Revised Draft Water Resources Management Plan 2024

Technical Report - Deciding on future options

June 2023

United Utilities

Water for the North West

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1. Introduction

This technical report sets out how we approached decision making for our Water Resources Management Plan 2024 (WRMP24). It should be read in conjunction with our main WRMP document, which sets out the full strategic context for decision making. Reflecting the considerable future uncertainties we face, and a step-change improvement in industry-wide planning guidance and methodologies, our decision making process is much more sophisticated than for previous WRMPs.

We adopted 'best value' planning techniques to ensure that our plan delivers wider value to society and the environment. We developed innovative research to help align our interpretation of best value to customer and stakeholder preferences. We appreciate that our future could follow many different pathways, some of which would present serious challenges. By incorporating these pathways into our adaptive plan we have created a WRMP that is robust to future change.

In order to create our best value plan, we took into account the Ofwat public value principles[1] in the design of our decision making process. A full list of these principles can be found in section 2. Our best value metrics take into account a wide range of environmental and social benefits and derived the value of these using research on customer preferences. We have demonstrated the impact of these metrics on our options appraisal in section 9 of this technical report.

The following sections explain our approach to deciding on future options.

1.1 Changes from draft to revised draft WRMP

As a result of consultation feedback, the revised Water Resources Planning Guidelines (WRPG) and updated baseline assumptions, a number of changes have been made to this document since draft submission. The biggest changes fall into four main themes: demand, options, sensitivity tests, and adaptive planning.

Demand

Since the publication of the Government's Environmental Improvement Plan 2023[2], we have included interim targets and new targets for the reduction of non-household demand and the use of public water supply in England per head of population. Detail on this can be found in Section 6.2.

The WRPG was also updated and guides water companies to include the benefits of water labelling from 2025 (Financial Year FY26). Therefore, rather than 2030 stated in the draft plan, we are now assuming that water labelling is introduced in 2025 (FY26) and that the benefits to reducing demand are in line with the Water UK study, Pathways to long-term PCC reduction[3]. Section 6.2.3.3 details how we rely on government intervention to reduce consumption to target levels.

We have taken consultation feedback into account and are now including non-household smart metering as preferred plan options as part of our demand strategy in Strategic RZ. Section 6.2.3.4 provides more detail about our non-household strategy.

Options

In a change from draft WRMP, option WR149 ITC_WIGAN was removed due to concerns regarding water quality deterioration. Details on the utilisation of the remaining water transfer options can be found in Section 3.4.1. In addition to this, fourteen drought permits and one Temporary Use Ban (TUB) options have been included in the Preferred (most likely) plan, in response to consultation feedback received from the Environment Agency. The revised preferred (most likely) plan can be found in Sections 6 and 7.

Cost assumptions have also been updated for demand options, including the unit cost of smart metering which underwent a full review. Costs for the preferred plan are discussed in Section 9.1, as part of our programme

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[1] Ofwat's Final Public Value Principles, March 2022

[2] Environmental Improvement Plan 2023, HM Government, February 2023.

[3] Pathways to long-term PCC reduction, Water UK and Artesia, 2019.

appraisal. In-combination environmental assessments have also been refreshed based on the new preferred plan and detail on this can be found in Section 8.

Testing our plan
We carried out sensitivity tests our plan to understand the impact of delivering resilience to 1 in 500 year droughts sooner or later in the planning period for both Strategic RZ and Carlisle RZ. We also took consultation feedback into account and detailed sensitivity tests on demand and carbon, the results of which are in Section 10.

Adaptive planning
During the consultation period, transfer partners revised their needs as part of a third reconciliation process. Three alternative transfer scenarios were agreed on 20 March 2023, and the impacts of these are set out in Section 5.2.4. Details on the adaptive plan that these scenarios feed into can be found in Section 11.6.

Overall the adaptive plan has been refreshed, with detail added on decision and trigger points, plus further description of how we monitor our adaptive planning uncertainties. A new diagram, Figure 31 Our adaptive plan as a whole, has also been added showing the whole adaptive plan and extra detail has been added to tables on alternative investments.

1.2 Objectives for the plan

In order to develop an effective and targeted plan it was important to set our objectives at the outset. These objectives take into account the views of customers, regulators and other stakeholders, pre-consultation feedback, statutory guidelines, customer research and engagement as part of United Utilities Water (UUW) and Water Resources West (WRW). The following list describes our main objectives for this plan:

- Ensure that we have a resilient water service now and in the future (2050 and beyond);
- Embrace government per capita consumption, non-household demand and leakage policies;
- Put customer preferences at the heart of our decision making, for example in delivering level of service improvements and creating ‘best value plans’;
- Support the national effort through water transfers, regional planning and Regulators' Alliance for Progressing Infrastructure Development (RAPID) processes; and
- Protect the environment, including delivery of our ‘environmental destination’.

1.2.1 Demand management and leakage

As described in our *Water Resources Management Plan 2024 - Main Report*, we are planning to achieve a 50 per cent reduction in leakage (based on 2017/18 reported values), a 15% reduction in non-household demand, and reduce per capita consumption (PCC) to 110 litres per person per day by 2050, in line with government policy. These activities play a key role in reducing overall demand across our company, hence ensuring a sustainable supply of water across the North West. Our proposed demand management plan therefore reflects this ambition.

In Section 6, we set out our demand strategy, the reasons behind it, and we demonstrate how our plan is built around the achievement of the 2050 targets, while supporting all of our objectives.

1.2.2 Levels of service

Customer and stakeholder views are instrumental to a successful WRMP. Our customer engagement has demonstrated that customers place a priority on improving the resilience of our water networks and levels of service. In line with government policy, we are also looking to improve our levels of resilience to extreme droughts. Sections 1.2.2.1 and 1.2.2.2 describe how and why we intend to improve our resilience and levels of service.

1.2.2.1 Temporary Use Bans

As a water company with a larger proportion of surface water sources, it is more challenging to be resilient to short-term shocks, such as brief periods of intense dry weather. This means that, at present, the risk of needing Temporary Use Bans (TUBs) in any one year is five per cent. This is described as a ‘1 in 20 year’ level of service in this document. This is the most frequent level of service in our region and at the lower end of the spectrum nationally. An innovative customer choice experiment was undertaken, and this indicated strong customer support to reduce this risk to 2.5 per cent each year. This is described as a '1 in 40 year' level of service in this document. Therefore, our plan is to decide on future options to obtain this level of service by 2031, improving our resilience to short-term shocks on the water network. Refer to the *Technical Report – Customer and stakeholder engagement* for more information on this research.

1.2.2.2 Emergency drought orders

New government policy requires that the chance of emergency drought measures (EDO) occurring must be reduced to 0.2 per cent annual chance by 2039. This is described as '1 in 500 year' level of resilience in this document. As required by the Environment Agency (EA) Water Resources Planning Guideline (WRPG)[4], we considered whether our best value plan could adopt alternative delivery timescales for this increased resilience. The results of this sensitivity test are detailed in Section 10, Testing Our Plan.

1.2.3 Water Resources West ambitions and objectives

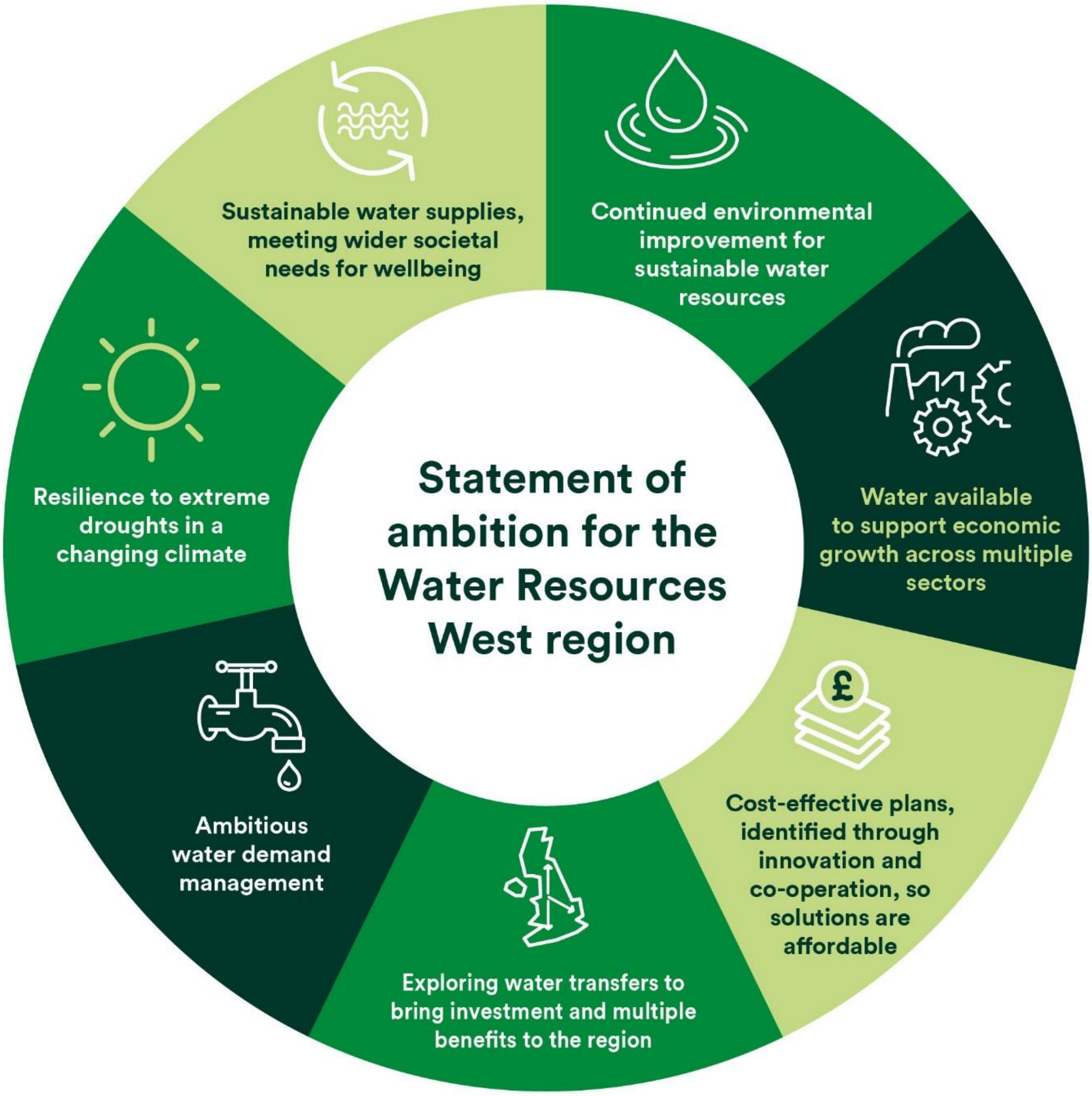
We are working with Water Resources West to produce an ambitious regional plan, which seeks to improve national resilience, the environment and deliver multiple benefits. In March 2020, Water Resources West published its Initial Resource Position[5] document, in which it set out a statement of ambition for the regional plan. We have been heavily involved in the development of the regional plan, and with water transfer being such a key component of our WRMP24, our plan objectives overlap significantly with the ambitions of Water Resources West.

Throughout the decision making process, we have engaged regularly with water companies in Water Resources West and across England. In doing so we have aligned our processes where possible to build a plan which is underpins United Utilities Water strategies, as well as being consistent with national strategy.

[4] Water Resources Planning Guideline, Environment Agency, July 2022

[5] Initial Resource Position, Water Resources West, March 2020

Figure 1 Water Resources West statement of ambition



1.2.4 Water transfer

We recognise the significant challenges that water companies elsewhere in England may face in the future due to the impacts of climate change, population change, and the need for enhanced environmental protection. We are in a strong position to provide support to other regions in times of need, and it is our ambition to do so.

We are a key member of our regional group, and play a major part in the RAPID processes through our Strategic Resource Option (SRO), the North-West Transfer (NWT). It is our objective to facilitate this transfer, while improving the service we provide to customers in the North West and enhancing our environment.

Between April and June 2022, regional groups came together for the reconciliation process. The needs for water transfers were set out by each region and a series of best value tests were carried out to confirm the availability and reliability of requests in a number of scenarios. The reconciliation process culminated in a final position, agreed on 6 June 2022. However, since this date, trading partners have revised their needs and carried out a third reconciliation process for the revised draft WRMP24, taking into account consultation responses and the updated WRPG. Three alternative transfer scenarios were agreed on 20 March 2023, and the impacts of this are set out in section 5.2.4. The final reconciliation report was published in May 2023[6].

[6] Inter-regional reconciliation 3: Summary report, WRW, WRSE, WRE, WCWR, WReN, May 2023.

These needs have been taken into account throughout our decision making, alongside the uncertainty surrounding the requirements of other water companies. Water transfer options form a key part of our proposed plan (more detail on this can be found in Section 7) and make up an adaptive plan, focused all around water transfer (more detail on this can be found in Section 11.6).

2. Measuring the benefits of our plan

Historically, WRMPs have been focused on delivering 'least cost' plans. However, our ambition for WRMP24 is to deliver a ‘best value’ plan, in accordance with the public value principles set out by Ofwat[1]. This involves selecting options not only on the basis of cost, but taking into account the additional value they can provide to society and the environment. We have followed the approach recommended in the EA WRPG and worked with industry experts to create the required methodologies, tools and datasets.

In order to quantify the benefit of each option in our plan and demonstrate the best value of our plan as a whole, we are using ‘best value metrics’. These metrics measure how well options perform against a number of criteria, across a range of economic, environmental and wellbeing aspects. The metrics, therefore, enable us to select options, which provide the most value to society and the environment.

2.1 Metrics consistency

During regional planning, we collaborated with Water Resources West to produce our best value metrics (Section 2.2). We mirrored the Water Resources West metrics in order to create a best value plan, which is consistent with the other water companies in our region.

We have an overarching strategy at United Utilities Water to adopt a six capitals approach to understanding and accounting for the value delivered by our activities. While strategy requirements sometimes differ, we have sought to ensure that these can be mapped, and the interrelationships understood. Six capitals thinking underpins how we have approached value assessment for the Drainage and Wastewater Management Plan (DWMP), the Water Industry National Environment Programme (WINEP) and the Water Resources Management Plan (WRMP), as shown in Figure 2. We have a long-term direction of travel towards using the Six Capitals approach (Figure 3).

Figure 2 Alignment with other areas of the business

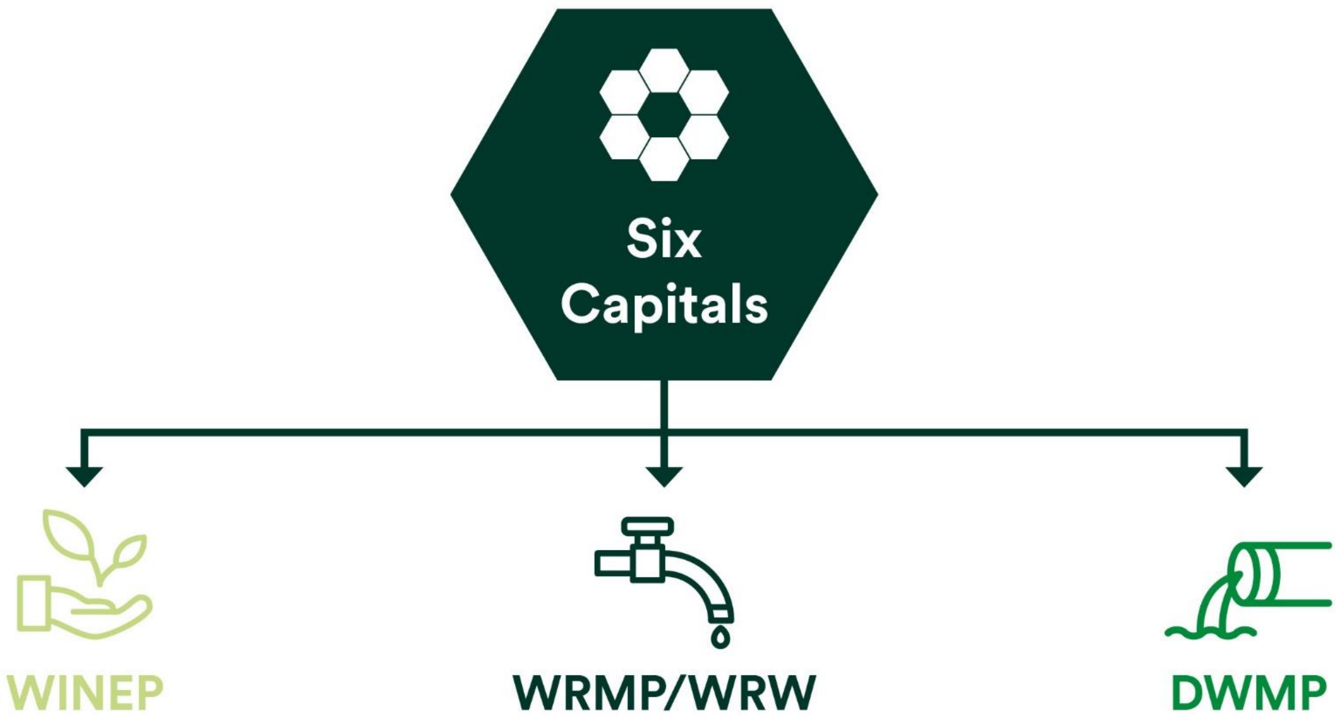
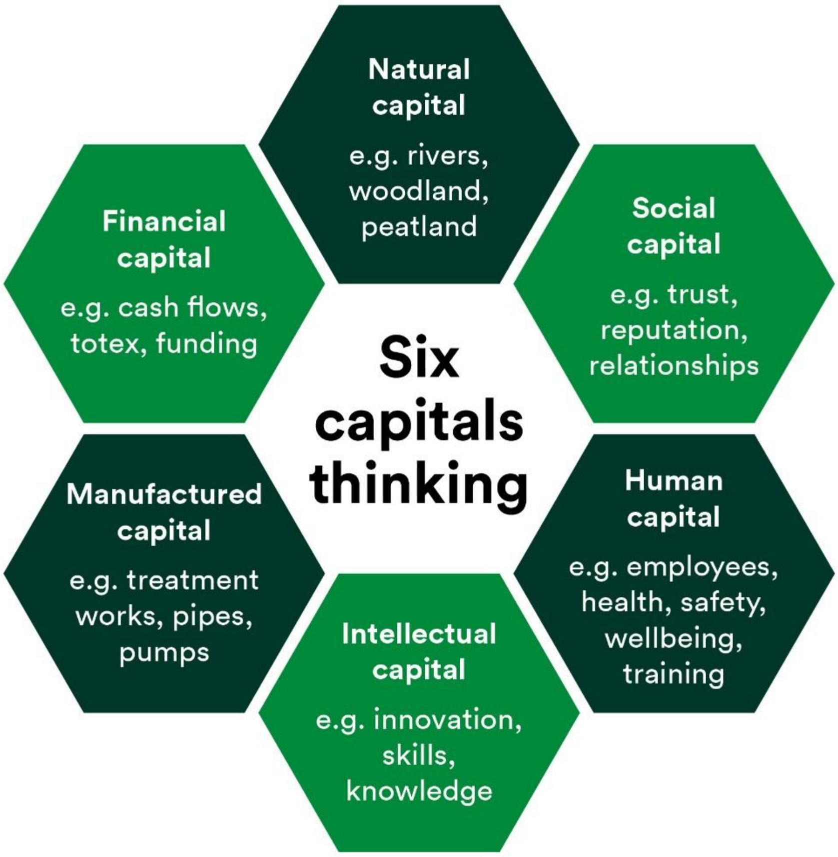


Figure 3 The six capitals



The six capitals represent the stores of resources available to an organisation. The financial power and asset base of a business are included (financial capital and manufactured capital) but the framework extends beyond traditional financial accounting measures to encompass other forms of capital such as the skills of their employees (human capital), the size of their social network (social capital), the knowledge grown by the organisation (intellectual capital), and the quantity and quality of the natural resources relied upon to provide goods and services (natural capital). The six capitals are in a constant state of flux, flowing between one another, growing and depleting over time, and requiring continuous maintenance. Capturing these stocks and flows is difficult as the boundaries are not always clear cut, their value is not always easily measurable, and the relevance of each capital will depend on the business context[7].

As well as a traditional focus on financial and manufactured capital, as mentioned at the start of the section, we have focused on bringing in natural capital and social capital into our decision making in line with Ofwat's public value principles[1]. The selection of supply and demand options has particular relevance to manufactured capital through the construction of new assets and associated equipment and tools and can be assessed monetarily using Net Present Value (NPV) based on Capital Expenditure (CAPEX, initial and replacement) and Operational Expenditure (OPEX, fixed and variable). Social capital is developed through the processes of engagement and consultation with customers, regulators and other stakeholders embedded in the decision making processes and measurable through indicators such as customer satisfaction surveys and the feedback received. Natural capital is relevant due to the impact of options on the natural environment and is evaluated through a number of environmental assessment sub-metrics including the Strategic Environmental Assessment (SEA) sub-metrics ‘biodiversity’, ‘sustainable natural resources’, ‘Invasive Non-Native Species (INNS)’, ‘soils, geodiversity and land use’, ‘water quantity’ and ‘water quality’ and the Natural Capital Assessment (NCA) sub-metrics ‘biodiversity and habitat’, ‘water purification’ and ‘water regulation’. This approach of incorporating natural capital into our decision making metrics aims to select options that provide a positive impact on the environment and the

[7] Capitals Background paper for <IR>, ACCA & NBA, 2013.

services that they provide. Measuring capital in this way also helps to monitor business progression and development so as to track our performance against the long-term direction of travel.

2.2 Our best value metrics

Deciding on the best value plan for water resources management is a complex task. Different stakeholders have different views on economics, the environment and wellbeing, including what they mean and their importance. We worked with experienced water managers, industry representatives, environmental regulators and assessors to derive the best value metrics in collaboration with Water Resources West, taking into account stakeholder views from the Initial Resource Position consultation[5].

All of our options undergo strategic environmental assessment (SEA) and natural capital assessment (NCA)[8]. Scores for SEA objectives are used (from significant negative affects to significant positive affects) to make up the Water Resources West best value metrics. The scale, impact and magnitude of options on natural capital is also converted into a best value metric score for each option. More detail on this can be found in the table below. SEA metrics are used in the primary approach for decision making and NCA metrics are used to provide additional context in the programme appraisal. Due to the nature of demand options, NCA metrics have not been derived for these options. Table 1 describes the best value metrics, the data used to derive them and the uncertainty around the values.

Table 1 Best value metrics

Best value metric	Description	Units of measure	Data basis	Uncertainty
Cost	Total Net Present Value (NPV) based on capital expenditure (initial and replacement) and operational expenditure (fixed and variable)	£ million NPV	Engineering assessments	+/- 30 per cent on engineering assessments
Carbon cost	Total NPV of monetised carbon cost	£ million NPV	Engineering assessments and HM Treasury Green Book[9]	+/- 30 per cent on engineering assessments
Public water supply (PWS) drought resilience	Supply-demand balance change at 1 in 500 level	Million litres per day (Ml/d)	Water resources modelling output	+/- 10 per cent of yield/DO
Flood risk	Qualitative assessment from environmental assessments	£ million NPV	SEA/NCA qualitative assessment converted to a linear scale and monetised	Qualitative assessment by Wood
Human and social wellbeing	Human health, social and economic wellbeing, cultural heritage, and air quality assessments	£ million NPV	SEA/NCA qualitative assessment converted to a linear scale and monetised	Qualitative assessment by Wood
Ecosystem resilience	Biodiversity, habitats and sustainable natural resource assessments	£ million NPV	SEA/NCA qualitative assessment converted to a linear scale and monetised	Qualitative assessment by Wood
Public water supply customer supply resilience	Supply interruptions, taste and aesthetics and hardness	£ million NPV	Derived from customer valuation assessment tool based on findings from customer research	+44 per cent to -19 per cent average range around central estimate

[8] In line with the Water resources planning guideline supplementary guidance - Environment and society in decision-making (England version), EA, 2020.

[9] The Green Book, HM Treasury, 2018.

Best value metric	Description	Units of measure	Data basis	Uncertainty
Multi-abstractor benefits	Water quality and quantity, and water resources	£ million NPV	SEA/NCA qualitative assessment converted to a linear scale and monetised	Qualitative assessment by Wood

2.2.1 Carbon cost

Carbon cost is one of eight best value metrics considered in our decision making. The whole life carbon values have been monetised using the Department for Business, Energy & Industrial Strategy (BEIS) modelling central value[10] (2021 £/tCO2e) as per the WRPG. Sensitivity testing using the high and low values has been undertaken to ascertain what if any changes would pertain to our preferred plan.

More detail on our approach to carbon can be found in the *Technical Report – Options identification*.

2.2.2 Public water supply customer supply resilience

The public water supply (PWS) customer supply resilience allows us to take into account three of the key issues that customers face:

- Interruptions to supply;
- Taste and aesthetics; and
- Water hardness.

Analysis of previous customer research conducted by all four water companies was commissioned through Water Resources West to better understand customer valuation of supply interruptions, taste, aesthetics and hardness based on a 'willingness-to-pay' approach[11]. This research was then converted into a customer valuation tool, which provided a method for evaluating the PWS customer valuation metric on an option and programme level. This analysis was carried out by FastTrackSquared and is detailed alongside an examination of the underlying data sources in a dedicated report[11].

The metric value is derived from willingness-to-pay and is generated from the reduction expected in interruptions to supply, aesthetic or taste events, after introducing a prospective option to the supply network.

2.2.3 Environmental and social metrics

Each environmental metric pulls together different objectives of the SEA assessment. These have been carefully mapped to prevent double counting of the same impacts. For example, SEA Objective 9, 'To reduce greenhouse gas emissions', was excluded from the WRW best value metric formulation as this is directly impacted by the carbon cost of an option, which is another existing metric.

Table 2 demonstrates the mapping of SEA objectives and NCA ecosystem services to the Water Resources West metrics. NCA metrics are used to provide additional context in the programme appraisal.

Environmental metrics were split into positive and negative impacts for use in our decision making. This ensured that the nuances of different benefits and disbenefits were not lost in an average value, and major impacts could, therefore, be clearly identified among the options. More detail on the environmental metric derivation can be found in Water Resources West's Decision metrics definitions note[12].

Water Resources West also commissioned expert consultants in economics and decision making to produce a tool called ValueStream1, which uses data inputs from non-monetised (SEA and NCA) assessments to produce scores for each option across the eight best value metrics, normalised to -100 to +100 scale, and weighted according to customer preferences. The weightings monetise the metric to provide a comparable value, against which an

[10] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, HM Government, April 2023

[11] Analysis of customer valuations for regional plan – Water Resources West companies, FastTrackSquared, March 2021.

[12] Decision metrics definitions, Water Resources West, September 2021.

option can be assessed for alternative benefits or disbenefits. This way, we are able to compare options like-for-like with regards to environmental and wellbeing metrics.

2.2.3.1 How our metrics are quantified using positive and negative costs

Metrics detailing a negative impact on environment and society will be treated as a cost within decision making, in a similar way to how we consider financial cost. Therefore, when quoting costs in this report, negative metrics have a value greater than zero. Equally, we aim to maximise the selection of options with a positive impact, therefore, metrics detailing a positive impact will have a cost value of less than zero. Our optimisation will, therefore, aim to minimise the overall cost of the plan.

Where an option has an overall best value cost that is negative, the metrics show that the option is better value to customers to implement in the long run than to not implement at all, due to the benefits that the option provides relative to its cost. However, this does not necessarily mean than an option should be implemented at that point in time. Options do have upfront costs, which must be taken into account, and the affordability of an overall programme is always considered alongside the long-term benefits of options and the objectives of our plan.

Table 2 Water Resources West environmental metrics

Water Resources West metric	SEA formulation	NCA formulation
Flood risk	Objective 7 – To reduce or manage flood risk	Natural hazard regulation service
Human and social wellbeing	Objective 8 – To minimise emissions of pollutant gases and particulates and enhance air quality Objective 10 – To adapt and improve resilience to the threats of climate change Objective 11 – To promote a sustainable economy and maintain and enhance the economic and social wellbeing of local communities Objective 12 – To maintain and enhance tourism and recreation Objective 13 – To promote and enhance human health and wellbeing Objective 16 – To conserve and enhance the historic environment including the significance of heritage assets and their settings and archaeological important sides Objective 17 – To conserve, protect and enhance landscape and townscape character and visual amenity	Recreation and tourism Health and wellbeing
Ecosystem resilience	Objective 1 – To protect and enhance biodiversity, including designated sites of nature conservation interest and protected habitats and species, enhance ecosystem resilience and habitat connectivity and deliver a net biodiversity gain Objective 2 – To protect and enhance sustainable natural resources and the ecosystem services they provide Objective 3 – To avoid and, where required, manage invasive and non-native species (INNS) Objective 4 – To protect and enhance soil quantity, quality and functionality and geodiversity and ensure the appropriate and efficient use of land Objective 15 – To minimise waste, promote resource efficient and move towards a circular economy	Biodiversity and habitat Agriculture
Multi-abstractor benefits	Objective 5 – To protect and enhance surface and groundwater levels and flows Objective 6 – To protect and enhance the quality of surface and groundwater resources Objective 14 – To promote and enhance the sustainable and efficient use of resilient water resources	Water purification Water regulation

2.2.4 Metric weightings

In our decision making, each metric does not necessarily carry the same level of importance. We apply weightings to our metrics to account for customer preferences in value and to account for the different detail making up each metric. We commissioned a specific set of customer research to understand weightings for our plan, putting customers at the heart of our decision making.

Metric weightings were initially generated during two dedicated workshops, facilitated by our consultants, to integrate the perspectives of environmental consultants and regulators, water resources planning experts, customer researchers and industry representatives from across the north west of England and Wales. These weightings were used initially in the decision making process and have been updated to reflect customer preferences following the customer research (*Technical Report – Customer and stakeholder engagement*).

