not occupied as domestic premises, for example, factories, offices and commercial premises.
Normal Year Annual Daily Demand	The total demand in a year with normal or average weather patterns, divided by the number of days in the year.
Ofwat	The Water Services Regulation Authority
ONS	Office for National Statistics
Outage	A temporary loss of deployable output. (Note that an outage is temporary in the sense that it is retrievable, and therefore deployable output can be recovered. The period of time for recovery is subject to audit and agreement. If an outage lasts longer than 3 months, analysis of the cause of the problem would be required in order to satisfy the regulating authority of the legitimacy of the outage).
Peak Demand	In water resource modelling, the time at which demand for water is at its highest.

PET	Potential evaporation/ evapotranspiration
PCC	Per capita consumption - consumption per head of population
PIC	Public Interest Commission
POT	Peak-under-threshold
Potable/ Non-Potable	Drinking water/ non-drinking water
Price Review	A review (normally every 5 years) conducted by Ofwat of water tariffs, price limits, water company investment plans and service levels to customers.
PR19	Price review at 2019 to determine water prices, water company investment plans and service levels for the period 2020-25
PR24	Price review at 2024 to determine water prices, water company investment plans and service levels for the period 2025-30
Ramsar	Ramsar sites are wetlands of international importance designated under the Ramsar Convention. More formally known as 'The Convention on Wetlands of International Importance especially as Waterfowl Habitat' it is an intergovernmental treaty.
Raw water losses	The net loss of water to the resource system, comprised of mains/aqueduct (pressure system) losses, open channel/very low pressure system losses, and losses from break-pressure tanks and small reservoirs.
Raw water operational use	Regular washing-out of mains due to sediment build-up and poor quality source water.
Resource zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall.
SAC	Special Area of Conservation designated under the EU Habitats Directive
SEA	Strategic Environmental Assessment
SELL	Sustainable Economic Level of Leakage
Source	A named input to a resource zone. A multiple well/spring source is a named place where water is abstracted from more than one operational well/spring.
SPA	Special Protection Area, as designated under the EU Directive on the conservation of wild birds (also known as the Birds Directive). Together with SAC's these form the Natura 2000 network of protected sites

SRO	Strategic Resource Option
SSSI	Site of Special Scientific Interest
Stochastic dataset	A weather (rainfall and potential evapotranspiration) dataset generated from the statistical characteristics of observed data. The stochastic dataset used in the WRMP24 reporting is 400 individual replicates of alternative historical outcomes (1950-1997), generated using a statistical monthly rainfall generator that is driven by large scale climatic drivers
Supply-demand balance	The difference between water available for use (including imported water) and demand at any given point in time (c.f. available headroom).
Supply Pipe Losses	Losses that occur from pipes which are the responsibility of the customer
Sustainability reduction	Reductions in deployable output required by the Environment Agency to meet statutory and/or environmental requirements.
Target headroom	The threshold of minimum acceptable headroom, which would trigger the need for water management options to increase water available for use or decrease demand.
Total leakage	The sum of distribution losses arid underground supply pipe losses.
Treatment work losses	The sum of structural water loss and both continuous and intermittent over-flows.
TUBs	Temporary Use Bans
UKCP	United Kingdom Climate Projections
UKWIR	United Kingdom Water Industry Research Limited
Water Available For Use (WAFU)	The value calculated by deducting allowable outages and planning allowances from deployable output in a resource zone.
Water Framework Directive (WFD)	The European Union Water Framework Directive (2000/60/EC) establishes a strategic 'river basin planning' approach to managing the water environment, including achievement of good ecological status in water bodies by 2015. It provides a consistent approach for ensuring compliance with standards and objectives set for protected areas, and implementation of programmes of measures to meet those objectives.
Water taken	Distribution input minus distribution losses.
Water UK	Water UK (formerly known as the Water Services Association (WSA). The organisation represents and works with the major water and wastewater service providers in England, Scotland, Wales and Northern Ireland.
WCWR(G)	West Country Water Resources (Group)

WINEP	Water Industry National Environment Programme (succeeded NEP – National Environment Programme)
WoC	Water-only Company
WRMP	Water Resources Management Plan
WRP tables	Water Resources Planning tables used for presenting key quantitative data associated with a water resources plan.
WRZ	Water Resource Zone. The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers should experience the same risk of supply failure from a resource shortfall.
Yield	A general term for the reliable supply of water from a source. More specific terms such as Water Available For Use and Deployable Output are also used.

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