Across Water Resources West, raw weights were found to reflect differences in company size rather than differences in preferences. Accordingly, the raw weights have, therefore, been scaled by our economist adjusting for factors of population, the size of the deficit (pre-demand management), and average scheme size.

In order to challenge and validate our assumptions around metric weightings we have carried out programme appraisal and considered how the weightings impact our option selection. During this activity, we have evaluated least cost and least carbon plans, along with a plan weighted entirely on the environmental and social metrics, which we name our 'best environment and society' plan. More detail on this is provided in Section 9.

2.2.4.1 Generating metric values using ValueStream

There are a number of steps involved in generating the non-monetised metrics ('Flood risk', 'Human and social wellbeing', 'Ecosystem resilience', and 'Multi-abstractor benefits') from SEA and NCA sub-metrics, and subsequently scaling these outputs so that the non-monetised metrics are on an equivalent comparable basis with the monetised metrics ('Carbon', 'PWS drought resilience' and 'PWS customer resilience').

2.2.4.2 Non-monetised metrics

The SEA and NCA sub-metrics incorporate qualitative assessments by expert environmental consultants. In part because of this, some judgement is required in the conversion of SEA/NCA sub-metrics to ValueStream1 metrics. The process of this conversion and the associated decisions are described below as agreed during the aforementioned workshops.

It was agreed at the decision making workshops that, in the derivation of the SEA-based metrics, the 17 SEA objectives (sub-metrics) are to be set as equal on the basis that there is no strong evidence to choose any other weighting, so this would be a suitable default[13]. It was agreed construction and operation should be weighted on the basis that the benefits would be more significant in the operation of schemes whereas the negative impacts would be more significant at the construction stage. As such, for positive impacts construction is weighted at 75 per cent of the value of operation and for negative impacts, operation is weighted at 75 per cent of the value of construction.

For NCA it was agreed that equal weighting was appropriate across the objectives for both positive and negative impacts. It was also agreed the scores for each option (between -3 and +3) across magnitude, scale and duration (also weighted equally) should combine multiplicatively rather than additively to reflect the impact of an option on the corresponding ecosystem service.

For both SEA and NCA, sub-metrics are combined for each best value metric. In the decision making workshop positive and negative impacts were considered to have equal weighting. Based on customer and stakeholder views, the most impactful of the SEA/NCA-based metrics was considered to be 'Ecosystem Resilience'. All other metrics were considered to have equal weight. It was, therefore, agreed to set all metrics to have 75 per cent of the value of the 'Ecosystem resilience' metric after normalising for the number of sub-metrics comprising each metric.

2.2.4.3 Converting to monetised metrics through metric weightings

The monetised metrics 'Carbon' and 'PWS customer resilience' are weighted against cost where a value greater than 1.0 represents a higher value than cost, and vice versa. Initially, these were given equal weighting, however, further customer research indicated carbon cost to have a higher value and was updated to have a weighting of 2.2 as shown in Table 3.

The SEA and NCA metrics are then weighted against the monetary metrics to ensure the SEA and NCA metrics can be measured on monetary-equivalent score. It was agreed at the second decision making workshop to compare the monetary metric 'Carbon' with 'Ecosystem resilience' so that carbon is worth 75 per cent of the swing from 0 to 100 'Ecosystem resilience'. The remaining SEA/NCA metrics weights are calculated relative to Ecosystem resilience.

Based on these weightings the tool outputs best value metric scores and weights for each option such that monetised and non-monetised metrics can be compared across a -100 to +100 scale in accordance with customer preferences. The tool also allows users to adopt different weights as a means of conducting sensitivity analysis.

[13] Water Resources West Regional Plan Decision Tool Workshop Report FWR6470-RT003-R01-00, HR Wallingford, August 2021.

Table 3 Metric weightings

	Relative importance to customers	
Metric	**Initial metric weightings derived in stakeholder workshops**	**Updated metric weightings following customer preferences research**
Cost	1.00	1.00
Carbon cost	1.00	2.20
Public water supply drought resilience	1.00	1.00
Flood risk	0.28	0.97
Human and social wellbeing	1.96	0.90
Ecosystem resilience	1.87	1.28
Public water supply customer supply resilience	1.00	1.00
Multi-abstractor benefits	0.84	0.79

2.2.5 Biodiversity net gain (BNG)

Our decision making approach takes account of biodiversity net gain (BNG) across all options in line with Water Resources Planning Guidelines[14]. Biodiversity loss for each option is assessed by expert environmental consultants (Wood). Losses are multiplied by 1.1 to include the ten per cent gain and then multiplied by the recommended unit cost of £20,000[15]. These costs are incorporated in the average incremental cost (AIC) for each option. This approach ensures the cost of providing the required ten per cent biodiversity gain is accounted for in decision making. More detail on the derivation of BNG in our options can be found in Section 7.4.5 of our *Technical Report - Options Identification*, which also includes information about a separate biodiversity opportunity project to identify strategic sites across the United Utilities Water estate for BNG.

Our environmental consultants produced a report detailing the BNG assessments undertaken for the WRMP. The assessment shows that the greatest impacts on biodiversity tend to be associated with options with long pipelines, particularly where they cross areas of woodland or blanket bog. For permanent, above-ground infrastructure, such as water treatment works, the greatest losses tend to be associated with options located on areas that are currently woodland. Specific detail on this can be found in the Biodiversity Net Gain and Natural Capital Assessment[16]. An opportunity mapping exercise has been carried out to identify potentially beneficial areas to locate the net gain associated with the Preferred (most likely) plan, and we are intending on carrying out further work towards selecting optimal sites, moving towards detailed design and implementation of the options.

2.3 Water transfer metrics

The North West Transfer Strategic Resource Option (NWT SRO) is a key input to our plan. The options required to facilitate transfer as part of the SRO were also selected using best value and performance metrics. However, as impacts of transfer on our supply area are very complex, we employed a wider range of best value metrics. The selection of options for the NWT SRO is described in Section 3.4. The process incorporated two steps involving the use of metrics:

(1) Portfolios of options were created using an approach known as ‘system simulation’. This essentially means appraising and selecting options directly within a water resources model rather than a supply-demand balance-based investment planning tool such as ValueStream (Section 3.2). This sophisticated approach ensured the transfer configuration will work in practice and fully protect customers and the

[14] Water resources planning guideline supplementary guidance – Environment and society in decision making (England version), EA, 2020.

[15] Consultation on Biodiversity Net Gain Regulations and Implementation January2022 (p9), Defra, 2022.

[16] Biodiversity Net Gain and Natural Capital Assessment, Wood and Ricardo, September 2022.

environment. The simulated performance of system was measured based on a range of performance metrics compiled to meet United Utilities Water's transfer principles relating to resilience and the environment, as shown in Table 4.

(2) Portfolios of options created by system simulation were then subsequently evaluated using the best value metrics described in Section 2.2.

It is important to note that despite the separation between the SRO and WRMP processes, the treatment of NWT SRO outputs as an input to the WRMP, and the use of additional metrics, there was a very high degree of consistency between the two workstreams. The teams worked closely together, and our processes and data were fully aligned.

Table 4 Water resources modelling metrics

Theme	Aspect	Performance metric
Resilience	Customer restrictions	Annual chance of implementing TUBs.
		Annual chance of implementing non-essential use bans (NEUB).
		Annual chance of implementing emergency drought orders (EDO) e.g. standpipes.
	Production capacity	Total Strategic Resource Zone production capacity.
	Supply-demand balance	Resource zone deployable output.
Environment	Drought permits	Annual chance of implementing drought permits.
	Water Framework Directive (WFD) no deterioration	Utilisation of sources under WINEP investigation.
Cost	Solution cost	NPV whole life total expenditure of solution (calculated outside of the model).
	System cost	Average annual operational expenditure (options and existing sources.

2.3.1 Production capacity metric

The NWT SRO production capacity metric is used directly in WRMP decision making. During a water transfer, we need to ensure that the service we provide to customers is maintained, including during outages.

The simplest way to protect production capacity would be to replace the 205 Ml/d total transfer[17] amount like-for-like with 205 Ml/d of sub-options. However, we were able to identify an alternative approach that provided significant cost savings by reducing this requirement to 167 Ml/d. This is achieved by allowing some water to be supplied to customers from the water treatment works during transfer periods. This would increase the level of abstraction above the sustainable yield of 180 Ml/d for short periods of time. In some dry weather periods, this would then need to be accompanied by a reduction in abstraction below 180 Ml/d outside of the transfer period. Water resources modelling was used to ensure this approach would work across a wide range of drought events using our 19,200-year stochastic hydrological dataset.

2.4 Other elements impacting our decision making

Not all elements of our decision making can be adequately captured through metrics, for example water quality and delivery risk. We have taken these elements into account during sensitivity testing and scenario analysis, where

[17] Correct at RAPID Gate 2 but subsequently reduced to 180 Ml/d (Section 5.1.6)

we have specific elements of the scenarios relating to water quality and to the delivery of the PCC and leakage reductions we are aiming to achieve. We have also carried out sensitivity testing around the delivery of our supply options for the preferred plan.

3. Decision making approach

3.1 Problem characterisation

We assessed the size and complexity of the planning problem in each of our Water Resource Zones (WRZs) through problem characterisation, following UK Water Industry Research (UKWIR) guidance[18,19]. This allowed us to understand the vulnerability of our WRZs to strategic issues, risks and uncertainties.

Problem characterisation is a two-dimensional assessment, which scores WRZs based on 'strategic risk' and 'complexity'. The scores are used within a matrix, which is then used to identify the appropriate level of sophistication for the planning approach.

The results can be found in Table 5. From this assessment, we concluded that a sophisticated planning approach is required for the Strategic Resource Zone (RZ), due to its complexity and the potential for water transfer. Whereas a simple approach is needed in North Eden RZ and Barepot RZ; and Carlisle RZ requires an extended approach.

The problem characterisation therefore led to choosing an aggregated approach; using Multi-Criteria Decision Analysis (MCDA) with scheduling to select options according to a supply-demand balance in each of the WRZs. In the Strategic RZ, a system simulated method was used before this stage to understand the benefits options provided to resilience and to short-list options for transfer. We also introduced adaptive pathways, which sit in the 'complex' approaches within the UKWIR guidance. Our approach is described in more detail in Section 3.2 and Section 3.4.

Table 5 Problem characterisation results

		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')	<7 (Low)	North Eden, Barepot			
	7–11 (Medium)			Carlisle	
	11+ (High)			Strategic	

We have developed a best value optimisation tool which can be applied to both Carlisle RZ and Strategic RZ. We can apply this to the Strategic RZ after using more sophisticated system simulation approaches.

3.1.1 Water Resources West problem characterisation

Water Resources West amalgamated the problem characterisation from each of the four water companies in the region. It found that the region is diverse, with many low concern zones, a few medium and high concern zones, shared river sources and the potential for water transfers. These outcomes strengthened the justification for our collaborative decision making approach and the development of water transfer opportunities. More information about the overall Water Resources West decision making approach is provided in the Regional Plan[20].

[18] WRMP 2019 Methods – Risk Based Planning, UKWIR, 2016.

[19] WRMP 2019 Methods – Decision Making Process: Guidance, UKWIR, 2016.

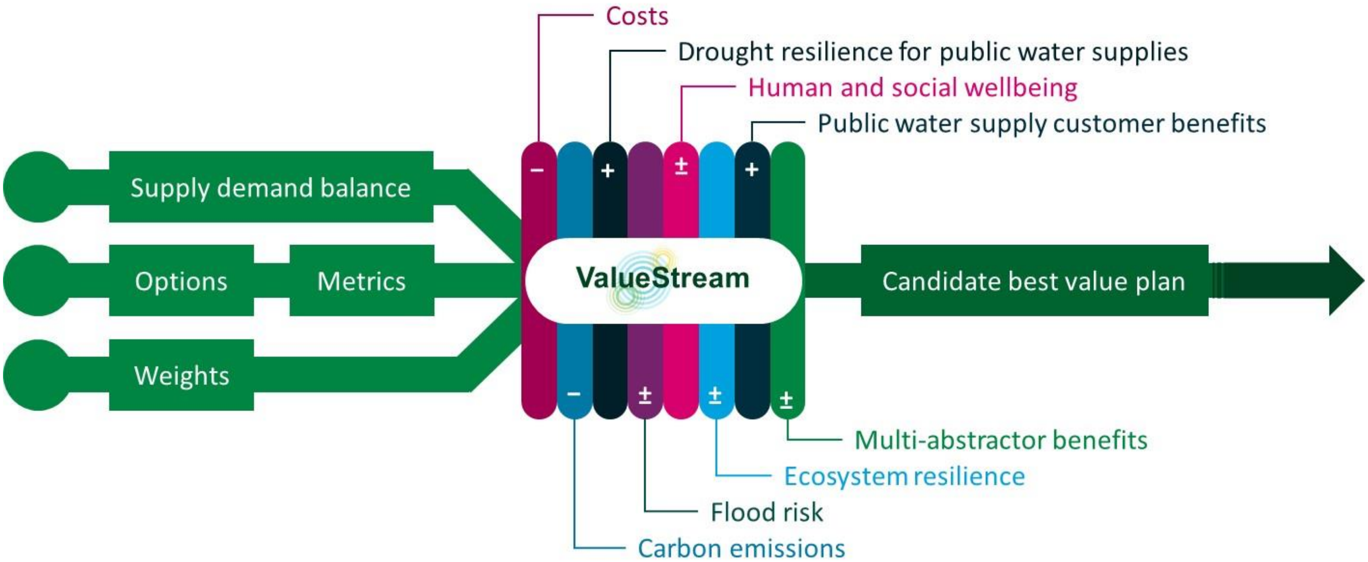
[20] Emerging regional plan, Water Resources West, January 2022

3.2 Best value optimisation tool

In line with the outcomes of our problem characterisation and in accordance with guidelines[21], as part of Water Resources West we have worked with industry experts to develop a regional-level best value optimisation methodology named ValueStream[22]. Water Resources West commissioned HR Wallingford to produce a Microsoft Excel-based decision support tool, which implements this methodology. In order to process larger amounts of data in quicker timescales, United Utilities Water commissioned the development of a python-based optimiser, implementing exactly the same methodology but with faster results and the capability to solve more complex problems in our Strategic RZ. This tool is named ValueStreamUU.

The tool uses solving algorithms to minimise overall cost, while generating a scheduled plan, which meets our supply-demand balance needs (SDB). The approach is based on UKWIR's Economics of Balancing Supply and Demand (EBSD) methodology[23]. The solver can optimise either financial cost or monetised best value cost. Best-value scores are multiplied by weightings taking into account customer preferences, and the resulting scores are used in the optimisation. We also use the tool to evaluate the best value performance of programmes generated by system simulation approaches. A diagrammatic summary of the approach is provided in Figure 4.

Figure 4 The ValueStream approach (source: Water Resources West)



The tool has undergone rigorous testing and we are confident with the optimisation process. We also recognise that ValueStream is a decision support tool, and as such, it is important to use judgement to check the reasoning of any outputs. Assurance around the tool is documented in a Technical Assurance report[24].

For supply and transfer options, the selection of options was carried out through a rigorous system simulation approach during the NWT SRO project, described in more detail in Section 3.4. For our demand management plan, the use of ValueStream was supported by expert judgement from across the company to account for the complexities inherent in demand management and ensure that our proposed preferred plan is fully aligned with our wider leakage and water efficiency strategies.

3.2.1 Decision support tool functionality

3.2.1.1 Input data

The decision support tool requires a range of input data and parameters including:

[21] Deriving a Best Value Water Resources Management Plan, UKWIR, 2020.

[22] Best value planning, Regional Plan Appendix, Water Resources West, 2022.

[23] The Economics of Balancing Supply and Demand (EBSD), UKWIR, 2002.

[24] ValueStream Technical Assurance Summary Report, Jacobs, 2022.

(a) Planning scenarios to solve;

(b) Start and end years of the planning period;

(c) Option IDs, names, earliest year available and whether they are included, excluded or selected in the run;

(d) Option capacity and DO profiles from the year of selection under each planning scenario;

(e) Option dependencies (i.e. some options cannot be implemented until another has completed);

(f) Mutual exclusive options (i.e. some options are designed around the same water source but with different implementation, and, therefore, cannot both be selected);

(g) Option metrics, including cost and best value metrics as described in Section 2.2;

(h) Baseline supply-demand balances for planning scenarios, as yearly values throughout the planning period. We include supply-demand balances for transfer requirements, demand reduction targets and each of our salient levels of service (1 in 20 years TUBs; 1 in 40 years TUBs; 1 in 200 years EDO; and 1 in 500 years EDO);

(i) Metric definitions and weightings; and

(j) Discount rates, applied as per HM Treasury Green Book guidance.

3.2.1.2 Optimisation

The objective of the optimisation is to select enough options (based on their option capacity or DO benefit), in the optimal years of the planning period, to meet any supply-demand balance deficits as set out in the inputs. The aim of the optimiser is to do this, while minimising the sum of the product of the options' metrics and their weightings for each year of the planning period.

Option costs will be time-value discounted, therefore, the later an option is selected, the lower the cost. Options will, therefore, only be selected when they are truly needed to meet a deficit.

3.2.1.3 Constraints

A number of the listed inputs are used as constraints within which the tool must optimise. These include the supply-demand balance. The final planning supply-demand balance is calculated each year as the initial supply-demand balance plus the benefits of the option selected. For every year of the planning period, the final supply-demand balance must equal or exceed zero.

Multiple supply-demand balances are input to the tool (as described in parameter (h) above), and each of these must be solved simultaneously using the corresponding DO benefits or capacity of the option for each SDB. This functionality allows us to ensure enough production capacity is selected to meet transfers in certain years, while continuing to maintain or improve our deployable output and therefore levels of service throughout the planning period. It also allows us to optimise the selection of demand options for PCC and leakage targets, while taking into account their impact on the overall supply-demand balance.

The options selected for the solution must meet the dependency and mutual exclusivity rules set out.

3.2.1.4 Settings

Weightings can be adjusted for different runs to evaluate least cost, best environment and society and other alternative plans. This has been explored in Section 9, programme appraisal. The start and end years of the planning period have been sensitivity tested to understand how making decisions taking into account the short-term and the long-term can impact option selection. Our default setting for the end year of the planning period is 2085, which is consistent with regional planning.

3.2.1.5 Solver

The python tool reads the set of inputs for each run and processes these to be read by a Mixed-Integer Linear Programme (MILP), which is a flexible and powerful method for solving large, complex problems such as this. It is widely used for this purpose across the industry. The programme looks for the single optimal solution, solving the problem within the constraints and producing the lowest overall best value cost solution, within the tolerance set.

3.2.1.6 Results

Once the optimisation is complete and a solution is found, the results are generated in Excel format. This shows the options selected, the value of each metric and the overall totals. The initial and final supply-demand balances are displayed along with the contribution of each option that has been selected.

3.3 A note on costs

3.3.1 Utilisation

It is important to note that all decision making using ValueStream was undertaken using 100 per cent utilisation of all options. This allowed a direct comparison between options in the appraisal. Therefore, to support the comparisons made in this report and aid the understanding of our decision making, costs are provided at 100 per cent utilisation.

Subsequent to this, our options were modelled to evaluate average expected utilisation. More detail on the results of this can be found in Section 3.4.1. In the WRMP Tables, submitted alongside the plan documents for preferred, alternative and adaptive plans, costs are provided at average utilisation.

3.3.2 80 year Net Present Value (NPV)

In ValueStream, costs are input as a stream of profiled costs over 80 years, discounted using Green Book[9] discounting factors. The optimisation then takes into account every year of costs when deciding on whether to implement an option. Overall, it looks to optimise the whole plan NPV (i.e. 80 years of costs, rather than 80 years of each individual option selected). For this, our best value metric scores were broken down into a profile of costs also using Green Book[9] discounting factors.

In this report, in order to fully represent the relative cost of each option, costs are provided as 80 year NPV for each option. The sum of these options, however will not equal to the 80 year NPV of the plan as a whole, as this is dependent on the year an option is selected.

3.3.3 Societal equity, intergenerational equity and distributional impacts

We have evaluated the best value metrics as whole life NPVs for each option. We provide plan totals in this report using these 80 year NPV costs for each option to demonstrate the value provided over the short and long term. Costs are discounted according to their start year, such that in the much longer term they are much less influential to the overall cost in the comparison. This is to ensure that decisions for the long term do not adversely impact the affordability for customers now when meeting shorter term needs.

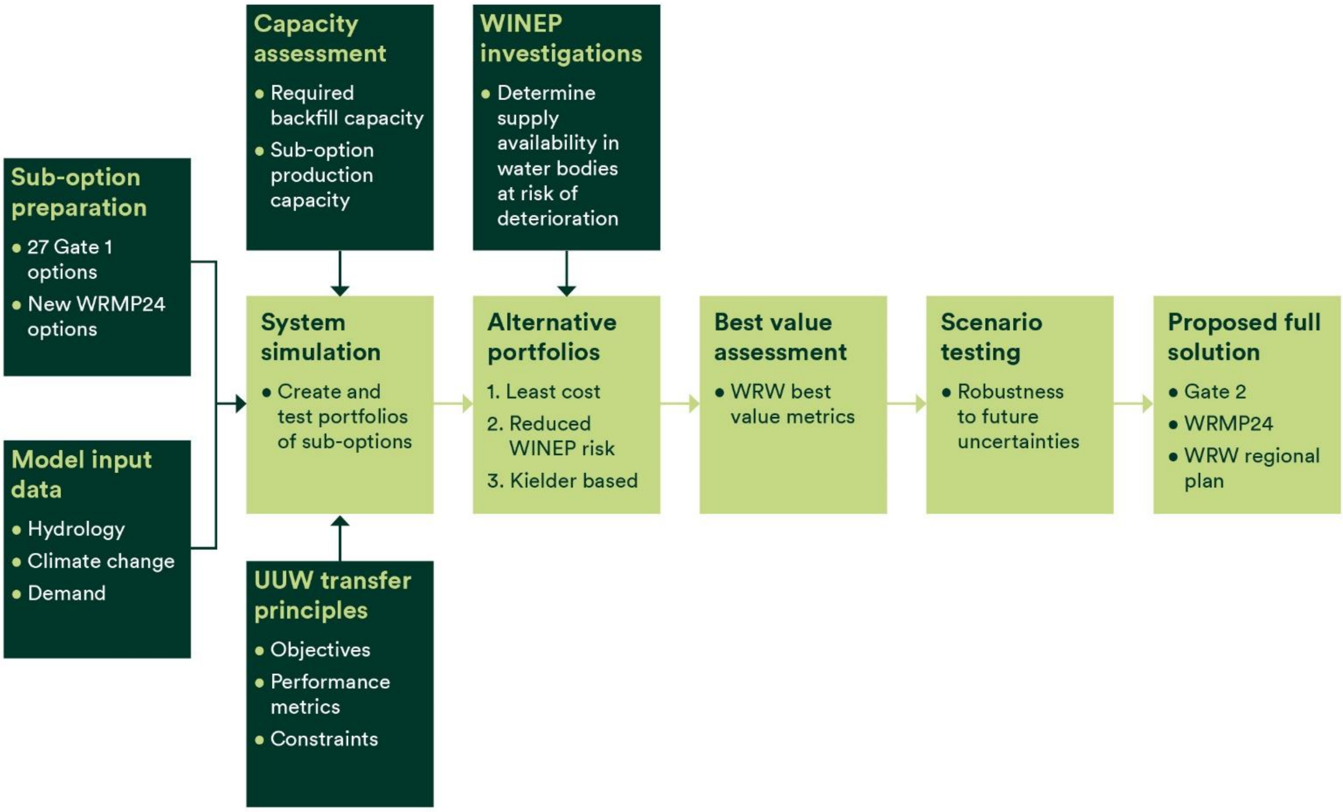
We have also considered different sensitivity tests and glide paths to ensure we are delivering our objectives at the optimum time. These are detailed in Section 10.

3.4 System simulation approach

The NWT SRO involves large-scale transfer from Vyrnwy, which, without mitigation, would significantly affect our supply area. Sub-options are, therefore, required to enhance our network to facilitate this form of transfer. Understanding how these sub-options work within our supply network to provide this benefit formed the bulk of the NWT SRO water resources assessment.

A sophisticated approach has been used to solve the planning problem for this zone, generating a programme, which was then subsequently evaluated and further developed in ValueStream (as illustrated in Figure 5). We worked closely with Water Resources West to define best value and the approach was also aligned to our company transfer principles.

Figure 5 Overview of water resources assessment for sub-options[25]



Our Strategic Resource Zone is a complex and non-linear supply system, with a large number of sources and demand centres. Using a supply-demand balance would grossly over-simplify the effects of large-scale water transfer on our system and make it impossible to design a solution, which would both function effectively and properly protect customers and the environment. Therefore, a system simulation approach was implemented for the NWT SRO to:

- Help meet several of our high-level water transfer principles, particularly around resilience;
- Take into account the huge complexity of the Strategic Resource Zone and properly understand the sub-options' water resources benefits within this context;
- Reflect the scale of the SRO, both in terms of its sheer size, at 180 Ml/d[26], and level of integration of Vyrnwy and the backfill sub-options within our network; and
- Ensure that the proposed configuration of sub-options is broadly operable (noting that for RAPID Gate 3 water resources modelling will be supported by other forms of more detailed modelling to ensure full operability), and properly protects customers and the environment.

Our Pywr model was used to simulate sub-options to demonstrate how they would improve the system. Their performance was measured using the metrics detailed in Section 2.3. The following steps were undertaken to create alternative portfolios of sub-options:

(1) Run the model to represent future conditions with no transfer occurring. Capture the metric scores to form a baseline.

(2) Implement transfer according to utilisation sequences provided by transfer recipients. Measure any drop in performance due to water transfer.

(3) Build groups of sub-options into the model to recover the drop in performance, at the same time minimising overall solution cost (Total expenditure 80-year NPV) by testing them in order of AIC.

[25] North West Transfer Detailed Feasibility and Concept Design, United Utilities Water, November 2022.

[26] Note: At draft the maximum trade amount was 205 Ml/d, but this was subsequently reduced to 180 Ml/d.

More detail can be found on this in the NWT SRO Gate 2 submission document[25].

3.4.1 Utilisation of water transfer sub-options

As part of the NWT SRO Gate 2 assessment we simulated the utilisation of water transfer sub-options in the full 205 Ml/d solution. This maximum trade amount from draft was subsequently reduced to 180 Ml/d. This work is fully described in the NWT SRO Gate 2 submission document[25] but a summary is provided below, as requested by Ofwat in its consultation feedback.

Utilisation is a key consideration for the NWT SRO, both in terms of the pattern of transfer need, which was provided by prospective recipients, and utilisation of our sub-options to mitigate Lake Vyrnwy releases. Using a water resources model we simulated the utilisation of sub-options to inform scheme design, cost and transfer prices. It was also a key input into our environmental assessments.

Whilst all of the sub-options are required to support transfers there are times when they can also be used to support resilience in the North West. A lack of correlation between drought conditions in the North West and South East means that in approximately half of droughts affecting the North West Transfer will not be required. The role of the sub-options can therefore be broken down into three elements:

(1) Meeting supply needs during transfer periods, i.e. as a direct response to transfer.

(2) Use for transfers but outside of specific transfer periods, either preparing the system for transfers or helping the system to recover from transfers. In some years we may prepare the system for transfers but a transfer request may not materialise. Allowing this indirect type of transfer support helped us to reduce the capacity of sub-options required for transfer well below the total transfer amount (167 Ml/d versus 180 Ml/d).

(3) Utilising the sub-options for our own needs, when they are not required to support transfers.

The results presented below correspond to all three types of use combined.

We used our Pywr water resources model to simulate the utilisation of the sub-options. We simulated our full 19,200 hydrological stochastic dataset in order to maximise the level of confidence in our statistical analysis. The model assumptions were consistent with the central scenario used for Gate 2 sub-option selection:

- 2035 planned supply network;
- WRSE stochastic transfer utilisation (also used for Severn Trent Water);
- Forecast 2035 demand;
- 2035 climate change (RCP 6.0); and
- Most likely predicted abstraction licence changes.

The results were processed to provide annual and monthly statistics, as presented in the tables below. We also separated out different severities of weather conditions and drought events by ranking each stochastic year according to total minimum reservoir storage reached. For 1 in 500 year drought utilisation we selected all years between 1 in 475 and 1 in 525 severity to prevent the results from being specific to only one drought event.

As this stage we have only simulated the utilisation of sub-options in the Full Solution of 180 Ml/d. However, for Gate 3 we plan to simulate smaller transfer volumes, as selected in regional planning reconciliation, phased over the planning period. We will take into account key changes between the Draft and Revised Draft WRMP, including additional leakage reduction and demand management (for example accelerating the benefits water labelling and introducing non-household smart meters). There are also a number of water resources model improvements planned.

The tables below therefore show the utilisation across different types of weather events, corresponding to the Gate 2 full solution and the Draft WRMP forecasted conditions. Additional analysis on the uncertainty in utilisation was undertaken and is outlined in the NWT SRO Gate 2 submission document[25]. Option WR149 ITC_WIGAN was included at draft, but this portfolio option was subsequently removed.

The levels of utilisation predicted demonstrate that the Sub-options will be effectively deployed and will not sit idle waiting for a 1 in 500 year drought to occur. This is because we were able to size the scheme below the overall transfer amount (167 Ml/d versus 180 Ml/d), plus generate some additional resilience benefits for the North West.

Table 6 Simulated utilisation across all years

			All years												
			% utilisation (Ml)												
Option	**Option Name**	**Capacity (Ml/d)**	**Annual Average**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
WR111	GWE_ WOODFORD	9	64	32	45	55	51	72	100	100	89	79	62	50	29
WR102b	GWE_WIDNES	17	57	29	35	42	51	69	88	93	83	74	49	39	26
WR076	SWN_RIVER BOLLIN	25	40	12	13	22	30	43	75	86	72	59	30	19	16
WR015	SWN_ RIVER IRWELL	40	38	12	13	21	29	41	74	85	69	57	29	19	14
WR107b	GWE_RANDLES BRIDGE	12	37	10	12	19	25	38	73	82	66	56	32	21	11
WR149	ITC_WIGAN	13.8	37	12	12	20	27	37	70	79	64	56	32	22	15
WR113	GWE_ TYTHERINGTON	3	46	16	21	33	34	37	65	75	77	73	59	43	21
WR049d	SWN_RIVER RIBBLE 49d	40	30	8	12	17	24	34	53	65	52	49	25	15	8
WR107a2	GWE_ AUGHTON PARK a2	10	18	2	1	2	4	7	25	52	50	42	20	8	2

Table 7 Simulated utilisation in "normal years"

			Normal year (bin 1:1 to 1:20 events)												
			% utilisation (Ml)												
Option	**Option Name**	**Capacity (Ml/d)**	**Annual Average**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
WR111	GWE_WOODFORD	9	63	32	46	54	50	71	100	100	88	78	60	48	27
WR102b	GWE_WIDNES	17	56	29	36	42	51	68	87	92	82	73	47	37	25
WR076	SWN_RIVER BOLLIN	25	39	12	13	21	29	41	74	86	70	57	27	18	15
WR015	SWN_RIVER IRWELL	40	37	12	13	21	28	39	73	85	68	54	26	17	14
WR107b	GWE_RANDLES BRIDGE	12	36	10	12	19	24	36	72	81	64	54	29	19	10
WR149	ITC_WIGAN	13.8	36	11	12	20	26	35	69	78	62	54	30	20	14
WR113	GWE_TYTHERINGTON	3	45	15	21	33	33	35	63	74	75	71	57	41	19
WR049d	SWN_RIVER RIBBLE 49d	40	29	8	12	17	24	32	51	63	49	47	23	13	7
WR107a2	GWE_AUGHTON PARK a2	10	16	1	1	2	3	5	22	49	48	39	17	7	2

Table 8 Simulated utilisation in "dry years"

			Dry year (bin 1:20 to 1:100 events)												
			% utilisation (Ml)												
Option	**Option Name**	**Capacity (Ml/d)**	**Annual Average**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
WR111	GWE_WOODFORD	9	78	36	42	55	66	88	100	100	100	100	98	88	66
WR102b	GWE_WIDNES	17	72	32	31	41	62	85	97	100	100	100	91	71	49
WR076	SWN_RIVER BOLLIN	25	59	15	13	21	40	72	95	100	100	99	81	44	30
WR015	SWN_RIVER IRWELL	40	58	14	13	21	39	70	95	100	100	99	80	43	29
WR107b	GWE_RANDLES BRIDGE	12	60	13	12	20	37	69	95	100	100	99	85	58	32
WR149	ITC_WIGAN	13.8	59	15	13	21	38	68	92	96	96	96	82	57	33
WR113	GWE_TYTHERINGTON	3	70	26	26	38	50	65	92	99	100	100	97	86	62
WR049d	SWN_RIVER RIBBLE 49d	40	52	10	12	18	36	60	74	90	94	97	69	36	22
WR107a2	GWE_AUGHTON PARK a2	10	43	5	3	5	10	25	74	98	99	98	65	28	11

Table 9 Simulated utilisation in "extreme drought"

			1 in 500 year droughts (bin, for e.g., 1:475 to 1:525 events)												
			% utilisation (Ml)												
Option	**Option Name**	**Capacity (Ml/d)**	**Annual Average**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
WR111	GWE_WOODFORD	9	88	41	45	73	91	99	100	100	100	100	100	100	100
WR102b	GWE_WIDNES	17	80	37	33	58	90	100	100	100	100	100	100	92	49
WR076	SWN_RIVER BOLLIN	25	70	6	13	38	81	100	100	100	100	100	100	83	26
WR015	SWN_RIVER IRWELL	40	70	6	13	38	80	100	100	100	100	100	100	83	26
WR107b	GWE_RANDLES BRIDGE	12	72	6	13	38	77	100	100	100	100	100	100	90	35
WR149	ITC_WIGAN	13.8	70	9	15	37	77	97	97	97	97	97	97	87	34
WR113	GWE_TYTHERINGTON	3	84	35	31	59	81	96	100	100	100	100	100	100	100
WR049d	SWN_RIVER RIBBLE 49d	40	67	4	11	39	76	90	93	97	99	100	98	68	24
WR107a2	GWE_AUGHTON PARK a2	10	59	0	0	19	43	74	98	100	100	100	98	53	17

3.5 Adaptive planning approach

We identified that an adaptive planning approach is desirable to take into account the key uncertainties influencing the WRMP and the relevant guidance[27]. In the development of an adaptive plan, there are a number of stages to follow. Section 3.5.1 outlines the steps we followed in the development of our adaptive plan for Strategic RZ. We have followed some of these steps for Carlisle RZ, however due to the lack of transfer need, some of the steps weren't required. We set out how we followed this process in Section 5.

3.5.1 Adaptive planning steps

(a) Develop the 'most likely' supply-demand balance, based on the Environment Agency WRPG and taking into account the level of service as set out in our objectives (Section 1).

(b) Develop plausible future scenarios, around which we will build the adaptive plan.

(c) Select a transfer portfolio using water transfer metrics, a system simulation approach and the Water Resources West best value metrics.

(d) Work with regional groups in 'Regional Reconciliation' to confirm transfer volumes and dates for the preferred plan and any alternative transfer pathways.

(e) Using utilisation data provided by recipients, and water resources modelling, evaluate the deployable impact of transfer on the system, and apply this to the supply-demand balance when transfer is expected to occur.

(f) Schedule the portfolio of transfer options using optimisation based on best value metrics and weights as set out in Section 2.2.

(g) Ensure that deployable output and total production capacity are not negatively impacted as a result of the transfer option selection.

(h) Carry out sensitivity testing around the most likely scenario.

(i) Produce alternative programmes including least cost to understand impact of best value selection on individual metrics.

(j) Identify best value options to achieve our level of service in each scenario.

(k) Analyse the selection of options in all scenarios to identify low regret options.

(l) Use estimates of implementation times to identify decision points, at which we need to progress options.

(m) Identify monitoring points, at which we will gather data to make these decisions.

(n) Build a monitoring plan, if our existing business processes do not monitor the required elements.

A number of our technical reports[28] set out how we arrived at our most likely supply-demand balance, achieving step (a) in the adaptive planning steps.

3.5.1.1 Low regret options

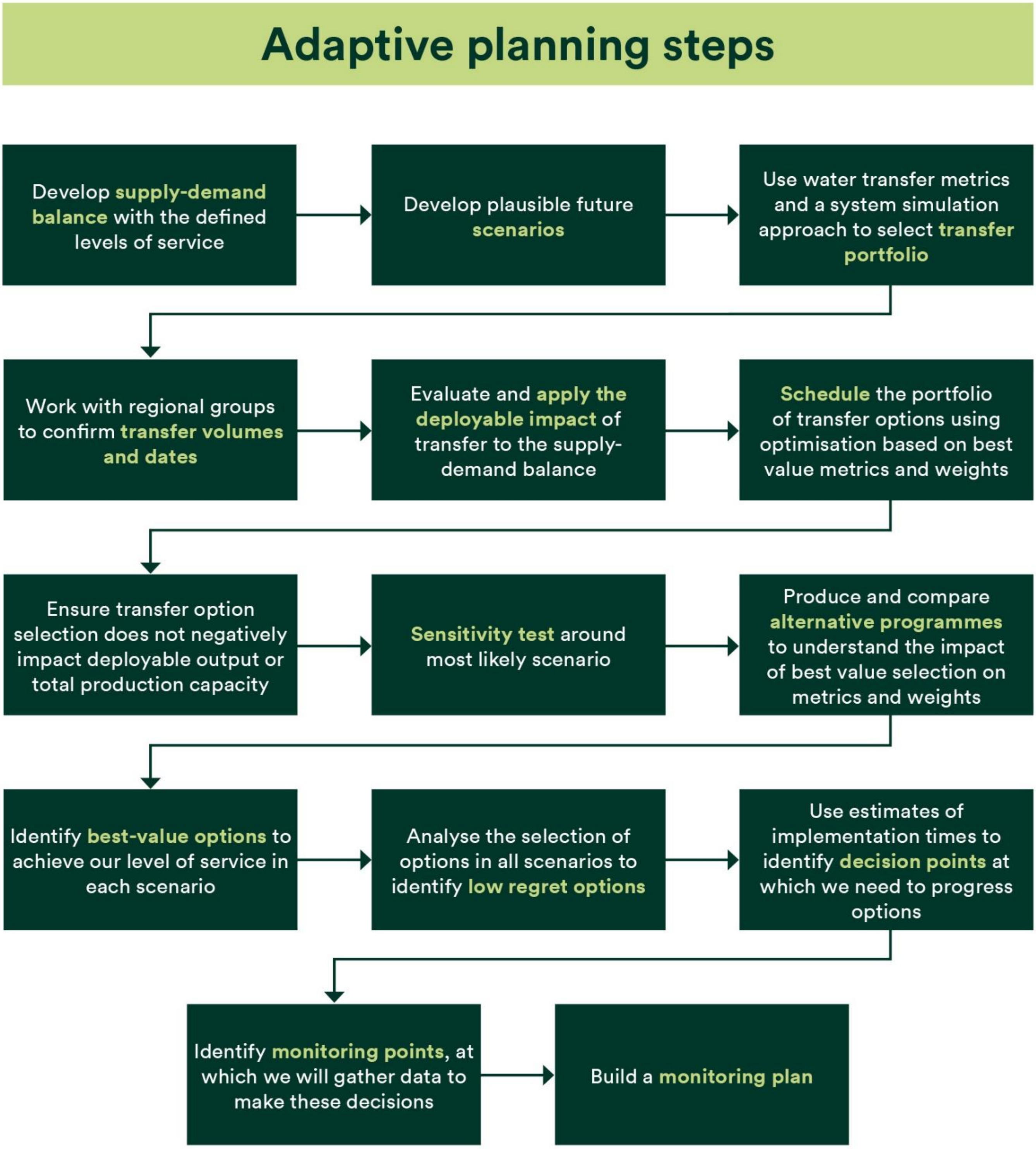
We have used alternative scenarios and adaptive planning to identify where options could be implemented in a low regret way (Section 11.1).

Low regrets options or investments are defined as those that are required in a wide range of plausible future scenarios, those that are required to meet short-term requirements, and those that are required to keep options open for the future or minimise the cost of future options. This definition aligns with the PR24 and beyond: Final guidance on long-term delivery strategies[35].

[27] Water resources planning guideline supplementary guidance – Adaptive planning, Environment Agency, 2020.

[28] *Technical Report – Supply forecast, Technical Report – Demand for Water, Technical Report – Allowing for uncertainty, Technical Report – Environmental destination*.

Figure 6 Adaptive planning steps



3.6 Sensitivity testing

We carried out sensitivity tests to understand the impact of timings, deliverability and risk resilience. These tests provide a wider view of the choices that are being made and provide insight into how changing the objectives of the optimisation can result in better or worse value programmes. The tests we carried out include:

- The timing of meeting 1:500 EDO and 1:40 TUBs;
- The pace of demand reduction delivery;
- Deliverability of supply options;
- Upper and lower carbon costs from the Green Book[9];

- Short and long term optimisation;
- Headroom glide paths; and
- Performance of transfer portfolios across a wide range of future conditions (system simulation).

The results of these tests are in Section 10 Testing our plan.

3.7 How our approach meets requirements for water resources planning in Wales

Our best value approach, which includes assessing carbon cost, aims to maximise the selection of options with positive social, economic, and environmental impacts in the long and short term. Rather than simply being cost-based, this more holistic approach aligns with the wellbeing goals under the Well-being of Future Generations (Wales) Act 2015[29] and the sustainable development principles.

Section 4 of the Environment (Wales) Act 2016[30] sets out nine principles of sustainable management of natural resources (SMNR): adaptive, scale, collaboration and engagement, public participation, evidence, multiple benefits, long-term, and preventative action. These principles are integrated into the decision-making process to deliver outcomes that provide multiple benefits and maintain and improve the health of our ecosystems over the long term.

Planning is structured across multiple scales to meet the national, regional, and local needs. As part of the regional group Water Resources West, United Utilities Water considers inter-regional transfers on a best value basis to promote plans that meet significant future national challenges in an efficient way through co-operation and collaboration. United Utilities Water also seeks to help maximise the benefits of shared resources within-region. Local scale action is carried out via workstreams dedicated to prioritising the needs of catchments.

Both regional plans and company WRMPs are inherently adaptive with aligned five-yearly reviews. Both plans also set out an adaptive approach with a single preferred pathway alongside alternatives that may be triggered at set decision points depending on continued monitoring and the results of ongoing investigations. The adaptive approach helps mitigate long-term uncertainty by considering supply and demand forecasts over a minimum of 25 years and accounting for high climate change scenarios (RCP8.5 RCM and the 4°C world) and environmental destination. Short and medium priorities are accounted for through low regrets measures such as river restoration as reflected in the current WINEP.

The WINEP investigations alongside Water Framework Directive (WFD) data and environmental appraisals (SEA, NCA, BNG, WFD, HRA)[31] carried out by environmental consultants generate evidence that feeds into the multi-criteria decision making approach. Evidence forms the basis for decision making; eight metrics represent the intrinsic value of natural resources and ecosystems to select options, which bring multiple benefits and promote building ecosystem resilience over ones that are harmful.

Taking an adaptive, long-term, and multi-criteria approach allows United Utilities Water to take preventative action against damage to ecosystems; an environmental destination workstream identifies and investigates sources at risk of deterioration and considers how protected sites and habitats may require enhanced protection. This approach is supported by the biodiversity net gain (BNG) policy, which mandates habitats to be left in an improved state helping to ensure ecosystems diversity, connection, scale, condition, and adaptability.

Crucial to decision making is building collaboration and engagement between water companies, regional groups, the regulators including Natural Resources Wales (NRW), non-PWS and wider stakeholders such as the Clywedog/Vyrnwy group and the Wales Water Management Forums, and customers. Public participation is carried out through multiple means including surveys, face-to-face interviews, and focus groups. These views feed

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[29] Wellbeing of Future Generations (Wales) Act, The Welsh Government, 2015.

[30] Environment (Wales) Act, The Welsh Government, 2016.

[31] Water Resources Planning Guideline 2024 Supplementary Guidance: Environment and Society in decision making (Wales), NRW, 2020.

into the decision making metrics to inform the strategic choices, which are further refined and tested through two rounds of consultation.

4. Engagement

Customer and stakeholder inputs are vital to a successful WRMP. We have a comprehensive customer research plan across United Utilities Water, supplemented by additional research commissioned by Water Resources West.

In March 2021, consultants for Water Resources West amalgamated, re-analysed and re-purposed the wealth of existing research from all four water companies in the region. They combined qualitative and quantitative analysis to provide a richer insight into customer preferences on different factors such as aesthetics, service levels and interruptions. This exercise output a customer valuation tool, used in the evaluation of the PWS customer supply resilience metric as described in Section 2.2.1.

Following this, we commissioned a range of specific WRMP qualitative and quantitative research projects. All of this work is outlined in the *Technical Report - Customer and stakeholder engagement*. Three of the exercises were pivotal to the decision making process:

(1) Customer choice experiment. We presented customers with a range of options relating to our strategic choices, to help us define how far to go. For example, at this point we decided to improve the level of service for TUBS to 1 in 40 years (2.5 per cent annual chance) because the customer 'willingness to pay' exceeded the corresponding cost of implementation, but failed to reach the cost to improve to 1 in 100 years (1 per cent annual chance).

(2) Customer weightings for our best value plan. The weightings generated in this exercise were used in our decision making process, as described in Section 2.2.4 and our *Technical Report - Customer and stakeholder engagement*. Customers attached greatest value to 'Carbon cost' (2.2) followed by 'Ecosystem resilience' (1.28); metrics 'Flood risk' (0.97) and 'Human and social wellbeing' (0.9) were weighted midway between these top criteria and 'Cost', 'PWS drought supply resilience' and 'PWS customer supply resilience', which were scored lower, had equal weightings (1.0).

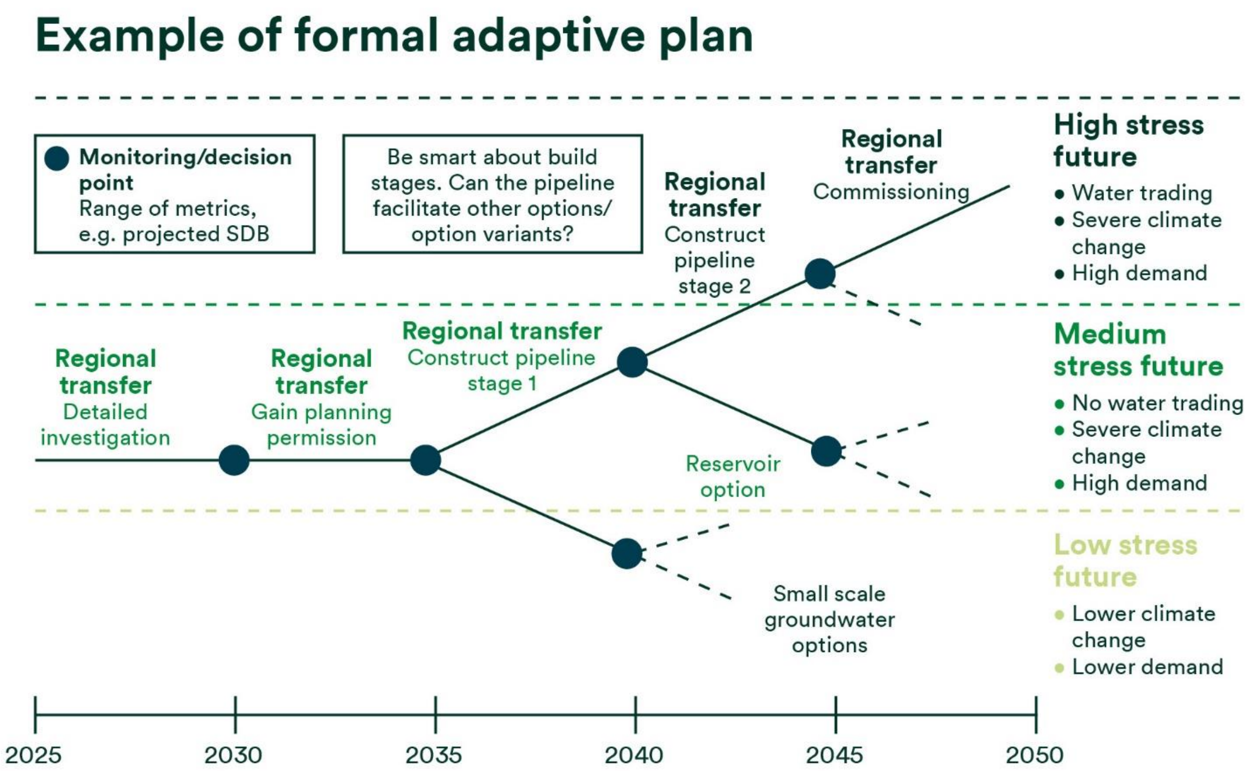
(3) Preferred plan acceptability. At the end of the process we presented our proposed preferred plan to customers to see if they found it acceptable and, if not, how they would change it. At the same time, we assessed their willingness to pay for the preferred plan in terms of bill increases. The outcomes are summarised in Section 10.9.

5. Scenarios for adaptive planning

We have carefully considered how we achieve our objectives for this plan in the face of increasing future uncertainty. We have identified that creating an adaptive plan is required to help us achieve our goals for the future, considering the WRPG Supplementary guidance on Adaptive Planning and the 'PR24 and beyond' final guidance on long-term delivery strategies. The need for an adaptive plan is driven by the potential need for our large strategic options, including those from the demand management plan.

In the following sections, we set out the decisions we will take in our preferred (most likely) pathway. The future is inherently uncertain, therefore, our adaptive plan includes a number of pathways, where the future may deviate from what we expect. In order to create the adaptive pathways, we have developed a number of scenarios based on variations of the most uncertain factors influencing our plan. In Section 11.9, we set out a methodology for monitoring these factors and managing a change of course.

Figure 7 Example adaptive plan



5.1 Key areas of uncertainty

We have identified a number of key uncertainties, which are most significant for our WRMP. These are:

- Climate change;
- Demand;
- Our environmental destination;
- Water quality; and
- The magnitude and timing of national water transfer.

Some aspects of these uncertainties have been taken into account in our target headroom, and the risk evaluation process is detailed in the *Technical Report – Allowing for uncertainty*. The following sections detail how they are taken into account in scenario analysis.

5.1.1 Climate change

Climate change impacts water availability and the natural environment, influencing the amount of protection it needs. It, therefore, has a large impact on our ability to provide water to customers at the levels of service they prefer. It is important that we plan for plausible futures, and the choice of climate change projection is significant for this.

In our most likely scenario, we are planning for a climate change scenario of 2°C of global warming by the year 2100. This assumes we follow the RCP6.0 climate change emissions scenario from the UK Climate Projections 2018[32] (UKCP18) study. The selection of this scenario in our most likely pathway is consistent with other water companies in Water Resources West. For more detail on this choice, refer to our *Technical Report – Supply forecast*.

There is significant uncertainty around the choice of climate change projection, as these different futures interact with government policy and the actions of people and businesses across the globe. While we consider RCP6.0 to be the likely future, we are planning for a world with more and less climate change in the creation of a low regrets plan.

Our scenarios, therefore, consider both RCP2.6 ('1-degree world') and RCP8.5 ('4-degree world'), along with RCP6.0 ('2-degree world'), for our adaptive pathways.

5.1.2 Delivery of demand management plan

We have carried out an impact assessment of the Census 2021 on our population data. From the Census in 2011 to the Census in 2021, there has been slightly higher growth than we predicted. We have, therefore, reflected a higher growth rate than the historical rate in our WRMP24 population forecasts, using data from local authority plans (note that this is also a requirement of the EA WRPG). We have also produced low estimates for population growth, according to the ONS-Main-2018 forecast.

The COVID-19 pandemic and associated changes in customer behaviour have added to the uncertainty around per-capita consumption. While we have a preferred demand management plan, which is designed to meet the reductions set out in Section 1.2.1, there are several factors that are outside of our control, therefore, we are also planning for alternative futures. These futures include more and less effective delivery of our demand management plan, achieving outcomes at different paces and to various extents. These futures also consider different outcomes for meter penetration, including smart meters, and changing government policy.

Aside from events like COVID-19, there are a number of reasons which introduce uncertainty into the delivery of our demand management strategy, and these are listed below:

- Economic and business growth in the North West may exceed our expectations and we could see higher than anticipated non-household consumption despite investment in the preferred plan options, as well as changes in use and types of business;
- Higher population growth than expected has the potential to lead to higher total non-household customer consumption by driving greater demand for certain goods which require water to produce;
- Our planned interventions may have unexpected effects on customer demand;
- Major socio-economic shocks, such as global conflicts, may impact water demand in unpredictable ways;
- Climate change is increasing the risk of extreme weather variability, which could induce more frequent freeze thaw events. Extended periods of freezing temperatures, followed by rapid thaw, results in higher levels of bursts and leaks, increasing leakage from our water network and from bursts in customer supply pipes and leaks from private plumbing (both domestic and commercial, internal and external).
  These leaks can cause significant increases in water demand and may impact our ability to meet our demand glidepath; and

[32] UKCP summaries and headline findings, Met Office, [Online] accessed 2022.

- Climate change is also increasing the risk of extreme dry weather, which could result in changes to peak demand.

As we cannot predict exactly which of these elements are going to impact the delivery of our demand management plan, and simulating and testing each individual and combined impact would be impossible to do for every feasible eventuality, we have simulated any of these events within alternative demand scenarios, where our glide paths achieve demand reduction at faster and slower paces, and some targets are achieved while others are not. Table 10 therefore demonstrates how demand has been changed in our scenarios, rather than the specific potential event that may lead to that outcome.

5.1.3 Environmental destination and future sustainability reductions

In the production of the National Framework for Water Resources, environmental destination scenarios[33] were derived to help us predict the future (long-term) sustainability reductions that we may need to carry out in order to protect the natural environment. Four scenarios were made available, along with corresponding abstraction reductions, which would be needed to meet the environmental flow indicator (EFI). There is more detail on this in our *Technical Report – Environmental destination.* The scenarios, 'Business as usual plus locally verified' (BAU+, previously called BAU) and 'Enhanced'.

The National Framework scenarios have some important assumptions built into the numbers for sustainability reductions, such as the impact of climate change. To estimate future natural flows, the Environment Agency used Future Flows Hydrology (FFH) data[34], which is based on a medium emissions scenario, SRES-A1B, representing slightly warmer global temperatures than our core climate projection of RCP6.0. This scenario has around 3.5°C of warming above pre-industrial levels by the end of the century. Within this data set, the scenarios focused on the AFIXK projection, which was one of the drier ensemble members. Our central view on supply, combined with our target headroom as described in the *Technical Report – Allowing for uncertainty*, puts us into a similar position as the environmental destination scenarios.

Our most likely pathway assumes that the environmental destination will follow the BAU+ scenario. The BAU+ scenario is similar to the previous BAU scenario but has been decided in discussion with local EA representatives and includes an additional review of European protected sites under Common Standards Monitoring Guidance (CSMG). For United Utilities Water, BAU and BAU+ scenarios have the same impact because CSMG catchments are deemed to be sufficiently protected by current environmental safeguards (Hands-off Flow) and, therefore, do not require further licence changes beyond what we assumed in the original BAU scenario. The Enhanced scenario sees greater environmental protection for protected areas, SSSI rivers and wetlands, and principal salmon rivers. In these water bodies, the enhanced scenario applies the most sensitive flow constraint appropriate, increasing the proportion of natural flow that is protected for the environment. This leads to larger licence reductions at specific sources which has the potential to impact on these protected areas in the long term. We are planning on undertaking a significant amount of investigations in AMP8 WINEP to better understand the uncertainty, and the time table for potential licence change requirements considering the risk of deterioration. There is more detail on this in our *Technical Report – Environmental destination*.

Two scenarios were tested around the most likely pathway in line with Ofwat's guidance on long-term delivery strategies[35]. The high abstraction reduction scenario assumes the Environment Agency's 'Enhanced' scenario, and the low abstraction reductions scenario assumes BAU+ but excludes highly uncertain abstraction reductions over and above statutory licence reductions required to prevent environmental deterioration in the short to medium turn.

5.1.4 Water quality

We recognise that there are a number of factors such as climate change, changes in land use and better understanding of emerging contaminants such as PFAS and micro plastics, which could cause deterioration to raw

[33] National Framework Appendix 4: Longer term environmental water needs, Environment Agency (March 2020).

[34] Future flows hydrology data, NERC Environmental Information Data Centre, Haxton, T.; Crooks, S.; Jackson, C.R.; Barkwith, A.K.A.P.; Kelvin, J.; Williamson, J.; Mackay, J.D.; Wang, L.; Davies, H.; Young, A.; Prudhomme, C. (2012).

[35] PR24 and beyond: Final guidance on long-term delivery strategies, Ofwat, April 2022.

water quality in the future. To reflect future uncertainty, in our target headroom assessment, we have undertaken a high-level review of potential water quality risks to our groundwater and surface water sources. From this review, we have identified best estimates of the percentage risk of source yield reduction, phased across the planning period, due to gradual pollution factors. We also estimated the potential magnitude of yield loss associated with each source and risk factor, taking into account mitigation measures including blending and AMP7 treatment improvements, which may be feasible to limit the magnitude of potential yield loss in some cases. Since there is uncertainty around the effectiveness of the blending and AMP7 treatment improvements, we have considered a scenario where these mitigation measures fail to provide any benefit. The impact on deployable output has been calculated using the Aquator™ modelling software and included within the company high scenario. It is important to note that while this forms part of the company high scenario, it is by no means a worst-case scenario for water quality.

5.1.5 Target headroom

Target headroom is an important consideration for our adaptive plan. Across Water Resources West, companies agreed to continue to include additional allowance in our supply-demand balance to account for significant uncertainty in the planning period (otherwise we would be effectively planning for a high rate of failure); while ensuring we are not double-counting uncertainty in our plan.

Each alternative pathway will be treated as a supply-demand balance and have its own target headroom. When we introduce and plan for these alternative pathways, we adapt the components of target headroom. Reflecting UKCP18 outputs, we have ensured that a higher degree of warming leads to a larger range of climate change impact uncertainty, and that lower warming leads to a smaller uncertainty range. We have also reformulated our demand uncertainty distributions to correspond with the growth projection used for each scenario.

Some components cannot be monitored and are not addressed in our adaptive plan. Instead, these will remain in our target headroom as uncertainties.

5.1.6 The magnitude and timing of national water transfers

Through our North West Transfer strategic resource option (NWT SRO), we are able to provide large amounts of water to other regions in water stressed areas, during time of need and supporting national resilience. The solution can provide benefits to a range of different parties, as well as United Utilities Water. Crucially, it contributes to recipients' 1 in 500-year resilience (0.2 per cent annual chance of failure) without constructing low utilisation assets. The current maximum transfer from the NWT SRO is 180 Ml/d, assessed with our 19,200-year stochastic hydrological dataset to the 1 in 500 resilience target. The original 205 Ml/d transfer included 180 Ml/d from Lake Vyrnwy, and a 25 Ml/d potable supply from the water treatment works within existing abstraction licence constraints. However, since the draft plan the 25 Ml/d potable transfer is no longer available due to the required level of utilisation (100% needed versus 15% offered). This water would be available either to support the Severn Thames Transfer scheme or as direct transfers to other parties. The need for this water has been identified through regional planning in a number of alternative water transfer scenarios, but the timing and magnitude of this need remain uncertain.

The NWT SRO has a large degree of inherent flexibility. The water resources benefits can be scaled, phased and readily incorporated into adaptive plans. We can essentially transfer any increment of the 180 Ml/d maximum, albeit there are some steps changes in engineering need for the Vyrnwy enabling works.

The same factors impacting the uncertainty in our plan will influence the decisions made in the plans of other water companies. We, therefore, need to anticipate future requirements for water transfers as part of our scenarios.

Throughout April to June in 2022, and following this in January to March in 2023, water companies worked together during a reconciliation process, setting out transfer requirements in a number of different scenarios. Regions then compared the value impact that different transfer scenarios had on each of the water company plans. Following a series of stress-tests, a final planning position for Strategic Regional Options (SROs) was agreed nationally for this stage in the planning process. More detail on these stress tests can be found in the summary report on reconciliation[36].

Stress tests for regional reconciliation:

- Main transfer portfolio vs Kielder portfolio;
- Maximum transfers to Water Resources South East;
- Excluding the North West Transfer;
- No transfers to Water Resources South East; and
- No transfers to Water Resources West.

The reconciliation process also demonstrated a number of alternative transfer requirements under different conditions, and we are including these in our adaptive planning alongside other alternative scenarios to inform the best value plan (Section 5.2.5).

5.2 Summary of adaptive scenarios

5.2.1 Supply-demand scenarios

Considering the key areas of uncertainty, as set out in Section 5.1, we have developed a number of scenarios in collaboration with Water Resources West and following Ofwat guidance[35], through which we have identified low regret options, developed and tested our preferred plan. These scenarios consider uncertainties in isolation and in combination to provide different plausible future world conditions.

[36] Inter-regional reconciliation of regional plans – spring 2022: Summary report, 1st July 2022.

Table 10 Scenarios

Scenario name	Climate change impact	Demand impact	Environmental destination impact
Most likely	2°C world (RCP6.0 Probabilistic)	Plan-based forecast	BAU+
Ofwat high (based on Ofwat scenarios)	4°C world (RCP8.5 RCM)	Plan-based forecast	Enhanced
Ofwat low (based on Ofwat scenarios)	1.3°C world (RCP2.6 Probabilistic)	ONS-2018 main forecast, water labelling with minimum standards introduced from 2025 (FY26)	BAU+ but with highly uncertain reductions removed
WRW demand scenario (which replaces the 'RCG PCC' scenario from draft plan	Same as most likely	Plan-based forecast, 50 per cent of the PCC reductions, 50 per cent of the non-household reductions.	Same as most likely
Company high	4°C world (RCP8.5 RCM)	Plan-based forecast, flat PCC, half of the desired leakage reduction by 2050	Enhanced
Ofwat high climate	4°C world (RCP8.5 RCM)	Same as most likely	Same as most likely
Ofwat high demand	Same as most likely	Same as most likely	Same as most likely
Ofwat high abstraction reductions	Same as most likely	Same as most likely	Enhanced
Ofwat slower technology	Same as most likely	Dynamic Network Management and Permanent Network Sensors options in place by 2040. Full smart metering options complete by 2045.	Same as most likely
Ofwat low climate	1.3°C world (RCP2.6 Probabilistic)	Same as most likely	Same as most likely
Ofwat low demand	Same as most likely	ONS-2018 main forecast, water labelling with minimum standards introduced from 2025	Same as most likely
Ofwat low abstraction reductions	Same as most likely	Same as most likely	BAU+ but with highly uncertain reductions removed
Ofwat faster technology	Same as most likely	Dynamic Network Management and Permanent Network Sensors options in place by 2035. Full smart metering options complete by 2035.	Same as most likely

5.2.2 Impact of scenarios on the supply-demand balance

In this section we present the projected supply-demand balance for each of our scenarios.

The preferred plan is designed to improve the level of service for TUBs from 1:20 to 1:40 in the year 2031. However, our adaptive plan considers the level of service improvement as an option which may or may not be implemented in alternative scenarios. Therefore, for simplicity, our supply-demand balance is shown here for the 1:20 TUBs level of service from the start of the planning period until 2039, at which point it changes to 1:500 EDO supply-demand balance.

In a change from the draft plan, the benefits of demand reduction options are not included in the supply-demand balance figures (Figure 8 and Figure 9). The trends presented are baseline, however they do include the impact of our selected demand savings and drought permits. Therefore, in most of the scenarios in Figure 8, including the preferred (most likely), there is a baseline deficit from 2026.

The scenarios for Strategic RZ were analysed to understand the impact on the supply-demand balance, and this analysis is described in more detail below.

After an initial drop and rise before 2029 driven by a change in deployable output from prolonged outage, the projections remain relatively stable until 2045 and 2049 where there are drops in supply driven by environmental destination impacts and long term drivers such as climate change no longer being offset by increased demand reduction.

The most positive outlook is the 'Ofwat low' scenario, which forecasts a surplus of 78.64 Ml/d Ml/d for 1:500 EDO in 2049, before dropping to a deficit of 28.46 Ml/d. This scenario combines the benefits of the lowest growth forecast (ONS-2018), the lowest climate change forecast (RCP 2.6), and the removal of highly uncertain abstraction reductions (Ofwat low ED) totalling an additional 154 Ml/d of water availability by 2050 compared to the most likely forecast.

The Ofwat high scenario combines the impact of the highest climate change forecast (RCP 8.5) and enhanced environmental protection totalling 105 Ml/d less water availability than most likely forecast in 2050.

The Ofwat high demand scenario has the same projection as the most likely scenario as they are based on the same assumptions. This is because although Ofwat considers using local authority growth forecasts as the upper assumption for demand, these assumptions form part of the baseline most likely forecast to comply with Environment Agency WRMP guidance.

The Ofwat low demand scenario results in a significant improvement in supply-demand balance (an additional 124 Ml/d by 2050 relative to the most likely scenario). This scenario uses the ONS-2018 growth forecast, rather a forecast based on local council plans. As previously noted, in the most likely scenario we have used the local authority plan-based forecasts as stipulated by the WRPG and supported by our data analysis. We also believe this is the most likely scenario as per the 2021 Census (further information can be found on this in the *Technical Report – Demand for Water)*.

The Ofwat low climate scenario is in surplus until 2027 and then again from 2029 to 2034 and creates a small benefit to the supply-demand balance relative to the most likely scenario (+30 Ml/d by 2050). This scenario assumes the world follows RCP 2.6 resulting in 1.3 degrees of warming rather than RCP 6.0, which results in two degrees of warming by the end of the century.

The Ofwat high climate scenario results in a significant reduction in water availability (-106 Ml/d by 2050 relative to the most likely scenario). This scenario assumes the world follows RCP 8.5 resulting in four degrees of warming by 2100 rather than RCP 6.0 which results in two degrees of warming by 2100.

The difference for the high scenario, which is based on the enhanced environmental destination scenario, relates to including a greater level of environmental protection representing the -181 Ml/d supply-demand balance deficit. This is only 2 Ml/d different to the most likely scenario. More detail on how the environmental destination is represented in the scenarios is provided in our *Technical Report – Environmental destination*.

The most negative outlook is the 'company high' scenario, which forecasts a deficit of 374 Ml/d 1:500 EDO in 2050. This scenario combines the impacts of the highest climate change forecast (RCP 8.5), high demand assumptions (flat PCC) and enhanced environmental protection (Enhanced ED) totalling a reduction of 191 Ml/d by 2050 compared to the most likely forecast. The scenario also results in reduced benefits of selected demand options as described in Table 10.

For Carlisle RZ, the demand management plan is sufficient to meet all scenarios in the zone, however the zone has still been considered in the adaptive planning due to the differing assumptions on demand options in the demand and technology adaptive plan.

Figure 8 Impact on the supply-demand balance for each scenario in Strategic RZ (limiting levels of service: 1:20 TUBs pre-2039; and 1:500 EDO from 2039) excluding the benefits of demand reduction options.

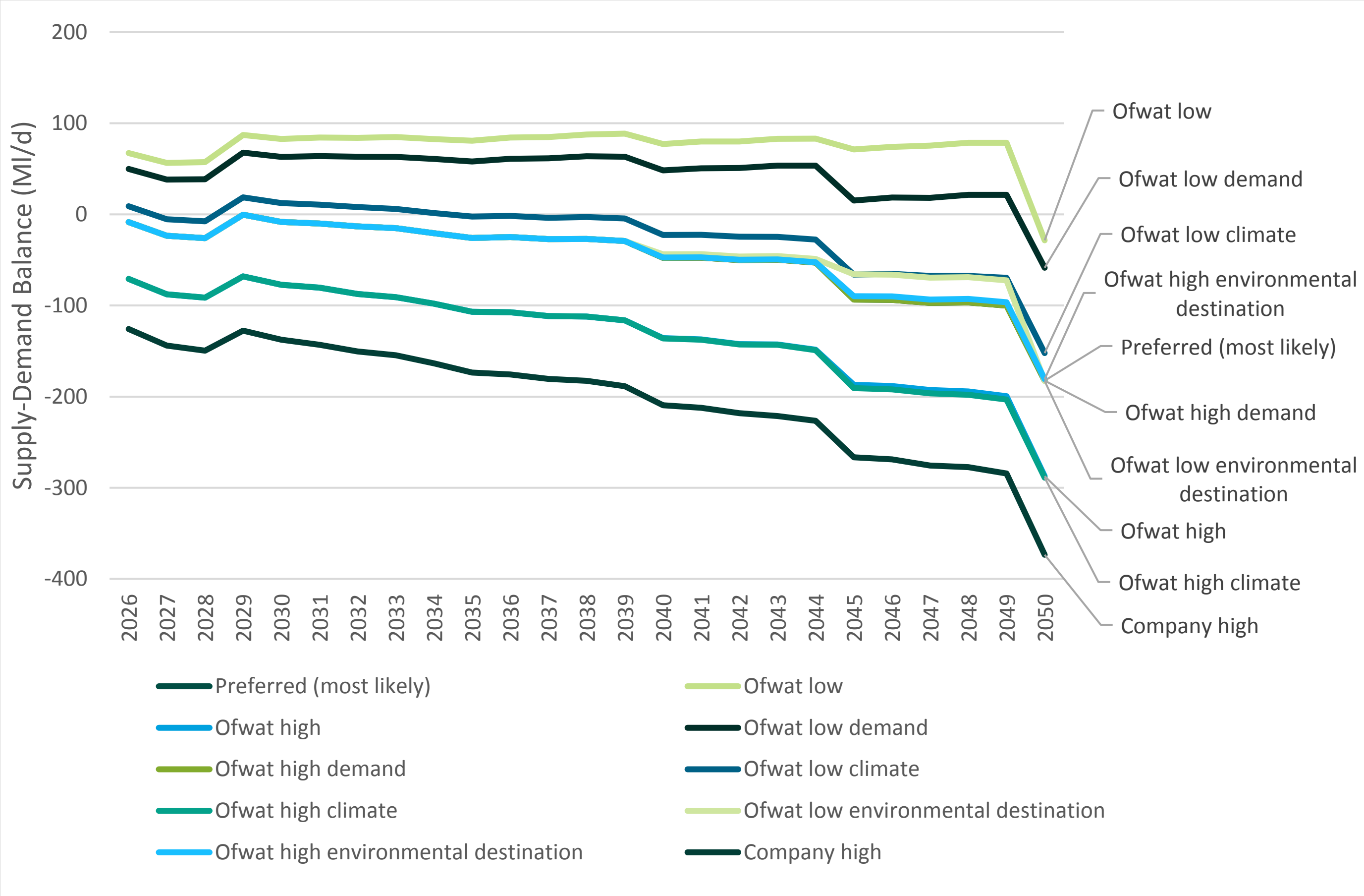


Figure 9 Impact on the supply-demand balance for each scenario in Carlisle RZ (limiting levels of service: 1:200 EDO pre-2039; and 1:500 EDO from 2039) excluding the benefits from demand reduction options.

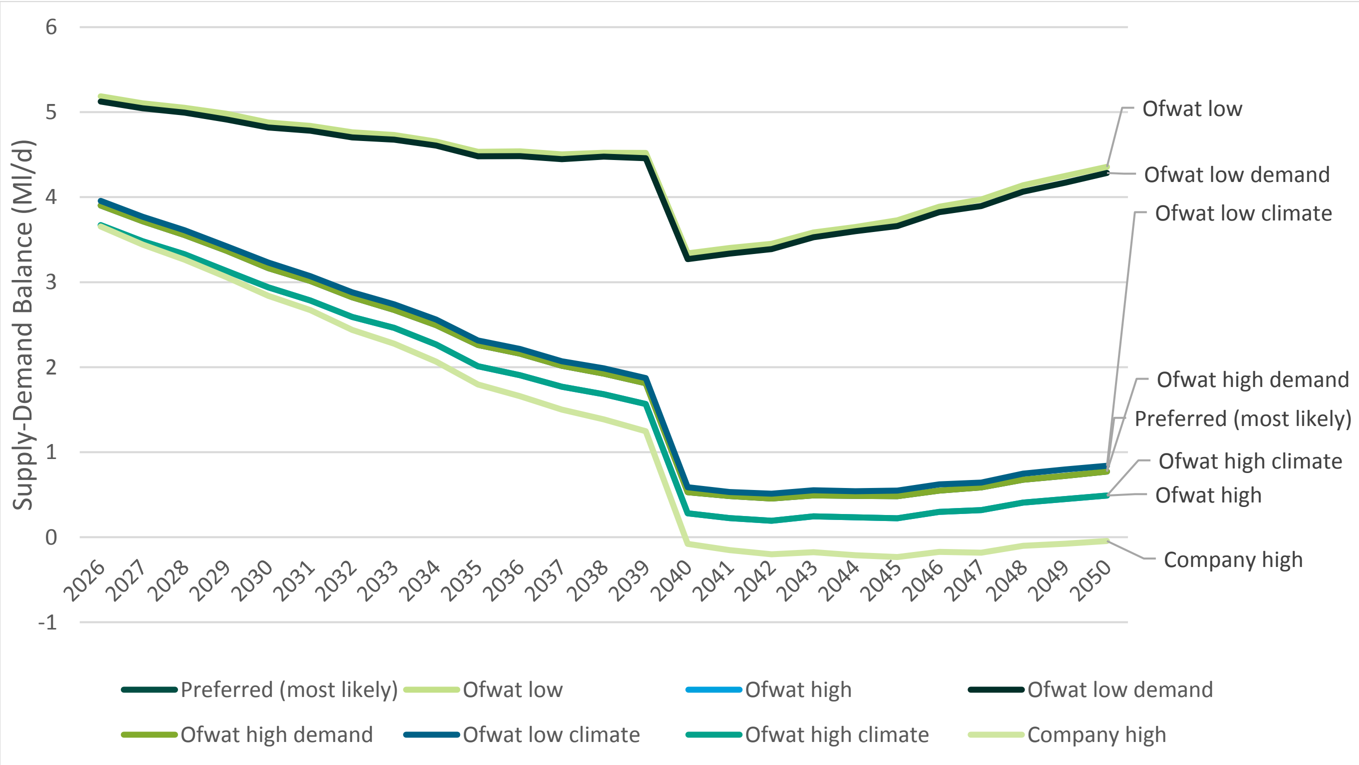


Table 11 Scenario overview illustrating drivers of change to the supply-demand balance in Strategic RZ

Scenario	Demonstrates the impact of: (compared to the most likely)	Supply-demand balance in 2050 (Ml/d)	Difference compared to most likely (Ml/d)
Preferred (most likely)	–	-183	
Ofwat low	ONS-2018, RCP 2.6, Ofwat low ED	-28	+154
Ofwat high	RCP 8.5, enhanced ED	-287	-105
Ofwat low demand	ONS-2018	-59	+124
Ofwat high demand	Same assumptions as Preferred (most likely)	-183	–
Ofwat low climate	RCP 2.6	-152	+30
Ofwat high climate	RCP 8.5	-289	-106
Ofwat low environmental destination	BAU+ with uncertain abstraction reductions removed	-183	
Ofwat high environmental destination	Enhanced ED	-181	+2
Company high	RCP 8.5, flat PCC and enhanced ED	-374	-191

Table 12 Scenario overview illustrating drivers of change to the supply-demand balance in Carlisle RZ

Scenario	Demonstrates the impact of: (compared to the most likely)	Supply-demand balance in 2050 (Ml/d)	Difference compared to most likely (Ml/d)
Preferred (most likely)	–	1	–
Ofwat combined low	ONS-2018, RCP 2.6, Ofwat low ED	4	4
Ofwat combined high	RCP 8.5, enhanced ED	0	0
Ofwat low demand	ONS-2018	4	4
Ofwat high demand	Same assumptions as Preferred (most likely)	1	0
Ofwat low climate	RCP 2.6	1	0
Ofwat high climate	RCP 8.5	0	0
Company high	RCP 8.5, flat PCC and enhanced ED	0	-1

5.2.3 Technology scenarios

The pace of technological development was also considered in the scenarios in line with guidance published by Ofwat[35]. The Ofwat faster technology scenario assumes full smart meter penetration by 2035 and implementation of a smart water supply by 2035. The Ofwat slower technology scenario assumes full smart meter penetration by 2045 and implementation of smart water supply by 2040. These scenarios have been implemented using the selection of different demand options within our demand management plan.

A smart water supply involves 'automatic detection of potential leaks' and 'robust real-time asset condition information including telemetry, robotic and drone inspection'[35]. To demonstrate the technology scenarios, we have assumed the roll out of permanent network sensors and dynamic network management in time for the specified dates.

In the case of the slow full smart metering scenario, our metering options are selected later in the planning period, and in the case of the fast full smart metering scenario, new options were generated to demonstrate how a quicker roll-out would impact our plan. These options are denoted 'Tech' and are hypothetical options only created in order to simulate the fast technology scenario. They are not considered to be feasible options and are therefore not detailed in WRMP Tables or the *WRMP24 Technical Report – Options Identification*.

All other scenarios, including the most likely, assume metering pace is as per our demand options. More detail on this can be found in our *Technical Report – Options Identification*.

5.2.4 Water transfer scenarios

5.2.4.1 The preferred transfer plan

The regional reconciliation resulted in an agreed preferred transfer pathway. The reconciled scenario supports adaptive planning by the regions and companies. United Utilities Water's transfer requirements for this pathway are set out in Table 13.

Table 13 National water transfer needs as set out in the regional reconciliation (the reconciled transfer plan)

Recipient	Year of selection[37]	Capacity (Ml/d)	Cumulative (Ml/d)	Description
Severn Trent Water	2030	25	25	Vyrnwy

5.2.4.2 Water Resources South East (WRSE) 'No South East Strategic Reservoir Option (SESRO)' scenario

This scenario reflects the potential for the major South East Strategic Reservoir Option (SESRO) scheme to not be delivered or available. Under this scenario, Severn Trent Water would select a raw water transfer from Vyrnwy of 25 Ml/d at the earliest date of 2030. Then, Water Resources South East would select United Utilities Water in 2042 and would take the full 180 Ml/d enabled by the North West Transfer from Vyrnwy in 2050, as Severn Trent Water can back away from the 25 Ml/d option in the longer term.

[37] For water transfer dates and years of selection, the year stated refers to the calendar year, in alignment with the Inter-regional reconciliation 3: Summary report[6] (this is represented as financial year within our WRMP Tables, i.e. the year the benefit becomes available and the transfer impacts are realised). All other options and years referenced outside of the water transfer context are financial years.

Table 14 WRSE No SESRO scenario

Recipient	Year of selection[37]	Capacity (Ml/d)	Cumulative (Ml/d)
Severn Trent Water	2030	25	25
Water Resources South East	2042	50	75
Water Resources South East	2045	85	160
Water Resources South East	2046	15	175
Severn Trent Water		-25	150
Water Resources South East	2050	30	180

5.2.4.3 WRSE higher demand scenario

This scenario is based upon WRSE not meeting Environmental Improvement Plan (EIP) interim targets and company level PCC targets of 110 Ml/d by 2050. To achieve these targets the companies in the South East are dependent on Government interventions, which means there is a risk that the expected demand management benefits will not be realised. The maximum transfer capacity of 165 Ml/d is selected by Severn Trent Water and Water Resources South East, with WRSE taking the majority from 2050.

Table 15 WRSE higher demand scenario

Recipient	Year of selection[37]	Capacity (Ml/d)	Cumulative (Ml/d)
Severn Trent Water	2030	25	25
Water Resources South East	2050	25	50
Water Resources South East	2060	85	135
Water Resources South East	2061	30	165

5.2.4.4 Maximum transfer by 2040

The reconciliation processes throughout 2021 to 2023 demonstrated the significant uncertainty around transfer requirements for the future and it is for this reason that we are including an alternative transfer scenario, which we believe to be plausible. In this scenario, we prepare for a full transfer requirement by 2040.

Table 16 Full transfer scenario

Recipient	Year of selection[37]	Capacity (Ml/d)	Cumulative (Ml/d)
Severn Trent Water/Water Resources South East/other	2040	180	180

5.2.5 Water transfer scenario summary

The different water transfer scenarios, which have been included in our adaptive plan are summarised in Table *17*.

Table 17 Summary of transfer pathways

Transfer scenario	Maximum transfer capacity over planning period (Ml/d)	Pathway
Reconciled plan	25	Preferred (most likely)
WRSE No SESRO	180	Alternative
WRSE higher demand	165	Alternative
Maximum transfer by 2040[37]	180	Alternative

6. Our preferred (most likely) demand plan

6.1 Our demand management strategy

Our leakage and demand management plan will aim to achieve our demand management objectives as set out in Section 1.2.1 as a minimum criterion, while using a best value approach. Therefore, the Water Resources West metrics and their weightings are also applied to our demand options.

Reducing leakage, non-household demand and PCC requires significant engineering work and behavioural change, both of which need time. In addition to the Water Resources West metrics, we are using a 'deliverability' constraint, which simulates the expected timing for implementation of demand options. This will ensure options are chosen early enough in the planning period to meet desired outcomes.

6.2 Our demand needs

As set out in our objectives in Section 1.2, we are planning to achieve a 50 per cent reduction in leakage and reduce per capita consumption (PCC) to 110 litres per person per day by 2050, in line with regulatory expectations and customer preferences (Section 4). Since the publication of the Government's Environmental Improvement Plan 2023, we have also included interim targets and new targets for the reduction of non-household demand and the use public water supply in England per head of population (referred to from hereon as our distribution input (DI) target).

Our glide paths for demand reduction have been developed with the following considerations:

- Our AMP7 plans and targets;
- Our AMP8 targets;
- Interim Government targets and those in 2050;
- Our previous options, plans and commitment at WRMP19 and PR19;
- The impact on bills these targets could have on customers;
- Customer preference;
- A stretching but achievable delivery plan;
- Balancing savings across household and non-household customers;
- Reliability of delivery; and
- Rapidly changing technology.

Our option optimisation has also assisted in improving the demand profiles to understand a best value approach to demand management. We have optimised our demand programme to achieve demand reductions as per Table 18, which meets the targets at a company level when averaged for PCC and totalled for leakage, non-household demand and distribution input.

Table 18 Demand reduction targets for the region

Policy	2027	2032	2038	2050
Leakage	-20%	-30%	-37%	-50%
Per capita consumption (PCC) in litres per person per day (l/p/d)	-	-	122	110
Non-household consumption	-	-	-9%	-15%

Policy	2027	2032	2038	2050
Distribution input	-9%	-14%	-20%	-

Due to the population differences between zones (Carlisle RZ and North Eden RZ make up less than 2 per cent of the total population in the region), most of the demand reduction will be as a result of demand management programmes in Strategic RZ where the changes are most cost effective to enact. We have, therefore, created a plan which will reduce PCC in all of our zones to various extents, reducing the company average PCC to 110 l/p/d.

6.2.1 Baseline demand activity

The primary baseline activities to manage demand for water are:

- Activity to maintain leakage levels, including "find and fix" to offset the natural rate of rise (we have now, therefore, discounted option WR500 "find and fix" as a baseline activity);
- Free Meter Option (FMO) optant metering and promotion of this, including our "lowest bill guarantee";
- Metering of new households and non-households, moving towards smart meter technology;
- Meter replacements; and
- Water efficiency communications and engagement.

Assuming they meet the screening criteria, activities not covered in the above list will be considered as options to reduce demand for water.

6.2.2 Leakage strategy

Water UK's 'A Leakage Routemap to 2050[38]' sets out how water companies in England plan to significantly reduce leakage by 2050. Our demand options have been supplemented with other important measures of value specific to network leakage, for example Prevent, Aware, Locate and Mend (PALM), which are detailed in the route map. These elements of our leakage strategy have influenced our decisions on options alongside the best value optimisation. Our leakage strategy is a transformation from "find and fix" to Dynamic Network Management, predicting and preventing leaks to drive continual improvement in our leakage performance.

In order to **Prevent** leaks, options are promoted where they:

- Ensure our networks are effectively optimised and managed via 'calm networks', live valve status and remote control;
- Apply intelligent maintenance to water network assets; and,
- Stop the deterioration in water network asset health, ensuring that we have already applied appropriate operational mitigation and that any new network is leak-free.

To be **Aware**, we will prioritise targeted enhanced monitoring and use the latest data analytics and prediction techniques to shift the balance from customer reported leaks to proactively found leaks.

In order to **Locate** leaks, we will work with our suppliers to develop and implement automatic correlation for pinpointing leaks to reduce leak runtimes.

And, to **Mend** leaks, we will implement a robust repair prioritisation, using customer impact and size of leak, and reduce disruption by continuing to seek out and implement 'no dig' and 'in pipe' repair techniques, as well as utilising temporary repairs for leak mitigation.

There are many considerations that we have made in the development of our leakage options, including:

- Balancing uncertain innovations with certainty and confidence, which we have achieved in the identification of feasible demand options with realistic deliverability constraints;
- Enabling efficiency in the longer term; a key part of this is our metering strategy; and

[38] A Leakage Routemap to 2050, WaterUK, 2022

- Intervention longevity and asset health; mains renewal done correctly leads to long-term improvements in performance and improves asset health[39], unlike other leakage reduction options such as network sensors, which require periodic replacement to be effective and do not improve asset health.

Options have been assessed using Water Resources West best value scoring aligns with our strategy. More detail on how these impact our plans can be found in Section 6.3 and Section 9.

6.2.3 Our consumption strategy

Our strategy has five key ‘pillars’ and seeks to reduce demand for water. The key pillars are:

- Boosting meter penetration;
- Consumption led interventions;
- Driving behavioural change;
- Addressing business usage; and
- Effective incentives for developers.

As part of this, we aim to maximise smart meter penetration and use the data from them to better understand customer usage and introduce targeted interventions, with increased personalisation and visualisation. We also aim to get retailers engaged and aligned to our objectives.

In the following sections, we detail the key elements of our consumption strategy and how they impact our demand management plan.

6.2.3.1 Per Capita Consumption (PCC) reduction

We have developed a metering strategy, which underpins our demand management plan in all of our zones. Not only does this strategy help us to identify and reduce leaks, as described in our leakage strategy, but it can encourage water efficiency and help to reduce PCC. More detail on our metering options can be found in Section 6.2.3.2 and in our *Technical Report – Options Identification*.

The smart element of our metering programme not only enables customers to understand their usage and to be more efficient, but also allows us to identify leaks more quickly and understand the type of leakage, whether customer side leakage or night-use.

Alongside our metering programme, we also have a number of other interventions forming our strategy for PCC reduction. It is part of our strategy to trial other water efficiency options such as rainwater harvesting and flow regulators, alongside water efficiency devices and household audits, which we have undertaken before. These options will be less effective without a metering programme, and we have found that the timing of these options can be key to meeting our targets. It is also important to note that we consider the benefits of options like these unlikely without interventions such as water labelling. More detail on water labelling can be found in Section 6.2.3.3.

6.2.3.2 Our household metering options

We have a created a number of metering options, which provide benefit to leakage and encourage water efficiency. Our metering options all involve the installation of smart meters and are split into three types:

(a) WR601: Enhanced metering of households (smart meters)

(b) WR603: Enhanced metering of households on single supplies (smart meters)

(c) WR619: Upgrade existing household meters to smart

(d) Options have been created for each water resource zone and for the Strategic Resource Zone a number of options have been made with varying programme length. The longer the programme length and the more benefit an option provides, the more it costs – as it relies on more meter installations. In particular, there is a large increase in cost between metering options WR603 to WR601, as WR601 includes households on

[39] Long-Term Performance of Plastic (PE) pipes, UKWIR, 2020.

common supply pipes. Linked to draft plan consultation feedback from Ofwat, we refined our metering costs and benefits for the revised draft plan. This led to a significantly lower unit cost, as measured in £/Ml/d saving.

(e) As a water company in an area not classed as 'water-stressed'[40], there is no capacity to compulsorily bill on a meter that has been installed. Billing can only occur on a meter where customers opt for this, or where a customer has moved into a property with a meter installed. Our metering options are based on proactive metering, which then allows us to bill on meters when customers move house. The water efficiency benefit of these options therefore takes time to grow, while the leakage benefit is immediate. This also means that our potential unit cost, as measured in £/Ml/d saving, is higher than for most companies.

(f) Achieving 100 per cent metering is difficult for other reasons too. In particular, around 20 per cent of properties in the North West are supplied through common supply pipes, making individual meters difficult and much more expensive to implement. Common supply pipes are where flats, apartments and other large, shared buildings are supplied through one main supply pipe, and there is no area in which to place an individual meter upstream of a property's supply. Occupants may choose to opt for a meter to be installed inside their home, however, some customers who have not already opted for a meter are unlikely to do so in the future during a proactive metering programme. Our full metering options currently assume relaying common supply pipes, however, this is not considered cost effective. In future, there may be a different more cost-effective approach to full metering, but we have built our current options on a present-day view of the world.

(g) Some other minor reasons which make 100 per cent metering difficult to achieve are voids and bulk meters, which introduce further complexity to metering programme.

(h) The options are structured to assume that 'full' metering occurs later in time.

(i) Our WR619 options (upgrading existing household meters to smart) are designed to replace meters at a rate of 50,000 meters per year. This aligns with the current asset life of the meters we have installed in recent years and allows us to be cost effective rather than prematurely replacing meters.

(j) In Table 19, we have also included technology options, which are denoted with 'Tech'. These form part of the technology scenarios, which are detailed in Section 5.2.3. These options are implemented at a different pace, with different scales of metering, however they are not considered feasible and do not align with our deliverability constraints. Incremental smart metering options are designed to meter those on common supply pipes only, and can only be selected once an option to meter households on single supplies has been selected.

Table 19 Smart metering options

Option ID	Option name	WRZ	Length of programme (years)	Household consumption reduction[41] (Ml/d)	Non-household consumption reduction (Ml/d)	Leakage reduction[41] (Ml/d)
WR601a	Enhanced metering of households (smart meters)	Carlisle RZ	10	1.0	0.0	0.4
WR601b	Enhanced metering of households (smart meters)	North Eden RZ	10	0.1	0.0	0.2
WR601c	Enhanced metering of households (smart meters)	Strategic RZ	10	23.7	0.0	15.7

[40] Water stressed areas – final classification 2021, Environment Agency, 1 July 2021.

[41] Estimated benefit at end of programme length. PCC benefits of some metering options are expected to grow following the programme completion. The true benefit of metering options should be measured and can vary.

Option ID	Option name	WRZ	Length of programme (years)	Household consumption reduction [41] (Ml/d)	Non-household consumption reduction (Ml/d)	Leakage reduction[41] (Ml/d)
WR601d	Enhanced metering of households (smart meters)	Strategic RZ	15	43.3	0.0	23.6
WR601e	Enhanced metering of households (smart meters)	Strategic RZ	15	43.3	0.0	23.6
WR601a_Tech	Enhanced metering of households (smart meters)	Carlisle RZ	10	1.0	0.0	0.4
WR601b_Tech	Enhanced metering of households (smart meters)	North Eden RZ	10	0.1	0.0	0.2
WR601c_Tech	Enhanced metering of households (smart meters)	Strategic RZ	10	41.3	0.0	26.7
WR601a_Incremental	Enhanced metering of households (smart meters)	Carlisle RZ	10	0.2	0.0	0.1
WR601b_Incremental	Enhanced metering of households (smart meters)	North Eden RZ	10	0.0	0.0	0.1
WR601c_Incremental	Enhanced metering of households (smart meters)	Strategic RZ	10	10.7	0.0	6.1
WR603a	Enhanced metering of households on single supplies (smart meters)	Carlisle RZ	5	0.6	0.0	0.3
WR603b	Enhanced metering of households on single supplies (smart meters)	North Eden RZ	5	0.1	0.0	0.2
WR603c	Enhanced metering of households on single supplies (smart meters)	Strategic RZ	5	9.3	0.0	7.9
WR603d	Enhanced metering of households on single supplies (smart meters)	Strategic RZ	10	24.0	0.0	15.7
WR603e	Enhanced metering of households on single supplies (smart meters)	Strategic RZ	15	40.1	0.0	20.3
WR615a	Replace existing non-household meters with smart meters	Carlisle RZ	5	0.0	0.1	0.1
WR615b	Replace existing non-household meters with smart meters	North Eden RZ	5	0.0	0.0	0.1
WR615c	Replace existing non-household meters with smart meters	Strategic RZ	5	0.0	7.3	3.1
WR619a	Replace existing household meters with smart meters	Carlisle RZ	10	0.2	0.0	0.0
WR619b	Replace existing household meters with smart meters	North Eden RZ	10	0.0	0.0	0.0

Option ID	Option name	WRZ	Length of programme (years)	Household consumption reduction [41] (Ml/d)	Non-household consumption reduction (Ml/d)	Leakage reduction[41] (Ml/d)
WR619c	Replace existing household meters with smart meters	Strategic RZ	10	10.2	0.0	0.0
WR619d	Replace existing household meters with smart meters	Strategic RZ	15	15.4	0.0	0.0
WR619a_Tech	Replace existing household meters with smart meters	Carlisle RZ	10	0.4	0.0	0.0
WR619b_Tech	Replace existing household meters with smart meters	North Eden RZ	10	0.1	0.0	0.0
WR619c_Tech	Replace existing household meters with smart meters	Strategic RZ	10	26.2	0.0	0.0

We have several ways to protect vulnerable customers who have a meter installed. An example of this is our 'lowest bill guarantee', which allows customers who have opted for a meter to revert back to their previous billing technique in the two years following meter installation. We also have tariffs such as 'WaterSure'[42], for customers who need to use lots of water and might struggle to afford bills while on a meter. This tariff puts a cap on how much these customers are charged. Customers can also apply for financial support with their bills Online[43]. Increasing our metering penetration also allows customers to influence their own bill, potentially reducing their bill where other billing practices might have resulted in a larger amount.

6.2.3.3 Reliance on government intervention

There are a number of measures that the government has identified to help reduce water consumption:

- Water labelling;
- Building new homes more water efficiently; and
- Minimum standards for products that consume water.

On 1st July 2021, the Department for Environment, Food and Rural Affairs (Defra) published a statement[44] announcing the intention to make regulations to introduce a mandatory water efficiency label to inform consumers and encourage the purchase of more water efficient products for both domestic and business use. Since the draft plan publication, the WRPG was also updated to direct water companies to include the benefits of water labelling from 2025.

Water labels allow customers to make informed choices about the water efficiency of the water-using products they buy. A mandatory water labelling scheme linked to minimum fittings standards has been in place in Australia since 2005, and such schemes have been deemed by Waterwise to be the single most cost-effective intervention that government could make to help reduce personal water use[45]. Labels set with minimum standards ensures that manufacturers develop more efficient products, and legislation would phase out lower rated products over time.

In the statement, Defra also announced the intention to write to local authorities, encouraging them to adopt the optional minimum building standard of 110 litres per person per day in all new builds where there is a clear local need, such as in water-stressed areas.

[42] Find out more about WaterSure here.

[43] Find out more about financial support with bills here.

[44] Reducing demand for water, George Eustice, July 2021.

[45] Why we need a Mandatory Water Label, Waterwise, 2019.

We are assuming that water labelling is introduced in 2025 (FY26) and that the benefits to reducing demand are in line with the Water UK study, Pathways to long-term PCC reduction[3] (in this case, water labelling is estimated to provide around 70 Ml/d worth of demand reduction by 2050, which equates to around 10 litres per person per day). As per the WRPG, we have also been cautious about the level of benefits realised in the first 5 years. We are also considering alternative scenarios in our adaptive plan, including the Ofwat scenarios from the guidance on long-term delivery strategies[35], such as the Ofwat low and high demand scenarios.

In the absence of the assumed benefits of water labelling, there are not enough feasible demand management options to reduce PCC to 110 l/p/d by 2050. If we implemented all of our most impactful demand management options straight away, we would only be able to stay on track to meet our targets until 2035.

At this point in time, the true impact of water labelling on the PCC of customers is unknown. It is important that we measure the impact of this intervention when implemented, in order to understand its effectiveness. This will be monitored as part of our adaptive plan in Section 11.7.2, in which we have set out what we would do in the case that it is not effective.

We are closely following government actions, but at this stage we are not assuming in the preferred pathway that building standards and minimum standards for products will be introduced before 2050.

6.2.3.4 Non-household strategy

We are including non-household smart metering and water audits as part of our demand strategy in Strategic RZ, as this helps us to meet the non-household demand target described in Section 1.2.1, and has been selected as part of our decision-making process (Section 3).

Following the publication of our draft plan and the feedback received through the consultation, including that from MOSL[46], in addition to our own research and ongoing internal reviews of our smart metering programme, we have included as part of our preferred plan the option to roll out smart metering to all metered non-household customers. Research undertaken by Artesia in April 2022[3] makes a strong case for enhanced metering technology for the benefit of non-household customers, water companies, retailers, and regulators. Alongside demand reduction benefits, the research identified a number of wider holistic benefits. Some examples of wider holistic benefits include, but are not limited to, improved non-household retail market service offerings, higher accuracy meter reading and billing, more effective information flows within the non-household retail market, and reduced meter read cost for retailers.

The scope our preferred non-household metering programme is to smart meter all non-households that are currently metered, which equates to roughly 90% of non-households. We will continue to assess the feasibility of smart metering the other 10%.

In addition to metering, we have found the option (WR677c Non-household water efficiency programme) to be a best value option. Not only do the financial cost savings of this option outweigh the cost expenditure over the whole life of the option, but the best value metric scores indicate it is a more beneficial option for environment and society. This option contributes to our non-household demand and distribution input targets as part of the Environmental Improvement Plan 2023.

6.3 Our demand plans

In the design of our demand plan, we have optimised our demand management strategy to achieve our targets glide paths in a best value way. We optimised PCC, non-household, leakage and total demand plans simultaneously to ensure we had selected the most effective metering options, which have benefits to PCC, leakage and distribution input reduction.

In each of our demand management plans, we have selected WR694 Water Labelling (with no minimum standards) in 2025 (FY26), as per our assumptions in Section 6.2.3.3.

[46] MOSL, https://mosl.co.uk/

6.3.1 Strategic Resource Zone demand plan

Table 20 shows our preferred (most likely) demand plan for the Strategic RZ. At the start of the planning period, we need to invest in large strategic demand programmes including metering and mains renewal to achieve not only our short-term AMP8 targets, but also the 2050 target.

We have selected WR603e, which meters all customers on single supply pipes. We have also selected WR619d to smart meter existing households. This is a change from the draft plan, where metering of common supply pipes also made up part of the demand plan. This is a hugely costly intervention which is no longer required when our assumptions on water labelling benefits are brought forward by 5 years. We have also explored other scenarios including minimum standards in our adaptive plan, detailed in Section 11.

To reduce PCC, we have also selected a wide range of water efficiency options, such as water efficiency audits for households and water efficiency devices (inside and outside). Alongside a metering strategy, these are effective options in reducing PCC and form a key part of our strategy on water efficiency. Water efficiency devices are options that are effective in the short term, i.e. in the few years after these devices are installed. The benefits of these options are predicted to deteriorate over time as the devices operate, becoming less effective or being replaced. In future, we may decide to implement this intervention again. Conversely, metering options are expected to grow in benefit after their programme length, due to customers moving into properties which are already metered. They are, therefore, better to implement earlier in the planning period to realise these benefits sooner.

Household water efficiency visits will be offered to customers where our data indicates high consumption or a potential leak. Customers will be sent communications informing them of their consumption and/or a potential leak. This will also contain a leaky loo strip to check for a leak in the toilet alongside information on how to fix any potential leaks. Where no customer action is evident we will offer the customer a water efficiency visit. The visit will identify and wherever possible fix leaking toilets, tap and showers, and where appropriate water saving devices will be installed and water efficiency advice will be given to the customer. Insight from our pilots has shown that savings are between 65-80 litres per property per day following a water efficiency visit. Water efficiency devices will be installed during a household water efficiency visit, as well as being available for customers to order when they register for Get Water Fit. Flow regulators will also be installed, which can reduce consumption by 3 per cent.

Non-household water efficiency visits will identify and where possible fix leaking toilets, taps, urinals and showers, where appropriate we may choose to fit water saving devices. Customer consumption will decrease meaning demand for water will be reduced benefiting the environment and reducing operational costs as less water is treated. The majority of our non-household customers are metered, so as consumption reduces they will benefit from a reduction in their water bill and a subsequent reduction in energy bills if heated water is used in their business.

We will work collaboratively with local councils and private or public developers to investigate the option of rainwater harvesting or re-use in new housing developments. This work will enable us to understand the current blockers to wide scale adoption of rainwater harvesting systems in new builds and ways to overcome them, thereby informing investment plans for future AMPs.

This metering programme is also designed to help us understand leakage in our network and locate leaks. We have included other options to reduce leakage such as upstream tile optimisation, DMA optimisation, permanent network sensors and pressure management. Our leakage programme aligns with our strategy to ensure longevity in our leakage reduction and improve asset health over the long-term. We are, therefore, investing throughout the planning period in a mains renewal programme alongside in-pipe repairs and technologies.

As discussed in Section 6.2.3.4, we have also included a metering programme for non-households.

Table 20 Preferred (most likely) demand plan in Strategic RZ

Option ID	Option name	Year of selection [47]	Capacity (Ml/d)	Best value cost (£ million NPV)	Financial cost (£ million NPV)[48]
WR502c	Permanent network sensors	2035	20.0	215.3	244.4
WR510	In-pipe repairs and lining technologies	2026	4.5	-19.9	4.0
WR511g	Pressure management	2049	1.0	5.6	13.0
WR520c	DMA optimisation	2030	2.0	-1.7	9.1
WR524d	Upstream tile optimisation	2027	5.8	12.5	33.7
WR619c	Replace existing household meters with smart meters	2026	10.2	-4.1	39.0
WR658c	Free water efficiency devices (inside/internal)	2026	4.6	-20.8	1.7
WR661c	Free water efficiency visits (households)	2026	13.0	-5.8	9.1
WR677c	Non-household water efficiency programme	2026	12.9	-21.9	6.2
WR694f	Government intervention (e.g. water labelling)	2026	36.3	-54.5	-6.3
WR659c	Free water efficiency devices (outside/external)	2026	4.0	-3.9	10.3
WR603e	Enhanced metering of households on single supplies (smart meters)	2026	60.5	469.6	572.8
WR516h1	Mains rehabilitation/renewal/replacement	2026	49.1	160.5	191.1
WR516h2	Mains rehabilitation/renewal/replacement	2037	50.8	265.8	271.9
WR615c	Replace existing non-household meters with smart meters	2026	10.4	-14.8	18.5

We have, therefore, optimised the selection of options to meet our reduction glide paths and targets. Our optimised demand plan, an output of ValueStream and decided using our best value metrics, encompasses the strategy that we detailed in Section 6.1. This demonstrates that the Water Resources West metrics validate our strategy as a cost-effective and best value approach to reducing demand.

6.3.2 Carlisle Resource Zone (Carlisle RZ) demand plan

We have optimised the selection of options in Carlisle RZ to meet our targets.

Flow regulators and rainwater harvesting are selected as a best value option in Carlisle RZ, forming some of our pilots to understand the benefits of these interventions. More information on these pilots can be found in our *Technical Report – Options Identification*.

We also use all of the options in our leakage strategy to achieve our leakage target. The metering programme provides a large benefit to our ability to locate leaks from the start of the planning period, and the later part of

[47] Year of selection is financial year for non-transfer options (i.e. where a demand option is selected in 2026, this refers to FY26 and therefore considers the period from April 2025 to March 2026).

[48] Financial costs include optimism bias in accordance with the WRPG and where applicable are discounted based on the option start year.

our leakage reduction is achieved through mains renewal. This option will enhance our asset health and provide long-term leakage reduction.

Table 21 Preferred (most likely) demand plan in Carlisle RZ

Option ID	Option name	Year of selection[47]	Capacity (Ml/d)	Best value cost (£ million NPV)	Financial cost (£ million NPV)[48]
WR502a	Permanent network sensors	2029	0.5	4.7	8.4
WR511a	Pressure management	2026	0.1	-1.2	3.9
WR520a	DMA optimisation	2027	0.5	0.5	4.9
WR603a	Enhanced metering of households on single supplies (smart meters)	2026	0.8	8.3	17.8
WR619a	Replace existing household meters with smart meters	2026	0.2	-1.2	0.6
WR658a	Free water efficiency devices (inside/internal)	2026	0.1	-3.9	0.0
WR661a	Free water efficiency visits (households)	2028	0.3	-3.5	0.2
WR677a	Non-household water efficiency programme	2026	0.4	-4.6	0.2
WR685a	Rainwater harvesting and water reuse (new builds)	2026	0.1	-1.2	2.5
WR694d	Government intervention (e.g. water labelling)	2026	0.6	-11.6	-0.2
WR659a	Free water efficiency devices (outside/external)	2048	0.1	0.0	0.1
WR669b	Flow regulators	2026	0.1	-4.6	0.1
WR516a1	Mains rehabilitation/renewal/replacement	2038	1.2	11.8	12.7
WR615a	Replace existing non-household meters with smart meters	2026	0.2	0.3	0.5

6.3.3 North Eden Resource Zone demand plan

We have put together a company metering strategy which allows us to understand leakage and consumption in all of our zones and contributes to leakage reduction in North Eden RZ. The metering options selected also provide a benefit to reducing consumption, and this results in a reduction in per capita consumption in this zone. In alignment with the assumptions in our other WRZs, we have included the benefits of government intervention through water labelling.

North Eden RZ received a 'simple' problem characterisation score, therefore, we did not apply the decision support tool to optimise the selection of options in this zone.

Table 22 Preferred (most likely) demand plan in North Eden RZ

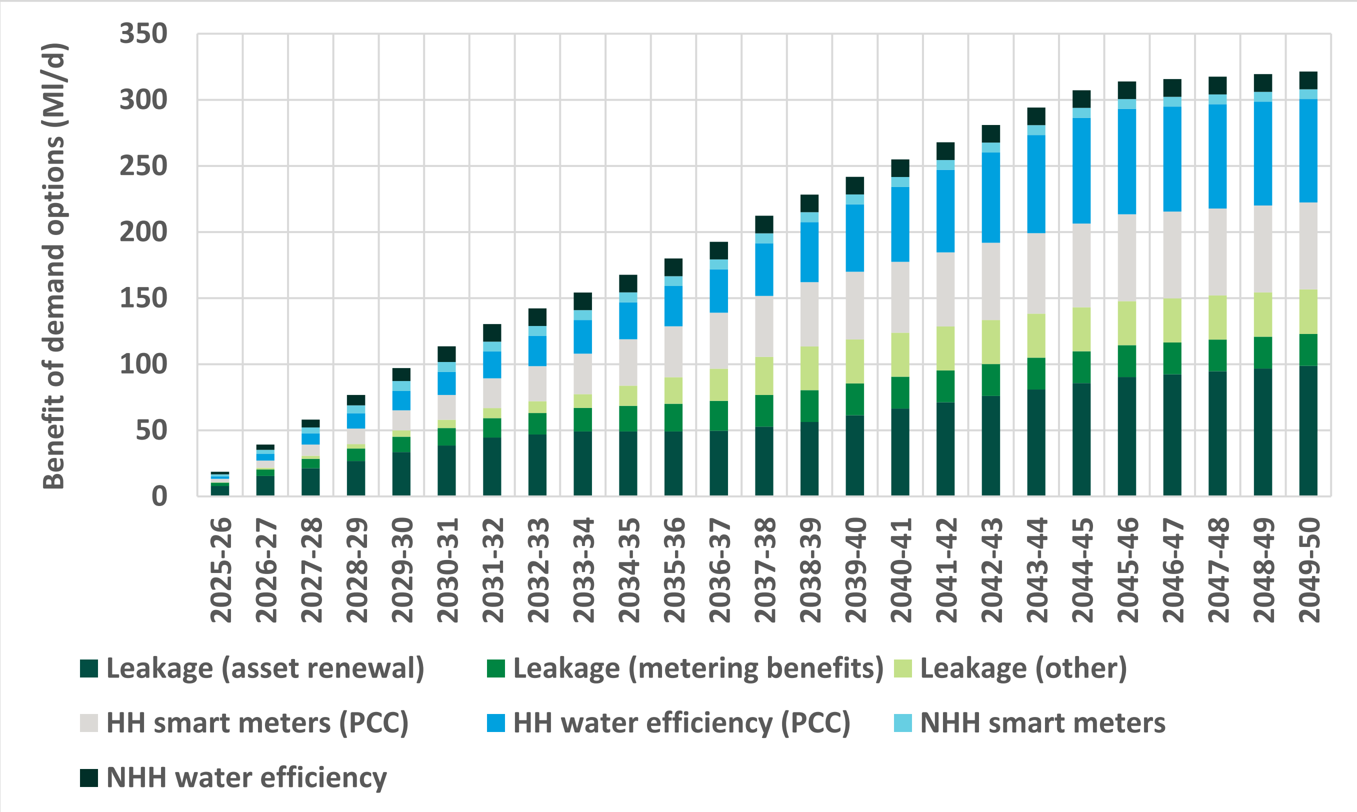
Option ID	Option name	Year of selection47	Capacity (Ml/d)	Best value cost (£ million NPV)	Financial cost (£ million NPV)48
WR603b	Enhanced metering of households on single supplies (smart meters)	2026	0.3	1.6	2.0
WR619b	Replace existing household meters with smart meters	2026	0.0	-1.5	0.1

Option ID	Option name	Year of selection47	Capacity (Ml/d)	Best value cost (£ million NPV)	Financial cost (£ million NPV)48
WR694e	Government intervention (e.g. water labelling)	2026	0.1	-3.8	0.0
WR615b	Replace existing non-household meters with smart meters	2026	0.1	-0.2	0.1

6.3.4 Our overall demand plan

Figure 10 shows the breakdown of different demand reduction categories in our revised draft demand plan, profiled across the planning period. The following sections detail how the plans look for each water resource zone.

Figure 10 Categorised benefits of demand reduction options



The following figures detail the resulting profiles of demand reduction in our preferred (most likely) plan. Sharp changes in non-household demand and per capita consumption in 2020-21 are impacts of COVID-19.

Figure 11 Leakage reduction as a result of our preferred (most likely) plan

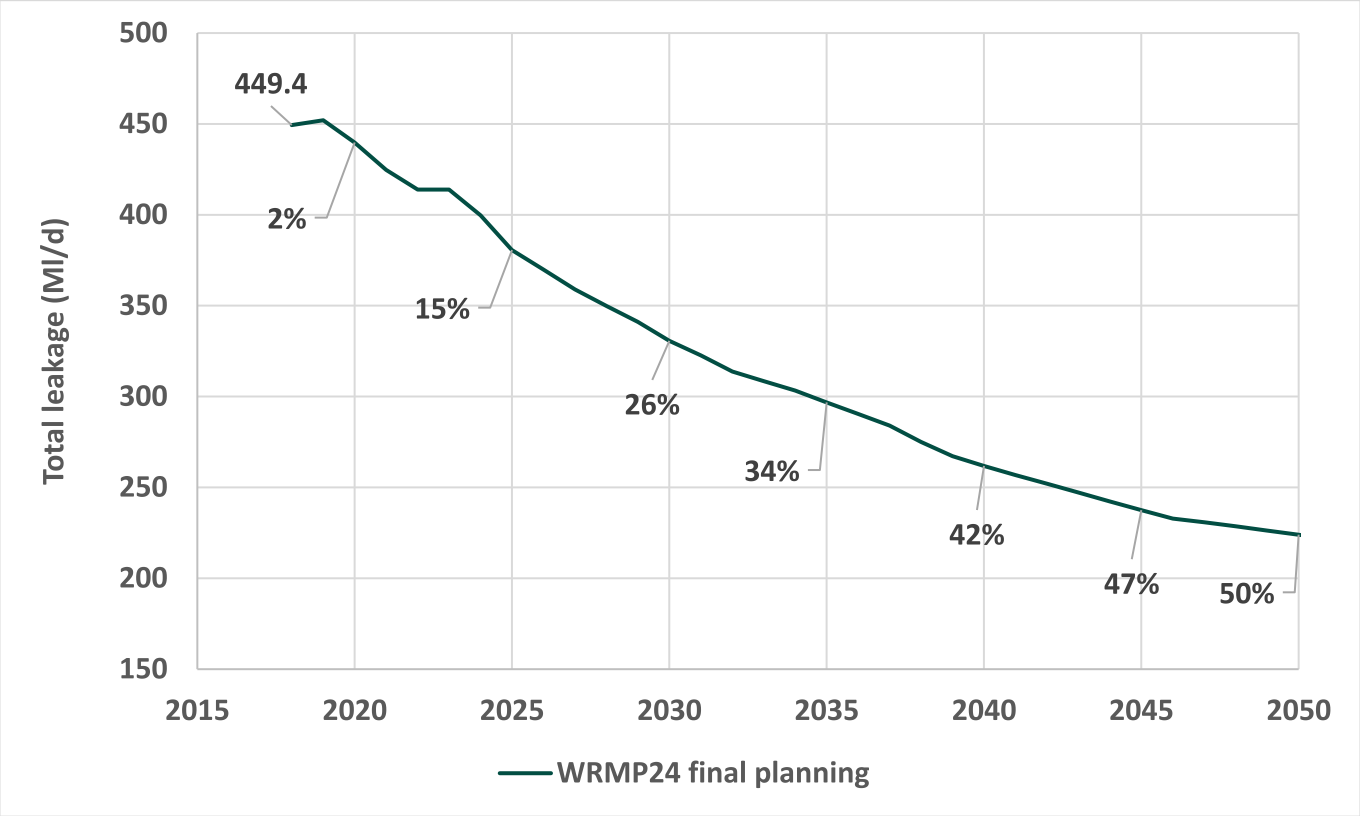


Figure 12 Non-household demand reduction as a result of our preferred (most likely) plan

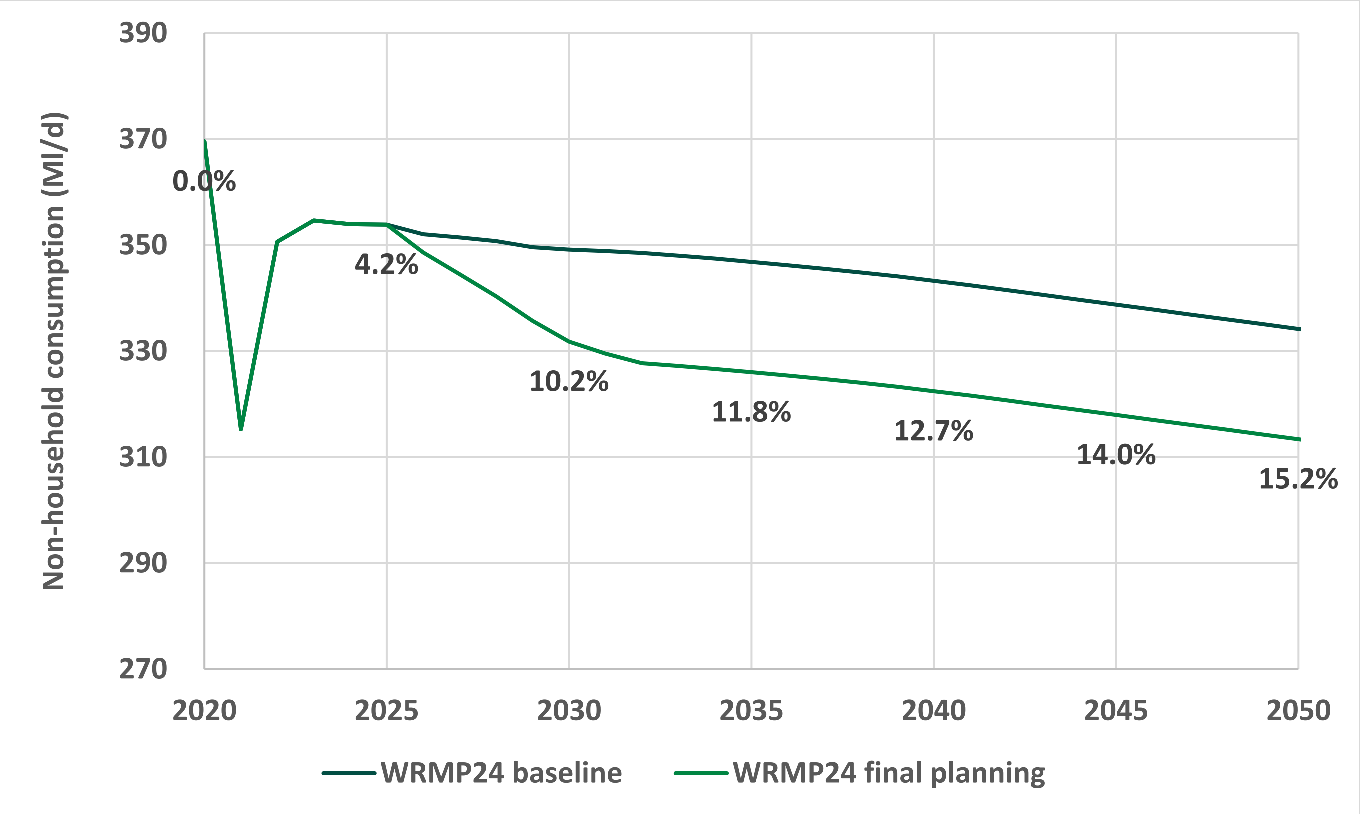
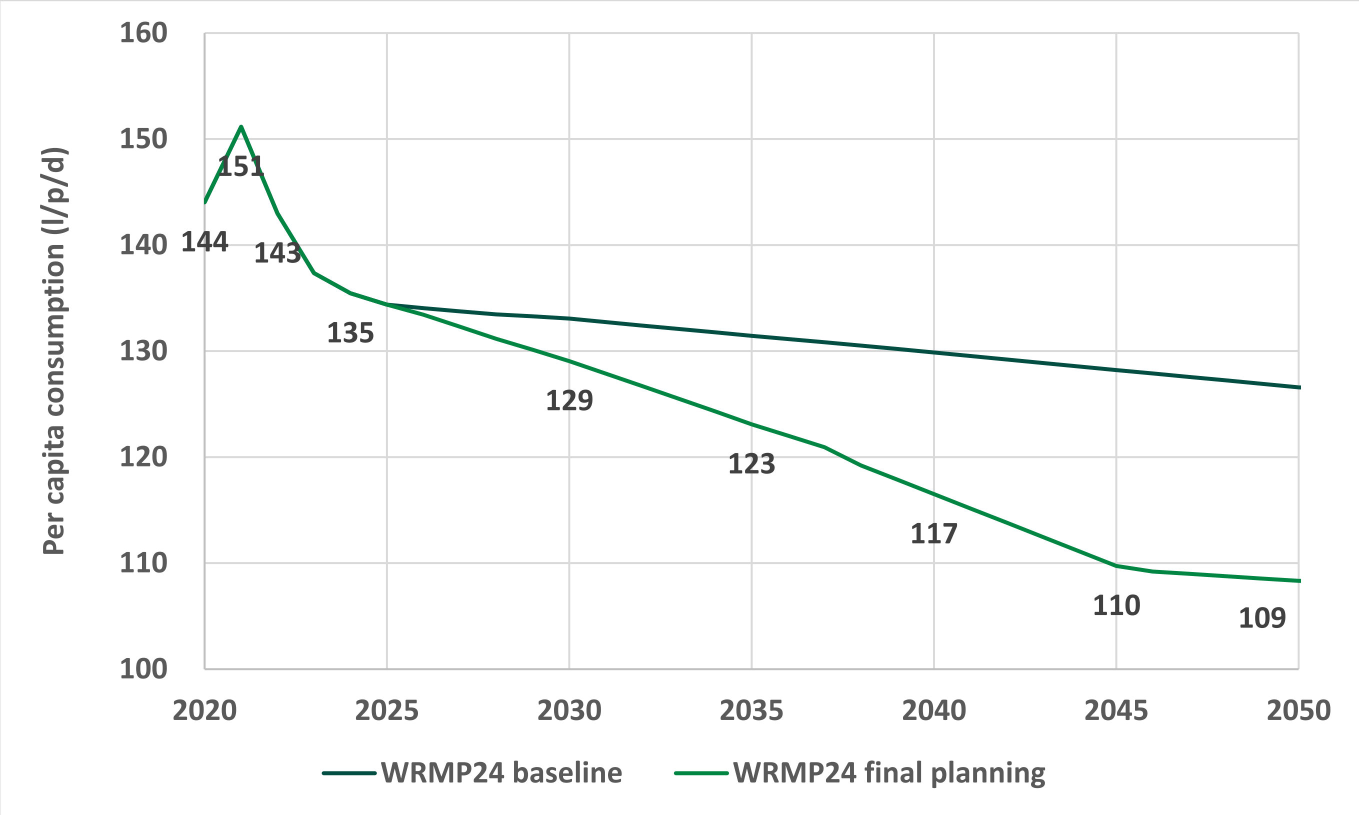


Figure 13 Per capita consumption as a result of our preferred (most likely) plan



7. Our preferred (most likely) supply plan

7.1 Supply-demand position post-demand management

Following the optimisation of our demand management plan against demand targets, we re-evaluated our baseline supply-demand position using the demand benefit of the options in each year of the planning period according to their year of selection.

7.2 Temporary use bans level of service improvement

As detailed in Section 4 and in the *Technical Report - Customer and stakeholder engagement*, during our customer choice experiment, we identified strong support for improving the level of service for TUBs from a five percent annual chance (no more than once in 20 years on average) to a 2.5 per cent annual chance (no more than once in 40 years on average).

Delivering an improved level of service for TUBs essentially involves implementing new options to increase supply or reduce demand, so that we are less likely to need to resort to restrictions. We calculated the requirement in Ml/d by comparing the DO of the resource zone with a frequency of 1 in 20 and 1 in 40 years TUBs implementation, as explained in the *Technical Report – Supply Forecast*. We then accounted for the benefit of options already needed to deliver our demand reduction targets. All of our levels of service are stated at company level, however all resource zones apart from the Strategic Resource Zone are already capable of providing a 1 in 40 year level of service for TUBs. Therefore, this strategic choice relates to the Strategic Resource Zone.

At the time we developed the customer choice experiment, relatively early in the WRMP process, the estimated average annual bill impact of delivering the improvement was £1.90. The average willingness to pay for the improved level of service (1 in 40) was £6.04 and 60% of customers would be willing to pay £4.75. These values therefore far exceeded the cost and provided a clear signal to proceed. In final acceptability testing (Section 10.9) the willingness to pay for 1 in 40 year (2.5 per cent annual chance) TUBs was inferred from the overall willingness to pay for the preferred plan. Despite being combined with the bill impact of our other strategic choices, the willingness to pay for the TUBs improvement remained fairly stable at £4.55.

We received consultation feedback from the Environment Agency requesting that we implement the change in TUBs level of service from 1 in 20 to 1 in 40 years as an option. In the draft plan we only included options that improved the supply-demand balance. This change, however, deteriorates the supply-demand balance by 100 Ml/d and requires the selection of others options to mitigate the impact.

In order to satisfy this request and determine if the TUBs improvement should form part of our preferred plan, we undertook the following steps:

(1) Created a feasible option to represent a 1 in 20 to 1 in 40 year TUBs level of service improvement; option ID WR749;

(2) Set the deployable output benefit to the volume of water required to halve the frequency of TUBs from 1 in 20 to 1 in 40 years (-100 Ml/d);

(3) Defined a cost profile based on annualised customer willingness to pay values multiplied by forecast property numbers. The costs were entered as negative values, reflecting the amount customers are willing to pay for the change;

(4) Ran our optimiser ValueStream to test if the option was selected, based on the principle that it could select other options to address the impact on the supply demand balance within the cost that customers are willing to pay; and

(5) Once ValueStream confirmed this to be the case, incorporated the option into the preferred plan.

We have carried out sensitivity testing to determine the optimum timing for achieving this level of service improvement. The sensitivity testing is detailed in Section 10; in which it was determined that 2031 is the optimum year to improve resilience to TUBs, providing benefit to customers in reasonable time at a reasonable cost.

7.3 Drought permits

Similar to the TUBs improvement option (Section 7.2), we also received consultation feedback from the Environment Agency requesting we assess our drought permits as options using our best value approach. Conceptually, drought permits fit into our approach much more readily than the TUBs improvement. We therefore undertook the following steps:

(1) Further developed the 14 feasible options already included in the draft plan (inclusion based on their assessment and selection in our 2022 Drought Plan);

(2) Derived an annual cost profile based on known and estimated drought permit application and implementation costs, as well as the estimated average duration of implementation (section 5.3 of the *Technical Report – Options Identification)*;

(3) Derived best value metric data using the 2022 Drought Plan Strategic Environmental Assessment (SEA) for the environmental metrics;

(4) Set the deployable output benefits based on water resources modelling already completed for the draft plan; and

(5) Used ValueStream to test if they would be selected ahead of other WRMP options as part of the best value plan. All 14 options were selected and incorporated into the preferred plan.

7.4 Transfer portfolios and impacts

7.4.1 Transfer portfolios

As part of the NWT SRO RAPID process, United Utilities Water selected ‘sub-options’ to mitigate the impacts of transfer. The three alternative portfolios generated are shown in Table 23. At the time of the assessment, groundwater bodies containing several sub-options were subject to investigation under the WINEP programme (i.e. linked to our current abstractions in these locations), with a corresponding risk to aquifer supply availability. Therefore, the first two portfolios followed the system simulation process to generate the most optimal solutions, but with and without the WINEP-affected options made available. The third portfolio explored the inclusion of the Kielder transfer from the Water Resources North (WReN) region. This is a large 100 Ml/d transfer that would provide significant benefits in terms of improving national drought resilience and utilising an underused asset. However, it is an expensive scheme with some environmental challenges to overcome related to the pipeline route.

Table 23 Alternative portfolios in best value assessment (excluding enabling works)

Portfolio	Description	Options for 180 Ml/d transfer	80-year NPV financial cost (£ million)[49]	80-year NPV best value cost* (£ million)	Outcome
A	Most optimal portfolio including WINEP sub-options	WR107b GWE_RANDLES BRIDGE WR144 SWN_RIVER TAME WR015 SWN_RIVER IRWELL WR102b GWE_WIDNES WR153 ITC_WEST CHESHIRE 1 WR107a2 GWE_AUGHTON PARK a2 WR049d SWN_RIVER RIBBLE 49d WR154 ITC_WEST CHESHIRE 2 WR111 GWE_WOODFORD WR149 ITC_WIGAN	1,002	1,779	Discounted due to WINEP conclusions
B	Most optimal portfolio excluding WINEP sub-options	WR107b GWE_RANDLES BRIDGE WR015 SWN_RIVER IRWELL WR102b GWE_WIDNES WR107a2 GWE_AUGHTON PARK a2 WR113 GWE_TYTHERINGTON WR076 SWN_RIVER BOLLIN WR111 GWE_WOODFORD WR049d SWN_RIVER RIBBLE 49d WR149 ITC_WIGAN	1,071	1,883	Gate 2 proposed full solution
C	Kielder-based	WR107a2 GWE_AUGHTON PARK a2 WR144 SWN_RIVER TAME WR015 SWN_RIVER IRWELL WR113 GWE_TYTHERINGTON WR111 GWE_WOODFORD WR812c WIT_THIRD PARTY_6c	2,317	3,769	Retained as a potential alternative solution

*A lower best value cost denotes higher value (our optimisation minimises cost).

In addition to being the most optimal solution discovered by system simulation, Portfolio A also represented the ‘least cost’ and ‘best value’ solution according to the Water Resources West metrics. However, Portfolio B, which removes the WINEP risk, was within five per cent of Portfolio A in terms of financial cost and six per cent in terms of best value. Portfolio C was significantly more expensive and lower best value (i.e. higher cost), hence would need to be promoted on the basis of factors not already explicitly included in our best value approach.

Subsequent to this assessment, the WINEP studies concluded that no further water would likely be available for the east of Cheshire sub-options, thereby rendering Portfolio A infeasible. Several other NWT sub-options were rejected for the same reason but had not been selected by system simulation. Portfolio B was progressed as the proposed full solution and Portfolio C retained as an alternative solution for future adaptive planning.

At draft plan, WR149 ITC_WIGAN was included within portfolios A and B. However, this option has subsequently been discounted from both portfolios. This was due to concerns regarding water quality deterioration in the wider groundwater unit, difficult to treat water quality issues and limited water availability.

[49] Costs were correct at the time of the assessment and include the options which are no longer feasible.

7.4.2 Transfer plan and impacts on the water network

The options in Portfolio B were subsequently scheduled according to the transfer requirements for the reconciled plan, which is explained in more detail in Section 5.2.4.1. The principal metric used was production capacity, as defined by the NWT SRO system simulation exercise (Section 2.3.1). This 'non-aggregated' type of approach[14] (UKWIR, 2016) which focuses on capacity inputs into the supply system, rather than DO. System simulation defined the overall production capacity requirement of 167.5 Ml/d for the full 205 Ml/d solution.

Unfortunately, there was insufficient time after regional reconciliation to select sub-options or determine production capacity requirements for each transfer amount requested during the planning period. Therefore, we calculated the proportional production capacity requirement (*transfer amount requested / 205[50] x 167.5*) for each transfer, and this was input as a time series into ValueStream. The tool then optimised the selection of transfer sub-options for each incremental transfer amount in the planning period, based on capacity need and sub-option capacity. At the end of the decision making process for the draft plan, we undertook system simulation-based portfolio testing using Pywr to close the loop and ensure that the transfer sub-options selected by ValueStream at each stage of the planning period provided the necessary protection. More details on the portfolio testing are provided in Section 10.8.

Transfers strongly interact with our other strategic needs and supply-demand balances. Therefore, we calculated the DO impact of each transfer in the planning period. For this we used our Pywr model, our full stochastic hydrological dataset and utilisation time series provided by transfer recipients to generate DO impacts for all DO metrics (1 in 20 and 1 in 40 years TUBs; and 1 in 200 and 1 in 500 years EDO). As part of the same exercise, we also calculated the conjunctive resource zone DO benefit of the transfer sub-options as a group, with transfers occurring.

This approach allowed us to very accurately reflect the effects of transfers in our supply-demand balances. In particular, it meant we could account for the effects of transfers when selecting the options to deliver the improvement to our TUBs level of service (Section 7.2). Ultimately, this led to us being able to deliver 1 in 40 TUBs much more cost effectively.

7.5 Combining the drivers to develop a preferred (most-likely) plan

Our baseline supply-demand balances along with transfer impacts and capacity requirements were fed into the decision support tool, ValueStream, as constraints. A schedule of options was optimised using ValueStream and the preferred plan was determined following programme appraisal and a number of sensitivity tests. More detail on these tests, their results and how they influenced the decision on the preferred plan can be found in Section 9 and 10. Having determined the optimum timing in sensitivity testing, the supply-demand balance for a 2.5 per cent annual chance of TUBs was therefore only added as a constraint from 2031.

The analysis resulted in the following option selection for supply, meeting transfer needs.

Table 24 Preferred (most likely) plan options

Option ID	Option name	Year in use (providing Ml/d benefit)[37,47]
WR107a2	GWE_AUGHTON PARK a2	2030
WR111	GWE_WOODFORD	2030
WR113	GWE_TYTHERINGTON	2030
WR167	DPS_DELPH	2026
WR168	DPS_DOVESTONE	2026
WR169	DPS_JUMBLES	2026
WR170	DPS_LONGDENDALE	2026

[50] 205 Ml/d is the original maximum transfer capacity of NWT. This proportion was determined on that basis and applied to the full 180 Ml/d transfer when the amount was reduced.

Option ID	Option name	Year in use (providing Ml/d benefit)[37,47]
WR171	DPS_RIVER LUNE	2026
WR172	DPS_RIVINGTON 1	2026
WR173	DPS_RIVINGTON 2	2026
WR174	DPS_ULLSWATER	2026
WR175	DPS_VYRNWY	2026
WR176	DPS_WINDERMERE	2026
WR179a	DPS_TARN WOOD	2026
WR179b	DPS_BOWSCAR	2026
WR179c	DPS_GAMBLESBY	2026
WR184	DPS_FERNILEE	2026
WR749	LOS_TUBs 1:20 to 1:40	2031

7.5.1 Detail on our preferred transfer options

Table 24 shows our preferred (most likely) supply plan for the region. All three supply options are groundwater enhancement options, for use in water transfers, and other options are selected drought permit or TUBs improvement options.

We have selected WR107a2, which involves commissioning two existing boreholes in north Liverpool to give 10 Ml/d benefit to the network. The scheme will also involve the transfer of water to the nearby water treatment works (WTW), which will have an increased capacity and modified treatment process in order to provide water to customers in the area. This option will cost £48.7m (80 year NPV).

Option WR111 is located in south Manchester and would involve increased groundwater abstraction from the Manchester and East Chester Permo-Triassic Sandstone aquifers. A new WTW would blend water into existing storage and would deliver 9 Ml/d into the water network. This option will cost £40.6m (80 year NPV).

Finally, option WR113 would involve the replacement of the existing water main to allow additional water to be transferred to existing treated water storage. The benefit of this option to the network is 3 Ml/d and it will cost £14.2m (80 year NPV).

Table 25 Expected benefit of supply options based on modelling carried out in Pywr in July 2022

		Expected benefit (Ml/d)			
Option ID	Option name	1:20	1:40	1:200	1:500
WR107a2	GWE_AUGHTON PARK a2	6.1	5.6	3.6	2.0
WR111	GWE_WOODFORD	5.5	5.0	3.3	1.8
WR113	GWE_TYTHERINGTON	1.8	1.7	1.1	0.6

Further detail on our supply options and how they impact environment and society relative to other options can be found in Section 9.

In addition to these three supply options and the TUBs level of service improvement, Table 24 shows our drought permit options. More detail on these options can be found in our 2022 Drought Plan[51].

[51] Drought Plan 2022

7.6 Catchment-based solutions

United Utilities Water is reliant on the natural ecosystems of the North West to provide a resilient water and wastewater service to customers. The natural environment and ecosystem services are under increasing pressure from demographic change and climate change, which is driving the need for us all to do more to protect and enhance nature. Through the delivery of the ground-breaking 'Sustainable Catchment Management Programme' (SCaMP) United Utilities Water is recognised within the UK water industry as being at the forefront of catchment management, which aims at securing multiple benefits at a landscape scale.

As the largest corporate landowner, with over 47,000 hectares of catchment land, we have always understood and embraced the importance and duty of catchment management for the protection of water quality. Approximately 30% of water supplied by us comes from these catchment sources. The remaining 70% comes from 550,000 hectares of catchment land that is owned and managed by others. We have built on our leading catchment management approach (Sustainable Catchment Management Programme (SCaMP)), which we have continued to develop through Catchment Systems Thinking (CaST) and place-based planning, which we expand on below.

The resilience and health of catchments in the North West is critical to the delivery of water services. However, catchments also offer much more in services to society; they hold water and slow the flow to reduce flooding, provide land for access and recreation as well as benefits to human health, they intercept pollutants in the air, land and water environments, they are a significant carbon sink and sustain biodiversity. As a result we have a Catchment Systems Thinking (CaST) approach which looks at the whole catchment system and aligns interests across UUW services and beyond to identify interventions in the catchments, both urban and rural, that can be aligned to meet the needs of stakeholders.

We believe land management is a crucial part of the water supply cycle and its effective management is important for the protection of water resources. We will therefore continue to own and manage a significant land holding to continue protecting water quality and to enable us to react appropriately to the emergence of new threats, for example the increasing prevalence of problematic organic compounds. Managing water can be complex and involves multiple agencies; we are aware that the challenges of the future cannot be met through the actions of individual organisations alone. Strong partnerships and collaboration between organisations are required to deliver a more resilient future. Core stakeholders include the Environment Agency, Natural England, Natural Resources Wales, local councils, Rivers Trusts, Wildlife Trusts, communities and other landowners. This collaboration will be driven by pilots of place-based planning in priority areas, where there is significant potential to work more closely with stakeholders.

Climate change poses a risk to long-term resilience of our catchments and public water supply. Customers expect us to take a proactive approach to tackling it. We recognise that climate change and nature recovery cannot be addressed in organisational silos, therefore, partnership working will support cost effective investment and planning within local areas. Place-based planning will help to diversify solutions to include a combination of traditional hard engineering approaches, nature-based solutions and behavioural change initiatives. Together, these will help to safeguard water resources for future generations.

During our current business plan period 2020–2025, we are trialling place-based planning within the Eden, Wyre and Upper Mersey catchments.

Place-based planning will help to support the delivery of our Catchment Systems Thinking (CaST) approach. By working with local authorities and planning agencies, we will be better equipped to manage water close to where it falls and tackle issues at source. This will allow us to extend the work completed through the Wyre Natural Flood Management project, for example, to tackle the challenge of pesticide use within the Wyre catchment. Existing monitoring currently in place identifies deteriorating water quality with regard to pesticides, *E.coli*, coliforms and ammonia, which can be linked to human and agricultural activity. We work to reduce the raw water challenges, such as pesticides, whilst maintaining a multi-barrier approach so we are not solely reliant on one treatment stage. Place-based planning, therefore, has the opportunity to improve these interactions with the environment to improve water quality and, if water quality is satisfactory and can be treated, provide benefit for water resources.

We will keep each catchment under review to target our response based on the risk presented by the catchment and to minimise the need for future capital investment in additional stages of water treatment. A significant focus of our planned work on catchment over the next 25 years and beyond will be to deliver “Natural Resilience”. The concept is to protect our valuable water resources to enable them to withstand extreme weather events and the impact of climate change.

One of the main lessons learned from the more frequently occurring storms experienced in the last five years is the susceptibility of upland catchment systems to significant high consequence but infrequent storm events. For instance, the 2015 storm named Desmond, which at Thirlmere had a return rate of approximately 1 in 11,000 years, caused significant damage to the catchment. This resulted in a significant deterioration in raw water quality, which exceeded the treatment envelope of the water treatment works (WTW) and resulted in a net reduction in the resilience of supply to customers. The net consequence caused by these types of events appears to be increasing. To address this issue we have reviewed the resilience of our catchments and will undertake work over the next 25 years and beyond to improve catchment resilience to these types of events.

Our first catchment resilience scheme was at Thirlmere, chosen due to its regional significance and susceptibility, caused by historic land management practices. Supported at PR19 by DWI, Environment Agency and Natural England, the work being delivered in the period 2020-2025 demonstrates our approach to catchment systems thinking, supported by our previous successful approach of partnership working across water catchments. Co-created with stakeholders, the overarching purpose is to restore natural processes to improve the resilient functioning of the catchment hydrology and vegetation.

Since 2020 we have kick-started long-term activity in the 4,000 hectare catchment in Cumbria including but not limited to:

- Catchment intervention and management;
- Forestry and Woodland Management;
- Farming and tenancy; and
- Geomorphological and hydrological studies.

Through the Water Industry National Environment Programme (WINEP) we will continue to work with partners to raise awareness of water quality and support measures to reduce risk and improve resilience within catchment safeguard zones. Supported by the WINEP, if approved through the PR24 process, by 2030 we will deliver a second phase of catchment resilience schemes related to improving the condition of habitat on our land holdings at Thirlmere, Haweswater, West Pennine Moors, Bowland Fells and South Pennine Moors. This will help to improve raw water quality in the long-term by restoring the underlying ecosystems and natural processes, building on the legacy of long-term catchment management delivered at these sites since 2005. We will go beyond the extent of our land holding to deliver catchment resilience schemes in Cumbria and Lancashire working in partnership with stakeholders at a landscape scale in the Lune (Lancaster), Wyre (Franklaw) Eden (Castle Carrock and Cumwhinton), Upper Duddon (Ulpha) and Poaka Beck catchments to improve habitat condition and hence the long-term resilience of water resources.

In the National Environment Programme for Wales (NEP) we have committed to working in partnership with other water companies and stakeholders in the River Dee catchment. We will implement the recommendations of our 2020-2022 turbidity investigation by delivering nature based solutions to reduce erosion in the highest priority areas. Contributions from partners will enable this project to deliver multiple benefits by combining our efforts to engage with farmers and land owners in the catchment to improve the resilience of the Dee catchment to the effects of extreme weather events and turbidity.

Beyond 2050, we expect the investment in catchment management to provide benefits, as the restored ecosystems become fully functioning and producing high quality raw water. In line with Defra’s 25 year Environment Plan, we will develop Natural Capital Accounting and outcomes based approach to agri-environment funding to provide opportunities to support those managing our catchments for water quality, benefitting customers and other stakeholders. We will continue to work with environmental regulators to develop the existing Water Industry National Environment Programme and include relevant aspects within our plan.

As there is limited evidence about the benefits of nature based solutions for additional deployable output (Ml/d), through the WINEP we have proposed four investigations related to the management of sensitive habitats in the catchment associated with our abstractions; namely at Grizedale Brook and Tarnbrook Wyre. We will work with partners such as the Wyre Rivers Trust to understand the costs and benefits associated with the use of nature based solutions (e.g. riparian planting) at these specific locations, specifically with regard to their ability to provide additional deployable output.

We will also be looking at the water resources benefit of sediment management and habitat improvement overall in the catchment, linked to other initiatives going on by UU and third parties such as the Wyre Natural Flood Management programme. Another area where there is a knowledge gap is around the impact of the Lune transfer on the Wyre and we will be investigating the impact on fish populations.

Over time, we will commit to repeating the methodology in other catchments according to the priority agreed. For United Utilities Water, this will align with our other two strategic catchments; Upper Mersey and Eden. As the catchment investigations will not deliver a benefit in terms of additional deployable output (Ml/d), therefore, they will be included in the PR24 programme build as WINEP driven activities, rather than WRMP activities.

8. Environmental assessment

Environmental assessment is crucial to the Water Resources Management Plan (WRMP) process, both in terms of choosing the right options and ensuring that our proposed overall preferred plan protects, and where possible improves, the environment. Four key assessments were completed as part of the WRMP process:

- Strategic Environmental Assessment (SEA);
- Habitats Regulations Assessment (HRA);
- Water Framework Directive (WFD) assessment; and
- Invasive Non-Native Species (INNS) assessment.

Full reports are published for the SEA, HRA and WFD assessments alongside our revised draft plan. It is important to note that these assessments form part of an ongoing process and the WRMP is a step along the way. Preferred option scopes are refined over time to eliminate or mitigate potential risks. It is therefore normal for risks to be present at this stage, and where this is the case we need to ensure the necessary steps are in place to resolve them. We have also identified alternative options should the development of certain options become infeasible.

All the supply options in our preferred plan form part of the North West Transfer (NWT) Strategic Resource Option (SRO). The environmental compliance assessments, and the supporting investigations, are ongoing with the outcomes available to inform the RAPID Gate 3 submission in 2024. In consequence, these findings have not been available in time for the revised draft plan.

Overall, the revised draft plan is expected to generate significant positive effects across several of the SEA objectives including climate change, economy, health and well-being and water resources as the provision of 22 Ml/d of water from new supply options and 291 Ml/d from the demand management, efficiency and leakage measures will improve resilience and adaptability to the effects of climate change, support population and economic growth, contribute towards maintaining health and aid sustainable water resource provision.

For one of the three groundwater abstractions options, there is the potential to result in deterioration of WFD status or prevention of achievement of WFD target status of waterbodies. However, the confidence assigned in the WFD assessment to this conclusion is medium, pending the update of the regional groundwater model later in 2023. Whilst such conclusions are provisional, they do indicate that the proposed supply options carry an element of environmental compliance risk at this stage.

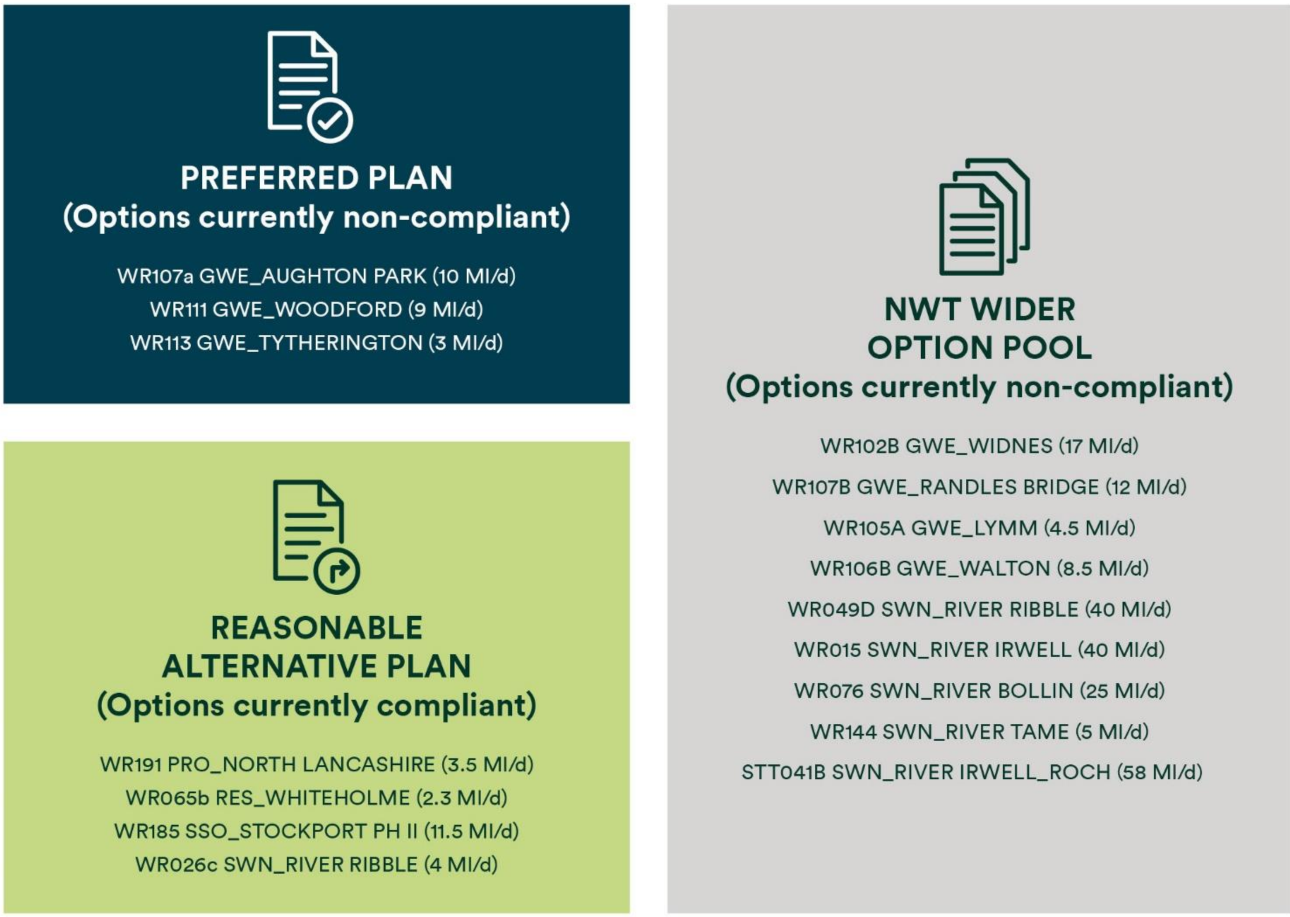
The HRA has provisionally concluded that there will be no adverse effects, alone or in combination, on Martin Mere SPA and Martin Mere Ramsar, Mersey Estuary SPA / Mersey Estuary Ramsar, the Sefton Coast SAC or the associated features of the Ribble and Alt Estuaries Ramsar and no significant effects on biodiversity have been identified.

As shown in Figure 14, the three groundwater options will be implemented by 2030. These options have residual uncertainties until the NWT SRO Gate 3 investigations conclude, and recognising this uncertainty, and in compliance with the revised WRPG requirements, we have identified four alternative WFD and Habitats Regulations compliant WRMP options from the constrained option list. At a total of 21.3 Ml/d, they provide sufficient capacity to completely replace the NWT options in our preferred plan in the unlikely event that they are required due to non-compliance of preferred plan options (the specific option capacity requirement is 20.4 Ml/d). In the revised draft plan WFD Assessment and HRA we have assessed these options alone and in combination as a 'reasonable alternative plan', to ensure that our revised draft plan is compliant, resilient and robust.

Note that option WR026c, River Ribble, is a new variant which downsizes option WR026b to ensure WFD compliance. In all cases compliant options will be selected for the preferred plan according to 'best value'.

A further nine options are also being assessed as part of the NWT SRO and, depending on the outcome of investigations for the RAPID Gate 3 submission, could be considered as supplementary options to the reasonable alternative plan.

Figure 14 Options selected in revised draft plan preferred plan and reasonable alternative plan, plus the NWT wider option pool being assessed for RAPID Gate 3



We have also taken into account Biodiversity Net Gain in our approach. More detail on this can be found in Section 2.2.5 and the Biodiversity Net Gain and Natural Capital Assessment, carried out by our environmental consultants (Wood)[52]. It is important to note that whilst there are some elements that are not directly included in the Biodiversity Net Gain approach, i.e. cultural capital (table 4.2 in section 4.3.3 in our WRMP24 SEA report), all options are assessed through the Strategic Environmental Assessment, which includes the assessment of options according to cultural heritage.

[52] Biodiversity Net Gain and Natural Capital Assessment, Wood and Ricardo, September 2022.

9. Programme comparison and appraisal

To ensure we have created the best value plan, we have generated several programmes, which include different trade-offs achieved by varying metric weights. Our approach was informed by the Ofwat public value principles[1] with the metrics taking account of a wide range of environmental and social benefits, which were traded off against financial benefits. All programmes are designed to achieve the same objectives (as outlined in Section 1.2), which include meeting our demand management policies, supporting the national effort through water transfer, and improving our resilience to drought. The programmes meet these objectives alongside the same most likely scenario assumptions, as presented in Section 6 and 7, to provide a good basis for comparison to understand the trade-offs that we have made in our decision making. This section details alternative programmes and their performance against our best value metrics.

In order to create a preferred (most likely) plan that is best value for customers, we optimised the selection of options according to best value weightings, which were evaluated from the results of customer preference research. These weightings are set out in Table 3. We also produced the following programmes to understand the trade-offs we had made in the selection of a best value plan:

- Least cost;
- Best environment and society; and
- Best value using NCA metrics.

The following sections provide an appraisal of the aforementioned plans at the company level. It is important to note that due to the constraints of the demand management targets and requirements for water transfers, option selection does not differ completely between programmes as a number of options are required to meet these constraints in all scenarios. For these common options, differences in metric costs across plans are solely attributed to changes in when the options are selected. The appraisal therefore focuses on exceptions (i.e. options that are unique to one or more plans) to better understand what trade-offs these options may have had on the selection of our preferred plan.

All costs mentioned in the following sections are 80 year NPV costs in millions of pounds and have been discounted based on the year of option selection. The drought permit and TUBs level of service change are common to all four plans, and therefore, costs stated in this section do not include the costs of these options.

9.1 Preferred plan overview

Costs for the preferred plan are summarised in Table 26 with the options listed in Table 38. Our preferred plan (like the other plans) is dominated by demand options as we look to meet our demand management policies and targets. The top five best value options are 69 Ml/d (or 22% of the plan capacity) of demand options implemented at the start of the planning period and characterised by being low cost (1.5% of the plan total) with positive multi-abstractor and human and social wellbeing benefits. Of these, water labelling without minimum standards in the Strategic RZ performs most favourably across most metrics due to the scale of the demand reduction (36 Ml/d) and the major positive effect this is expected to have on operational cost savings, increased resilience of supply and societal benefits. On the other end of the spectrum, for the bottom five best value options set to deliver 189 Ml/d (60% of the plan capacity), cost has the biggest impact accounting for 84% of the plan total. The options are however comparable to better value options in terms of multi-abstractor benefits realising a saving of £97m (compared to a saving of £105m for the top five best value options). Smart metering of households is the most expensive option (£573m) but delivers similar multi-abstractor and human and social wellbeing benefits as the best value (and cheapest) water labelling option due to its size (60 Ml/d).

Three supply options, used for water transfers, feature in the preferred plan. Compared to the demand options, these groundwater enhancement options are among the most costly in terms of carbon, PWS customer supply resilience, human and social wellbeing, ecosystem resilience and multi-abstractor benefits due to a combination of factors including temporary/permanent habitat loss associated with new infrastructure, congestion/disruption/noise disturbance to residential receptors during construction and energy requirements for machinery and plant during construction and ongoing energy/chemical use during operation. The exception is WR107a2 Aughton Park which has a favourable human and social wellbeing cost saving of £7m (compared to a cost of £4m for the other two supply options) due to its more rural setting which is considered to have less impact on residential receptors, and its slightly larger size which provides more benefit in terms of increased resilience and support to the local economy, community and population growth. In addition to these supply options, there are 14 drought permit options and 1 TUBs level of service increase option.

The total greenhouse gas (GHG) emission of our preferred plan over 80 years is a reduction of 417,688 tCO_2e (Table 27) which will support achievement of our science-based targets to reduce our scope 1 and 2 emissions by 42% and our scope 3 emissions by 25% by 2030 and help achieve our long-term net zero ambition by 2050. Construction and operation of the plan will not cause or exacerbate flooding and except for temporary minor noise and vibration impacts during construction, will not affect opportunities for recreation and tourism in the operational area. Overall, the plan will realise a human and social wellbeing saving of £167m based on the perceived benefit to wellbeing (socio-economic and improved health), climate change resilience and environmental conservation. The prevalence of demand options, especially the larger leakage and metering options, will result in an overall multi-abstractor benefit saving of £376m as the amount of water saved through these interventions means there is more water in the supply network resulting in improved resilience and reduced risk of deterioration of waterbodies (quality and quantity) as less abstraction is required.

The plan strikes a good balance between financial, environmental and societal costs (financial cost is approximately 2.3 times the total positive benefit cost of the environmental and societal metrics) and will add £7.70 to customers' bills by 2030 and £18.37 by 2050 (Table 28). These costs are well within the average household willingness to pay value of £23.05 as determined from customer research on the acceptability of our preferred plan. In fact, the research found that there was limited scope to improve preference scores for the plan, meaning that the plan is highly optimised in terms of maximising customer preferences. Further detail on acceptability testing of the preferred plan can be found in the *Technical Report – Customer and stakeholder engagement*, Section 8.

Table 26 Programme comparison and appraisal (discounted depending on year of option selection)[53]

Metric (80 yr £m NPV)	Preferred plan	Least cost plan	Best environment and society plan	Best value plan using NCA metrics
Financial cost	1562.57	1549.18	3396.67	1578.29
Carbon cost	-102.03	-92.19	-124.87	-95.61
PWS customer supply resilience	-13.19	-3.82	-35.62	-0.10
Flood risk: positive	0.00	0.00	-12.08	0.00
Flood risk: negative	0.00	0.00	0.00	33.21
Human and social wellbeing: positive	-166.92	-127.76	-264.45	-150.22
Human and social wellbeing: negative	63.83	65.78	85.10	57.07
Ecosystem resilience: positive	-22.84	-19.54	-50.88	-21.37
Ecosystem resilience: negative	177.26	139.39	260.48	158.59
Multi-abstractor benefits: positive	-375.61	-286.07	-516.83	-344.20
Multi-abstractor benefits: negative	20.65	20.65	20.65	19.67

[53] Total costs are not comparable to NPV costs in WRMP tables (explanation in Section 3.3). These totals do not include costs associated with drought permits and TUBs.

Metric (80 yr £m NPV)	Preferred plan	Least cost plan	Best environment and society plan	Best value plan using NCA metrics
Best value score	1143.73	1245.63	2758.18	1235.33

Table 27 80 year whole-life carbon of the preferred and alternative plans

Plan	80 yr WLC (tCO_2e)
Preferred	-417,668
Least cost	-413,635
Best environmental and society	-490,185
Best value using NCA metrics	-400,830

Table 28 Bill impact of the preferred and alternative plans

Plan	2030 bill impact	2050 bill impact
Preferred	£7.70	£18.37
Least cost	£6.97	£17.43
Best environmental and society	£18.62	£22.15
Best value using NCA metrics	£6.36	£17.27

9.2 Alternative programmes

9.2.1 Least cost plan

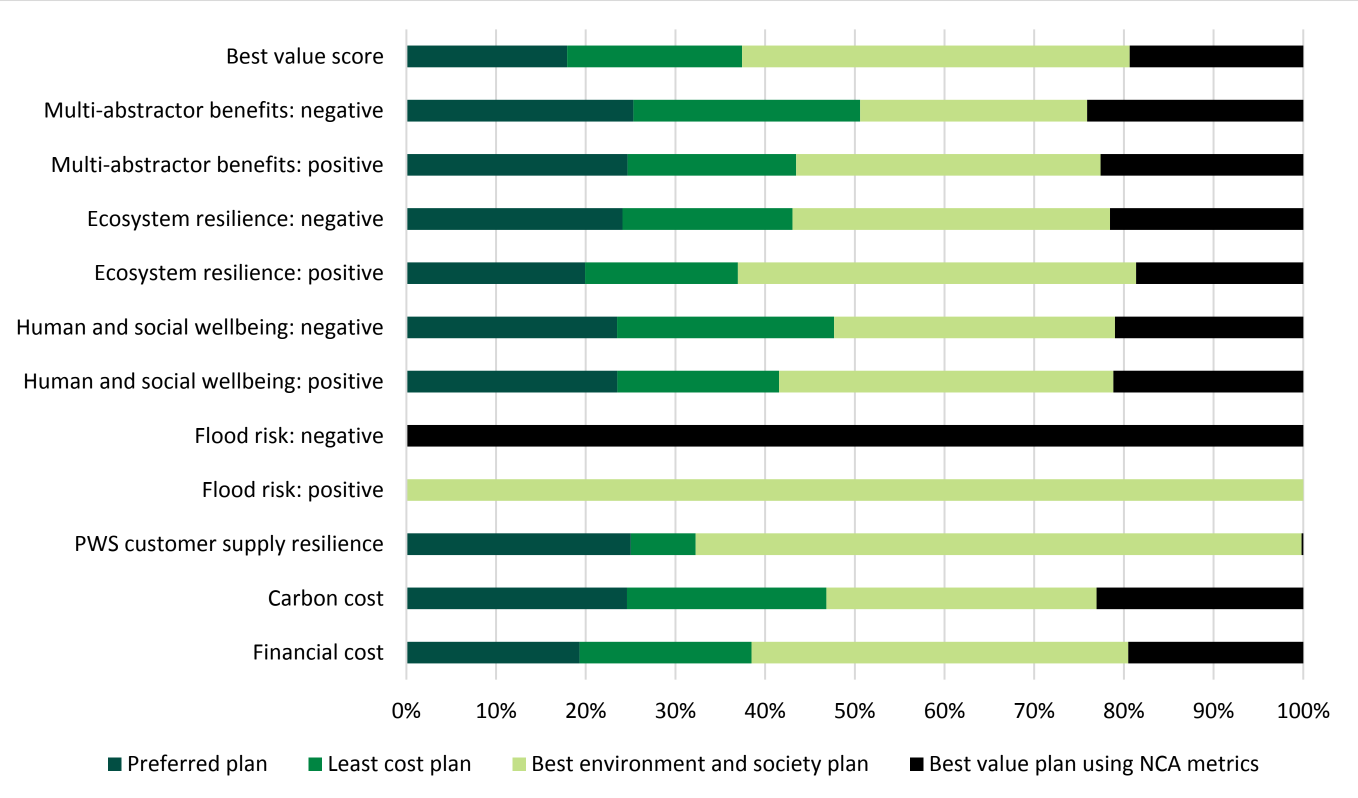
The least cost plan has been produced based on the methodology set out in the UKWIR Economics of Balancing Supply and Demand (EBSD) Guidelines. To create this plan, metric weightings were set to zero except for financial cost (set to 1) so that the decision support tool would optimise for a least cost plan.

Costs for the least cost plan are summarised in Table 26 with the options listed in Table 39. Forty-two of the fifty options (including the three supply options, fourteen drought permits and one level of service change option) in the preferred plan are also in the least cost plan. There is no change to when the supply options are selected in the least cost plan due to water transfer requirements and as such their metric costs are the same as in the preferred plan. For demand options common to both plans, most of the changes observed in the least cost plan result in a reduction of metric costs as the options are selected later than in the preferred plan (Figure 32). This delay effectively reduces the period over which benefits are realised and results in lower financial costs (£245m in the least cost plan compared to £357m in the preferred plan) as later years of an option's costs are outside of our 80 year plan (Section 3.3 details our approach to costs). In percentage terms, the largest benefit reduction is to PWS customer supply resilience largely driven by Strategic RZ leak reduction options. The delay in implementing these options means that we do not see as much demand reduction in the short term and hence the benefit realised is less (i.e. until implemented, there is more water required in the supply network and hence greater chance of supply interruptions and customer complaints).

Three small scale pressure management and water efficiency Strategic RZ options with a combined financial cost of £32.4m (and demand reduction of 7 Ml/d) in the preferred plan are not included in the least cost plan and there are no options directly replacing them. Similarly, there is no replacement in the least cost plan for a 0.1 Ml/d pressure management Carlisle RZ option with a financial cost of £3.9m in the preferred plan. Two household metering North Eden RZ options with a combined financial cost of £2.1m (and demand reduction of 0.3 Ml/d) in the preferred plan are replaced by three new leakage and efficiency options (permanent network sensors, DMA optimisation and non-household efficiency) in the least cost plan with a combined financial cost of £2.3m (and demand reduction of 0.6 Ml/d). The phased 100 Ml/d mains rehabilitation/replacement options in the preferred plan with a combined financial cost of £463m are replaced by a single 100 Ml/d option with a financial cost of £597m in the least cost plan. Although an equivalent option in the least cost plan (in terms of demand reduction), the replacement option has a higher financial cost as it is implemented early over a shorter duration (10 years compared to the 10 year phase 1 and 25 year phase 2 programme in the preferred plan). The net impact of the above exceptions indicates a slight increase in financial cost and overall best value score.

At the programme level, the least cost plan ends up being not too dissimilar to the preferred plan in terms of financial cost (1% cheaper) as the reductions caused by the delayed implementation of some options are generally balanced out by the overall higher financial cost of the options replacing them (Figure 34). This results in a lower bill impact in the long term (5% cheaper than the preferred plan by 2050). The least cost plan offers fewer environmental, wellbeing and resilience benefits compared to the preferred plan (£105m less or 33% lower) with financial cost about three times the total positive benefit cost of the environmental and societal metrics. GHG emissions are slightly higher (4,033 tCO_2e more) and overall the plan ends up with a less favourable best value score than the preferred plan.

Figure 15 Relative proportion of metric costs in each plan



9.2.2 Best environment and society (BES) plan

To create the best environment and society (BES) plan, the weightings for carbon cost and all the metrics derived from SEA scores were set to one while the cost metric weighting was set to zero to promote options which provide favourable ecosystem resilience, flood risk, human and social wellbeing, multi-abstractor and carbon reduction benefits. Costs for the BES plan are summarised in Table 26 with the options listed in Table 40.

In the BES plan, all of the demand options are selected in 2026 ahead of the supply options (selected in 2030) to begin to realise the benefits of demand reduction early in the planning period. Of the 33 demand options in the preferred plan, 27 are in the BES plan, most of them realising more favourable benefits in terms of building resilience in the supply network and environmental conservation (reducing the risk of deterioration caused by abstraction) as they are implemented earlier than in the preferred plan (Figure 32 Metric cost differences for common options relative to the preferred plan). To maximise these benefits, 18 additional demand options are included in the BES plan including water efficiency options such as flow regulators and rainwater harvesting and reuse in Strategic RZ and North Eden RZ (in the preferred plan we have chosen this for a trial in Carlisle RZ), and leakage options such as Strategic RZ dynamic network management. These new options (15 of which are only found in the BES plan) have a combined multi-abstractor benefit valued at £184m and human and social wellbeing benefit of £93m.

Not only are some demand management options implemented earlier in the BES plan compared to the preferred plan, but they are also of longer duration to maximise benefits. In Strategic RZ and Carlisle RZ for example, the 5 year pressure management options are replaced by 15 year programmes. Likewise, the 5 year Strategic RZ permanent network sensor option is replaced by a 12 year option and the 10 year household smart metering option is replaced by a 15 year option. In Carlisle RZ and NERZ, the 5 year household smart metering options are replaced by 10 year options. Extending these programme durations realise multi-abstractor and human and social wellbeing benefit improvements of £20m and £33m respectively.

Once water transfer requirements have been met by the three supply options also included in the preferred plan, the BES plan introduces three new supply options which are very different to the typical abstraction type option sometimes associated with disbenefits such as risk of deterioration of waterbodies (quality and quantity). WR065b is a reservoir raising option and the only option in any of the plans to bring tangible flood risk benefits valued at £12m by providing additional capacity in the catchment to reduce downstream flood risk. The other supply options capitalise on operational efficiencies by making network improvements (WR185) and process washwater treatment (WR191) to make use of water already in the system without need for additional abstraction. These supply options realise an ecosystem resilience benefit of £27m by promoting resource efficiency and enhancing ecosystem services. These three options appear in reasonable alternative plan.

The total GHG emission of the BES plan over 80 years is a reduction of 490,185 tCO_2e (17% improvement on the preferred plan) brought about by operational savings from the large demand management programme. This is also reflected in the 22% increase in carbon cost saving of the BES plan compared to the preferred plan.

Selection of more environmentally and socially beneficial options however comes at a price with the financial cost of the BES plan 117% more than the preferred plan (Figure 34 Metric cost differences relative to the preferred plan) and about four times the total benefit cost of the environmental and societal metrics. This is also reflected in a higher bill impact especially in the short term which is 142% more than the preferred plan by 2030. With a bill impact of £22.15 by 2050 (Table 28). Optimising environmental and social metrics leads to an expensive demand management plan which at the resource zone level is disproportionately more expensive in North Eden RZ, a zone with no supply-demand balance driver (1140% more than the preferred plan) than it is in Strategic RZ and Carlisle RZ (117% and 72% more than the preferred plan respectively).

9.2.3 Best value plan using NCA metrics

The best value plan using NCA metrics (NCA plan) is optimised using weightings derived for the NCA formulation of the environmental and social metrics. This applies to the supply options only as NCA metrics have not been derived for demand options. This is explained further in Section 2.2. Costs for the NCA plan are summarised in Table 26 with the options listed in Table 41.

The NCA optimisation leads to an alternative selection of demand options due to the emphasis only being placed on financial and carbon cost (there are no metric values in the NCA formulation for demand). The differences are shown in Table 41, however this selection is not used for the comparison in this analysis as the focus is on NCA metrics only.

The NCA optimisation selects a different combination of options for water transfers, with WR102b incorporated in the place of WR111 and WR113. This is due to the alternative formulation of the metrics, which places a different emphasis on certain elements of the environmental impact, for example in relation to flood risk and associated mitigation. All of the other alternative programmes, however, are consistent with the preferred plan in relation to the water transfer options.

10. Testing our plan

In addition to understanding the impact of alternative metric weightings on our plan, we also carried out a number of sensitivity tests to understand the impact of timing, deliverability and risk resilience. This section explores the trade-offs made when considering the following aspects of the plan:

- The timing of achieving a 2.5 per cent annual chance of TUBs;
- The timing of achieving resilience to 1 in 500 year droughts;
- Alternative delivery profiles for demand reduction, including doing more on leakage;
- The impact of preferred plan options becoming infeasible;
- Upper and lower profiles for carbon pricing;
- Long-term vs short-term optimisation; and
- Making adjustments to the headroom glide path.

10.1 Timing the TUBs level of service improvement

We sensitivity tested our plan to understand the optimal year by which we should improve our level of service for TUBs, balancing affordability for customers with the value of the improvement. Table 29 shows the different optimised plans for achieving the improvement in different years, and costs of options within those plans. This sensitivity test is for the Strategic RZ only as this is the only zone where TUBs is a limiting level of service.

We looked at the earliest we could deliver a TUBs level of service improvement. Due to the implementation time of options, this would be 2030. However, we found that in 2030, we would require the additional benefits of water transfer options outside of water transfer periods to boost our resilience to a 1 in 40 year event. This additional support and therefore operational costs of the transfer options would be part funded by customers in the North West. Instead, when delaying the TUBs level of service improvement, we found that the year of additional leakage reduction and demand management was sufficient to achieve the level of service improvement. It was therefore decided that the optimal year for this improvement for customers is 2031.

If 1:40 TUBs is achieved any later than 2031, this results in the same long-term option selection as the preferred plan, with no cost saving to be made from the delay. The preferred plan already results in an eight year wait for the level of service improvement from 2023, and there is no benefit to extending this.

Table 29 Sensitivity test results for the timing of achieving 2.5% annual chance of TUBs

Option ID	1:40 TUBs in 2030	1:40 TUBs in 2031	1:40 TUBs after 2031
Best value cost (£ million 80yr NPV) of options[54,53]	1144[55]	1144	1144
Best value cost vs preferred plan (£ million 80yr NPV)	-	-	-
Total trading capacity of options (Ml/d)	22	22	22
Total 1 in 20 DO of options (Ml/d)	13.36	13.36	13.36
Total 1 in 40 DO of options (Ml/d)	12.32	12.32	12.32
Total 1 in 500 DO of options (Ml/d)	4.32	4.32	4.32
Years before level of service improvement to United Utilities Water customers	7	8	9+

10.2 Timing our resilience to 1 in 500 year droughts

We sensitivity tested our plan to understand the impact of delivering resilience to 1 in 500 year droughts sooner or later in the planning period for both Strategic RZ and Carlisle RZ.

The test was not done for North Eden RZ (or Barepot RZ) as the zone is not limited by 1:500 EDO. In a 1 in 500 year drought, aquifer levels remain high enough and the constraint on supply continues to be the due to abstraction licences and asset capacities. The supply-demand balance in this zone is therefore the same for all drought levels.

Our analysis suggests that there could be no cost saving or bill impact as a result of bringing 1:500 EDO sooner or later in the planning period. The results therefore suggest that we could meet the 1:500 level of service sooner. However, we are concerned about the uncertainties in the current assessment of 1:500 resilience, and therefore do not intend to guarantee this minimum level of service until 2039. From the start of the planning period until 2039, our guaranteed level of service for emergency drought orders will therefore be 1 in 200 years.

Table 30 Sensitivity test results for the timing of achieving resilience to 1 in 500 year droughts.

Option ID	1:500 EDO in 2030	1:500 EDO in 2039	1:500 EDO in 2050
Best value cost (£ million 80yr NPV)[53],[54]	1144	1144	1144
Best value cost vs preferred plan (£ million 80yr NPV)	-	-	-
2030 bill impact (annual, £)	£7.70	£7.70	£7.70
2050 bill impact (annual, £)	£18.37	£18.37	£18.37

10.3 Alternative delivery profiles for demand reduction

Alongside other demand scenarios which have been considered as part of our adaptive plan, three alternative profiles were used to sensitivity test our plan to changes in demand reduction. These are detailed in the sub-sections below and a summary of the results can be found in Table 31.

It is important to note that our preferred demand plan was optimised using the demand targets for PCC, leakage, non-household and distribution input set out in the Environmental Improvement Plan 2023[2]. These include

[54] The costs here include the cost of water transfer options.

[55] As described in Section 10.1, customers of United Utilities Water would have an increased bill impact in this scenario due to the utilisation of water transfer options to boost TUBs resilience.

targets at various years throughout the planning period. As the number of targets throughout the planning period increases, it constrains the optimisation further such that there are a smaller number of ways to achieve them. Through these tests, we have endeavoured to demonstrate the range of possibilities for demand reduction, including those specifically requested in guidelines and consultation feedback.

We designed our options to have a pace of delivery which is achievable and an impact that is sustainable, as well as allowing us to measure the benefits and effectiveness of our interventions. Our plan is designed to meet all of our demand reduction targets, including the interim and final targets on leakage reduction.

Increasing our planned levels of leakage reduction would exceed these targets at a much greater cost and reduced affordability, and have no further supply-demand balance benefits to customers in this planning period. This is because our preferred plan meets our desired levels of service in a timely way. We therefore consider our preferred (most likely) plan to be a best value plan.

Table 31 Summary of alternative demand profiles costs and benefits

Plan	Preferred plan (most likely)	More than 50% leakage reduction	Achieving as much on demand as soon as possible	Slower demand reduction
Best value cost (£ million 80yr NPV)	1144	1479	3562	1067
Best value cost vs preferred plan (£ million 80yr NPV)	0	335	2418	-77
Financial cost (80 yr £m NPV)	1563	1935	4014	1475
PCC reduction in 2050	108 l/p/d by 2050	108 l/p/d by 2050	105 l/p/d by 2050	108 l/p/d by 2050
Leakage reduction	50% by 2050	60% by 2060	74% by 2050	43% by 2050

Table 32 AMP by AMP financial cost profiles for alternative demand reduction delivery

Total Enhancement Expenditure (£m)	AMP8	AMP9	AMP10	AMP11	AMP12
Preferred (most likely) plan	449.12	352.47	295.32	306.99	242.19
More than 50% leakage reduction	447.60	353.91	212.26	202.88	332.06
Achieving as much on demand as soon as possible	1119.31	1938.31	486.88	46.07	71.83
Slower demand reduction	448.57	358.08	204.59	45.55	213.83

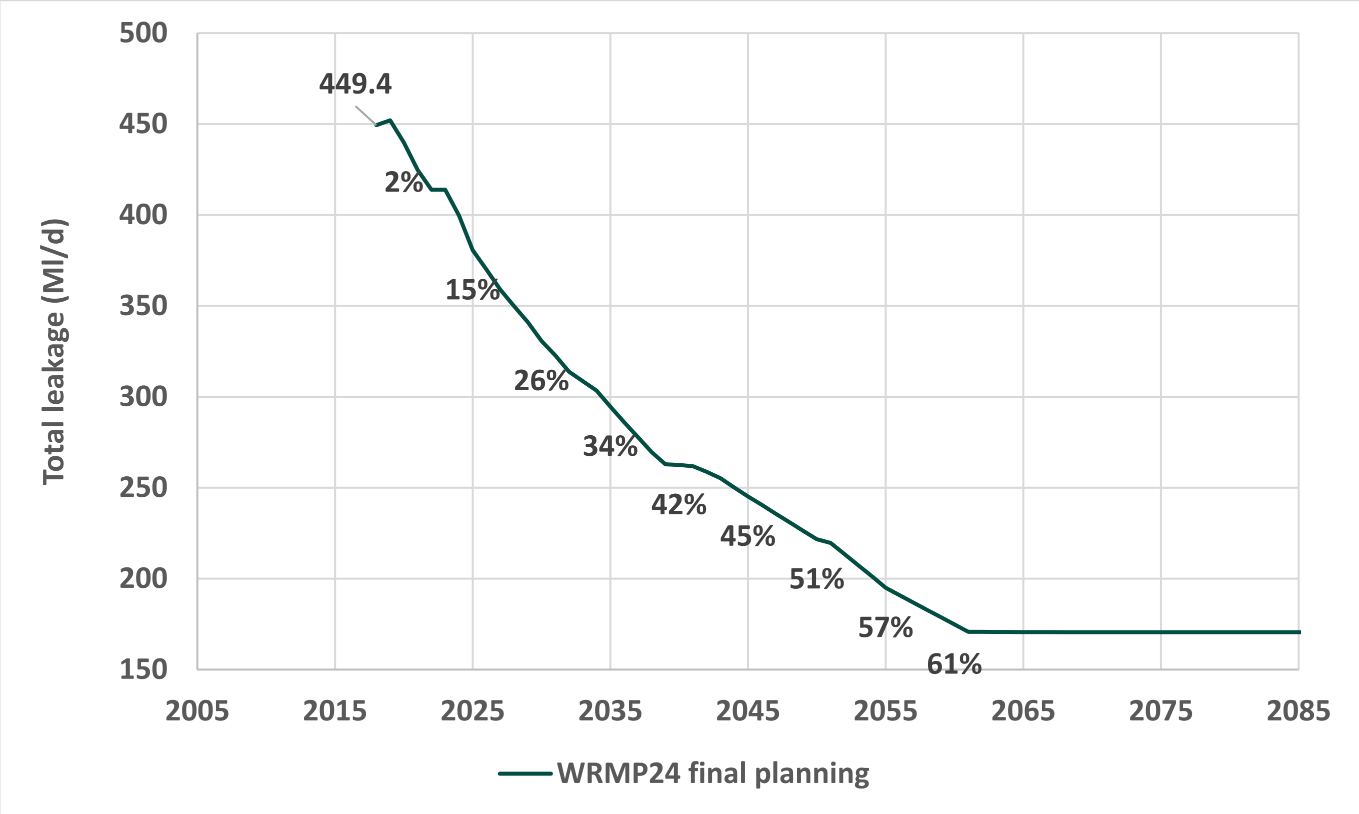
10.3.1 Achieving more than 50% leakage reduction

For this test, we adjusted the targets to include a further 10% leakage reduction by 2060, totalling 60% leakage reduction in total. Table 31 demonstrates the increase in costs, including best value costs as a result of this plan, and Figure 16 shows the resulting leakage reduction profile.

In this plan, a much larger programme is selected for permanent network sensors, and dynamic network management is also selected. The financial cost of the plan increases by around £400m (80 yr NPV), which also causes an increase in best value cost. Table 32 demonstrates that the cost of the plan resulting from this test starts to increase in AMP12.

Given that there is no supply-demand balance driver for this additional reduction in demand, and it surpasses the targets as set out by the Government, investing in a programme of this size would negatively impact affordability of bills without the willingness to pay from customers in the longer term.

Figure 16 Sensitivity test for leakage reduction beyond 50%



10.3.2 Achieving demand reductions more slowly than expected

For this test, we moved the demand targets as follows:

- The 20% reduction in Distribution Input target was moved from 2037-38 to 2049-50;
- The leakage reduction target was changed to 40% in 2050 and 50% in 2060;
- The PCC target was changed to 110 l/p/d by 2060; and
- The 15% reduction target for non-household was changed from 2050 to 2060.

Table 31 demonstrates that most of the demand targets are closely met, such as PCC and non-household demand reduction. This is because these elements of the demand reduction plan contain best value options to meet shorter term targets, such as the 9% reduction in distribution input by 2027 from the Government's Environmental Improvement Plan, alongside the improvement to 1 in 40 year level of service for TUBs. Expensive demand options such as permanent network sensors and mains renewal are moved to later in the planning period, when they are required for leakage reduction, and pressure management is no longer selected.

In summary, the investment largely stays the same at the start of the planning period, as demand reduction is the preferred approach to delivering key objectives. Reducing our targets does not necessarily mean we would make alternative choices in the shorter term. In the later years of the planning period, fewer options are required and costs are lowered.

Figure 17 Leakage reduction where demand reductions are slower than expected

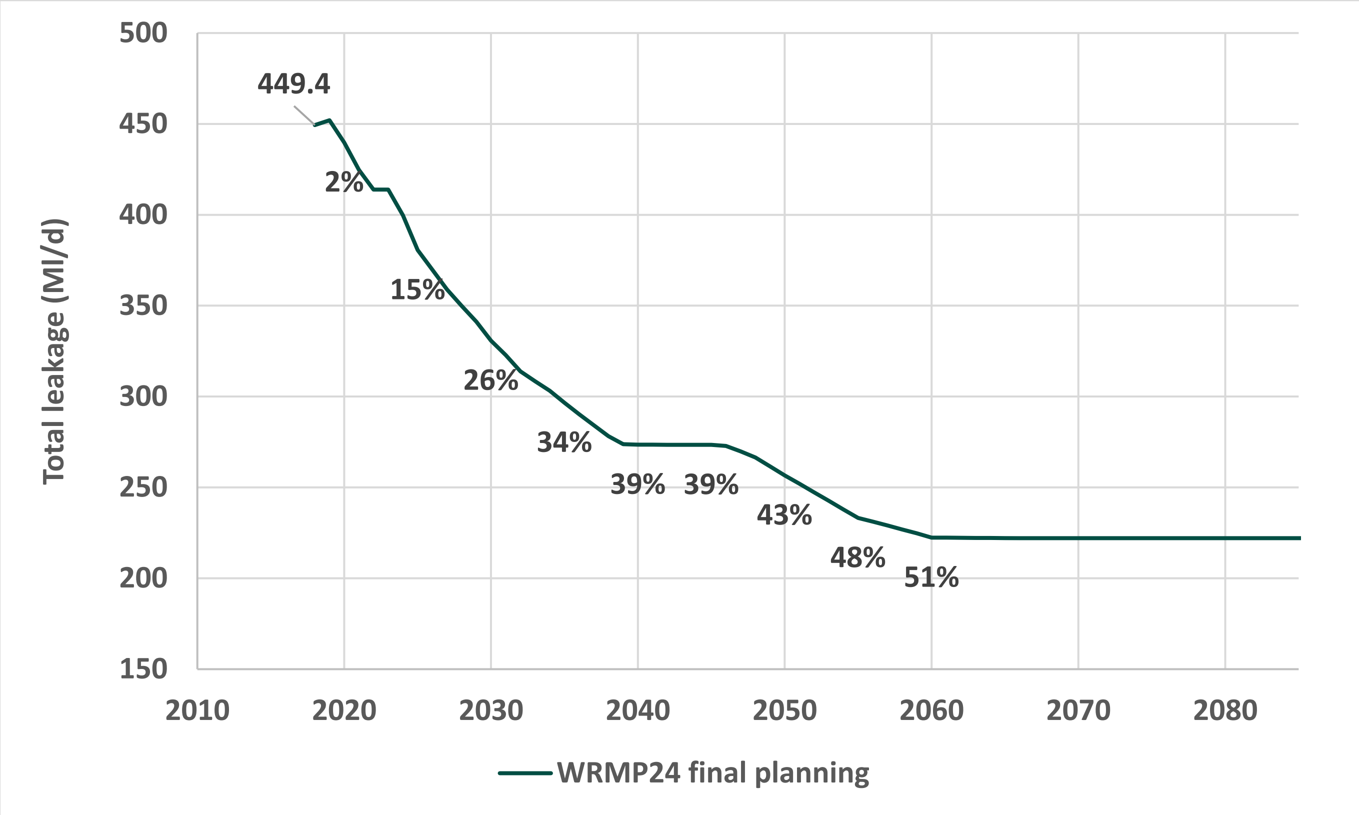
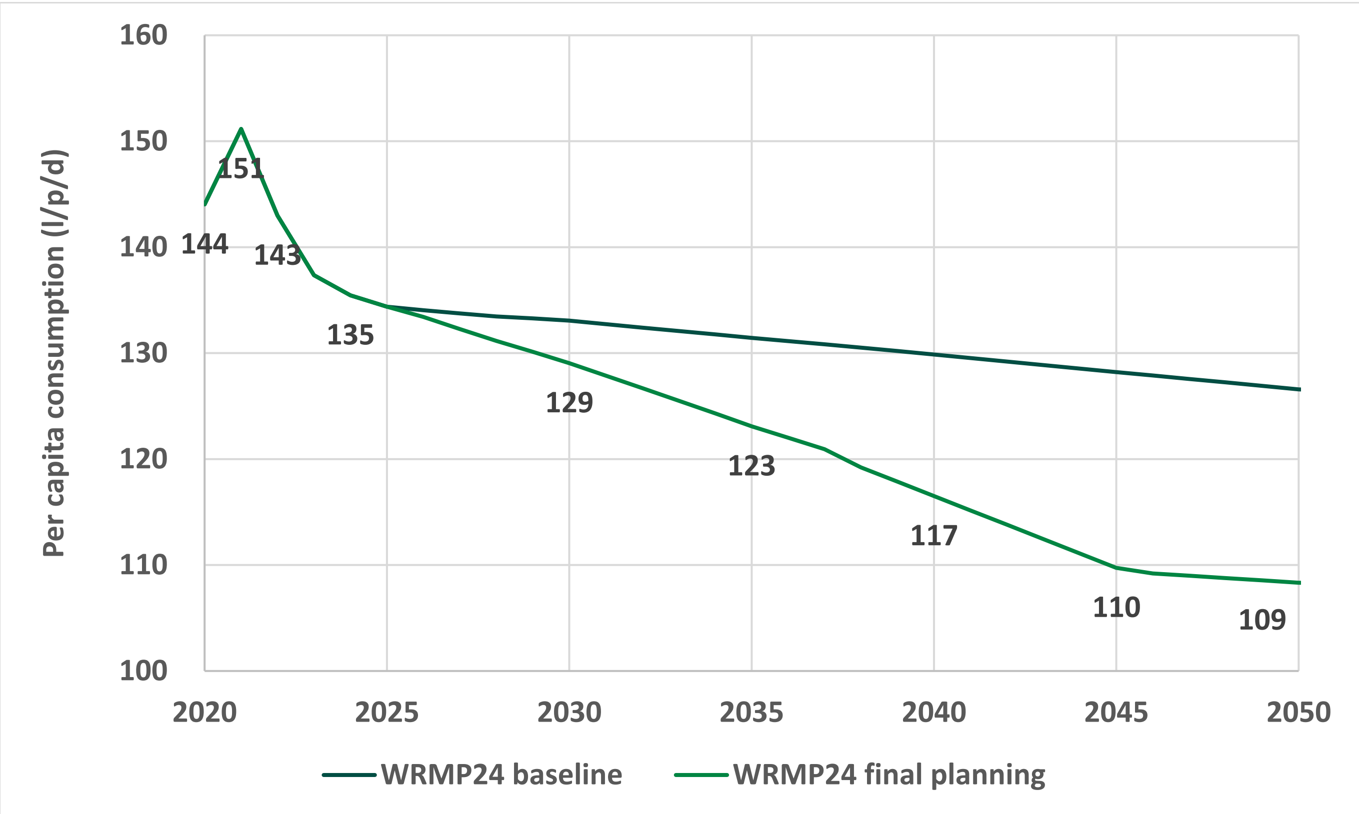


Figure 18 Per capita consumption reduction where demand reductions are slower than expected



10.3.3 Achieving demand reductions as soon as possible

For this test, we moved the latest demand targets up to 2026, which caused the model to move the most impactful demand options to the start of the planning period, simulating the achievement of demand reductions as soon as our options could allow. The assumption on water labelling remained as per the most likely scenario.

This analysis demonstrates a scenario which is 2.5 times as expensive as the preferred, best value plan, and three times the best value cost. The bulk of these costs is in AMP8 and AMP9. Our customer research on affordability (Section 10.9) does not suggest that there is the willingness to pay for this level of intervention in AMP8, and has supported the level of ambition of the commitments in our plan.

This scenario also generates an inefficiency relating to option delivery. In our preferred programme, we have designed a pace of delivery which is achievable and allows us to measure the benefits and effectiveness of our interventions. When introducing all of our most beneficial options immediately, there is a strong potential to introduce inefficiencies into our programme which leads to less cost beneficial interventions across the planning period. In carrying out these large-scale interventions simultaneously, there is also the potential to reduce the certainty around the benefits they are providing.

Figure 19 Leakage reduction where demand reductions are achieved as much and as soon as possible

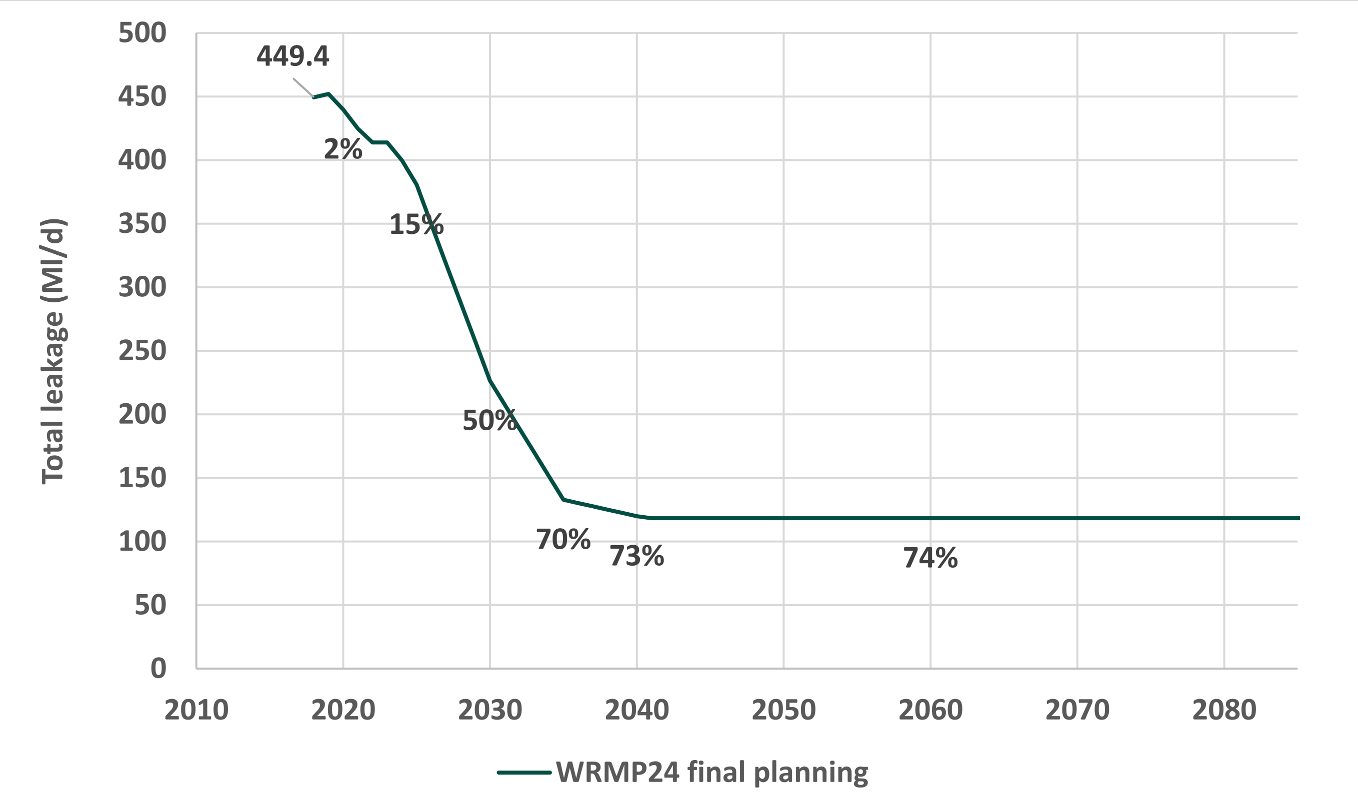
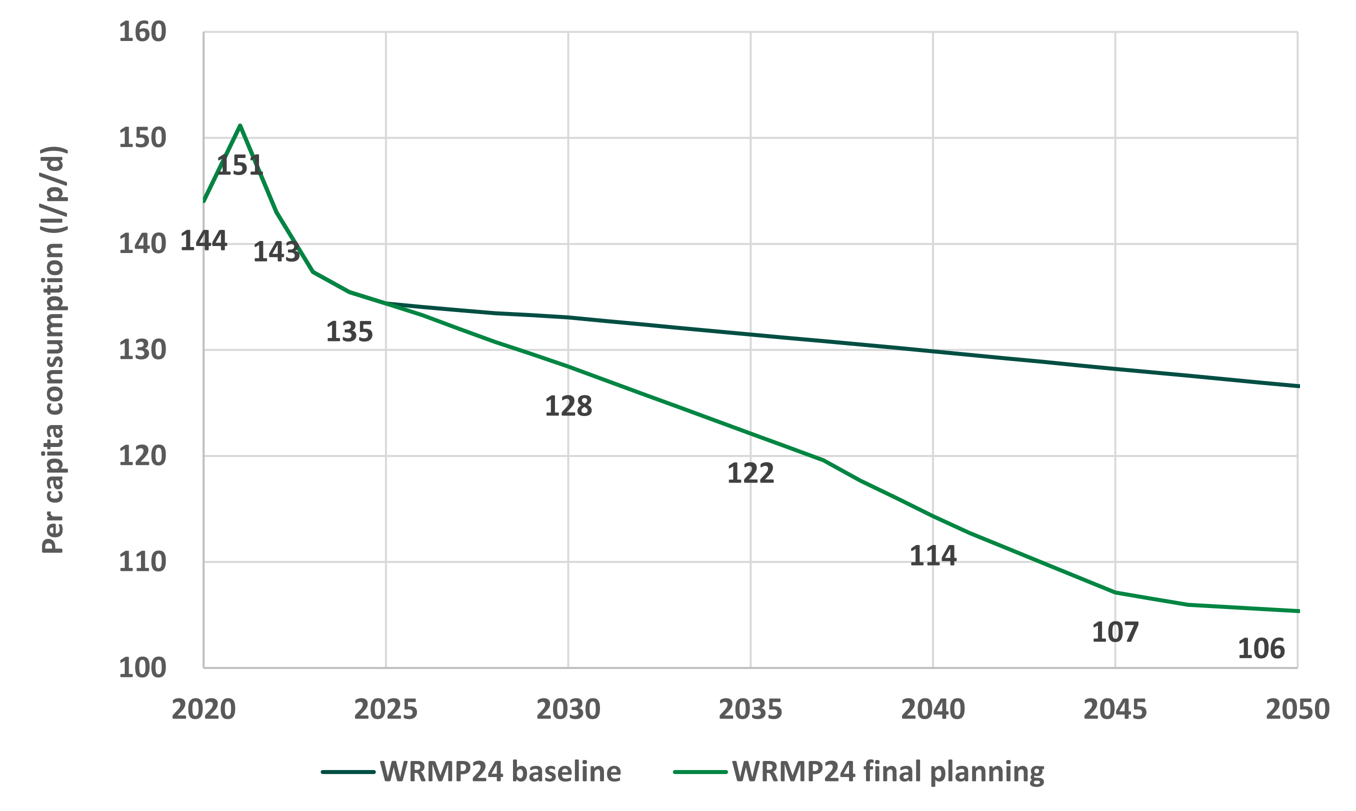


Figure 20 Per capita consumption reduction where demand reductions are achieved as much and as soon as possible



10.4 The impact of preferred plan options becoming infeasible

We tested the plan to understand how preferred plan supply options becoming unavailable might impact the transfer option selection. To do this, we excluded preferred plan options from the optimisation in turn and in combination and optimised to find the next best value option selection.

Table 33 Impact of NWT option delivery on best value selection

Option ID	Option name	Preferred plan	Excluding Aughton Park	Excluding Woodford & Aughton Park[56]	Excluding Tytherington & Aughton Park	Excluding Woodford	Excluding Tytherington
WR076	SWN_RIVER BOLLIN			2031			
WR102b	GWE_WIDNES		2030	2030	2030	2030	2030
WR107a2	GWE_AUGHTON PARK a2	2030				2030	2030
WR111	GWE_WOODFORD	2030	2030		2030		
WR113	GWE_TYTHERINGTON	2030		2030			
Best value cost of water transfer options (£m 80 yr NPV)		172	254	450	254	251	251
Total trading capacity of options (Ml/d)		22	26	45	26	27	27
Total 1 in 20 DO of trading options (Ml/d)		13.36	15.79	27.32	15.79	16.39	16.39

[56] In this scenario, insufficient sub-options are available to meet the full trading amount in 2030. River Bollin is selected for 2031 to meet the need as soon as possible.

Option ID	Option name	Preferred plan	Excluding Aughton Park	Excluding Woodford & Aughton Park[56]	Excluding Tytherington & Aughton Park	Excluding Woodford	Excluding Tytherington
Total 1 in 40 DO of trading options (Ml/d)		12.32	14.55	25.18	14.55	15.11	15.11
Total 1 in 500 DO of trading options (Ml/d)		4.32	5.11	8.84	5.11	5.3	5.3

The test demonstrated that WR102b GWE_WIDNES is a best value alternative option in the trading portfolio for most of these alternative programmes, and WR076 SWN_RIVER BOLLIN is another best value alternative option in the case that further capacity is required. This analysis supports the selection of reserve options for the NWT programme.

10.5 Upper and lower carbon cost profiles

We tested the plan against high and low Department for Business, Energy and Industrial Strategy (BEIS) modelling values for carbon costs[9]. The model runs showed no changes for Carlisle RZ and some small changes for Strategic RZ. The changes apply to 3 options, WR511g Pressure management, WR619c Upgrade existing household meters to smart and WR659c Free water efficiency devices (outside/external).

For WR511g and WR659c, the changes are minimal: the former is decelerated one year in both upper and lower profiles and the latter is accelerated one year in both upper and lower profiles. This change in option selection is not significant to the preferred plan as the investment in these options is required and the programmes still begin within the AMP.

For WR619c, the change is slightly larger. This option is a best value option which provides benefit to help meet the PCC targets. It has a highly negative carbon cost due to the reduction in water use, and its overall best value cost is low compared to other options. Therefore, it is selected in 2026 in our best value preferred plan. However, when the low carbon costs values are used, this increases the overall best value cost of the option, and it is then selected later. The option is required to fulfil the PCC targets by 2037/38, so its latest year of selection is 2035 for the low carbon cost plan.

In terms of overall best value score, when high carbon cost values are used, the overall best value cost of the plan reduces. This is because our options deliver a net negative whole life carbon impact as a result of their demand reduction.

This sensitivity test therefore resulted in no change to our preferred plan, however it provides a useful insight into the impact of carbon our on our plan.

10.6 Testing variations in the target headroom glide path

In our *Technical report – Allowing for uncertainty*, we have described how the target headroom glide path was derived, including how we evaluated the uncertainty in our supply-demand balance and how we selected our risk profile. In our sensitivity testing, we have used different risk profiles to understand how this decision has impacted our best value plan.

For the WRMP baseline, our selected risk profile for the Strategic Resource Zone is based on a probability of 80 per cent at the start of the period (representing a risk of 20 per cent that the target headroom allowance is exceeded), tapering down to a probability of 70 per cent in 2049/50 (30 per cent risk). For sensitivity testing, we also optimised the plan for the following profiles:

(a) 95 per cent at the start of the period, tapering down to a probability of 70 per cent (30 per cent risk, as per WRMP19).

(b) 90 per cent throughout (10 per cent risk).

(c) 80 per cent at the start of the period, tapering down to a probability of 50 per cent (50 per cent risk).

For North Eden RZ, the target headroom change has no impact on the option selection. This is because there is no supply-demand balance need in this zone even at higher target headroom profiles (lower risk profiles). The demand strategy therefore remains the same.

For Carlisle RZ, the target headroom change also has no impact on the option selected as, even at lower risk profiles, the supply-demand balance remains in surplus. At the lowest risk profile, demand management activity as a result of the targets maintains a supply-demand balance surplus.

For Strategic RZ, where target headroom is larger at the start of the planning period and therefore there is a lower risk profile, significant investment is required to maintain the supply-demand balance in earlier years. For example, in the case where the profile begins at 95% target headroom and ends at 70%, the 2026 TUBs supply-demand balance cannot be met. Significant investment in demand management programmes would be undertaken, larger than that which is affordable and significantly more than is required to meet targets. This is because demand management programmes grow in benefit over time as they are implemented. As the target headroom reduces through the planning period, the supply-demand balance surplus continues to grow as these demand management activities take effect. This reinforces our choice of an 80% to 70% glide path.

A similar effect is seen where target headroom exceeds 80% at the start of the planning period. In the case of 80 – 50% headroom, there is no difference in option selection compared to the preferred plan. This is because our preferred plan is designed to meet demand management targets, water transfer needs and improves our TUBs resilience in the short term. It is not driven by longer term needs in the most likely scenario.

Table 34 Best value and financial costs of plans with different target headroom profiles

Target headroom test		**A**	**B**	**C**
Plan	**WRMP baseline headroom, 80% to 70% (preferred plan)**	**Headroom 95% to 70%**	**Headroom 90% throughout**	**Headroom 80% to 50%**
Best value cost (£ million NPV)	1144	3123	3123	1144
Financial cost (£ million NPV)	1563	3588	3588	1562

10.7 Long-term vs short-term optimisation

Tests were carried out to understand the impact of only optimising option selection for short-term needs. In our default analysis, needs are taken into account until 2085, and this ensures that all of the transfer requirements are considered. In testing this optimisation, we varied the end year of the optimisation from 2085 to 2040 and 2050. We found that the option selection in earlier years remained largely stable between these plans, and as the longer term targets were no longer a constraint, fewer options were selected overall. Most of the options which were no longer selected were those selected later in the planning period for the preferred plan. This helps to demonstrate that our demand management portfolio is low regret should our longer term needs change.

10.8 Portfolio testing

The water resources planning approach has become very complex. For example, when we calculated DO we needed to obtain results for multiple levels of service metrics and assigned the results across different supply-demand balances. This included the testing of options we used to improve these supply-demand balances. As a result, it has become challenging to have confidence that a supply-demand balance surplus truly delivers the levels of service we are promising. The use of target headroom and scenario planning further complicates this picture. This is a particularly salient issue in our large Strategic Resource Zone.

Therefore, at the end of the process we closed the loop by returning to our water resources model to check that our proposed preferred plan will deliver our stated levels of service in the future. We loaded the preferred plan options, both supply and demand, and all of the other features of our final planning supply demand balance into the model and ran a series of simulations representing salient years in the planning period (years in which there is an incremental change in water transfer volume). As shown in Section 13 of the *Technical Report – Supply forecast*, we found that all minimum levels of service were exceeded throughout the planning period.

This testing was carried out using the 'most likely' pathway, which statistically gives us the best estimate of future levels of service. Unfortunately, there was insufficient time to simulate some of our other adaptive pathways. However, during the initial system simulation exercise we sensitivity tested the solutions against a very wide range of future conditions (Section 7.4).

10.9 What do customers think of our preferred plan?

As introduced in Section 4, and detailed in our *Technical Report - Customer and stakeholder engagement*, working with industry experts DJS we conducted innovative customer research to test the acceptability of our preferred plan. A screenshot of the tool we developed with DJS is shown in Figure 21.

Figure 21 Screenshot of customer preference research tool

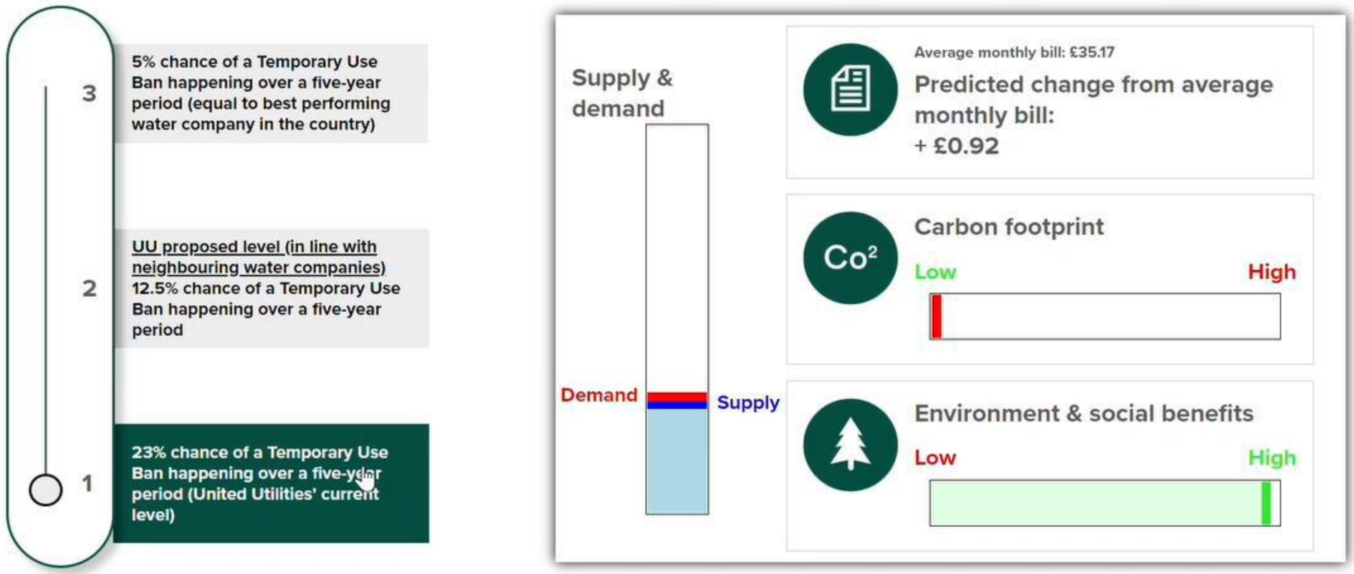


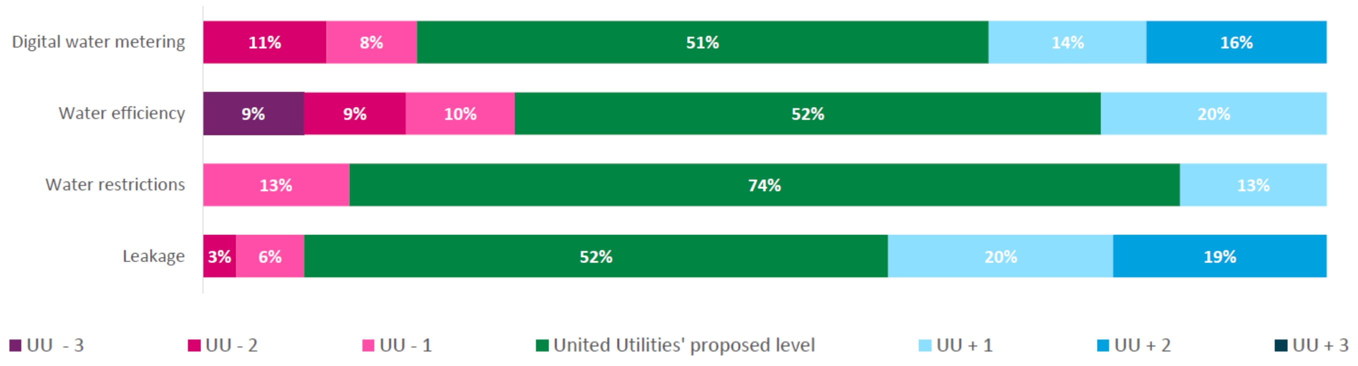
Figure 22 presents customer preferences for preferred plan activities required to deliver our strategic choices. This is based on selections customers made for different levels of activities, for example frequency of water restrictions, when presented with information on environmental and societal impacts plus the associated impact on bills. The figure shows the preferences of household customers; the customer and stakeholder engagement technical report also provide results for non-household customers and future bill payers, but their preferences are broadly similar.

The green bars represent the percentage of customers that selected our preferred plan. Pink or purple bars represent customers that would prefer us to do less activity than in our preferred plan, for example install fewer smart meters, with an associated lower impact on bills. Blue bars indicate customers who would prefer us to do more.

At 74 per cent, the highest level of support was for our strategic choice to improve the level of service for water restrictions, or more specifically to halve the frequency of TUBs from 1 in 20 years (5 per cent annual chance) to 1 in 40 years (2.5 per cent annual chance). Preferences related to the activities required to deliver the government's leakage and PCC targets showed a lower level of support, but still with a majority in favour. In relation to the measures required to reduce PCC, the remaining customers were fairly evenly distributed around our preferred plan, with some wanting us to do more and some less. For leakage, 39 per cent wanted us to do more, however the majority of customers still selected the level of reduction in our preferred plan.

Due to the high level of support for our preferred plan we have not made any alterations. By shaping our plan to the outcomes of previous engagement we have built a plan for customers; this has been confirmed by this piece of research. We will continue to engage with customers and stakeholders on our plan, in particular with regards to leakage reduction. This will happen both as part of WRMP24 and our PR24 business plan submission. As part of PR24 we will examine customer preferences, acceptability and affordability in the context of the full range of services we provide including relating to wastewater.

Figure 22 Overview of final customer preferences (household customers)



From this piece of customer research, we were also able to determine 'willingness to pay' for our proposed preferred plan. If willingness to pay exceeds the cost of the plan it indicates that customers believe it represents good value for money.

Table 35 provides the willingness to pay value for household customers. Our *Technical Report - Customer and stakeholder engagement* provides results for non-household customers and future bill payers, as well as a comprehensive breakdown of different social groups and geographical areas. Due to the timing of our WRMP programme, the customer research necessarily used an earlier version of bill impact data. The bill impacts shown in the table correspond to the latest data; this does not invalidate any of our results and both sets of data are included in the customer and stakeholder technical report for completeness and consistency with DJS outputs. The customer research was conducted reflecting the proposed preferred plan in 2030, but we have also presented the bill impact for 2050. Costs related to water transfer are not included in bill impacts as they will not be funded by customers in our area.

The results show that household customers view our proposed preferred plan as good value for money. As presented in the customer and stakeholder technical report, this conclusion in fact extends to all 30 sub-groups for which results were generated; the lowest willingness to pay value was £18.00 for the under 35 age group.

Table 35 Customer willingness to pay versus estimated bill impacts

Plan	Estimated average annual bill impact	Household customer willingness to pay
Proposed preferred plan in 2030	£7.70	£23.05
Proposed preferred plan in 2050	£18.37	Not tested

11. Our adaptive plan

To help us manage uncertainties and ensure a low regrets approach, we have further developed our adaptive planning. Adaptive planning allows us to test a range of future scenarios to account for uncertainty and sets out how programmes may change in the future to meet long term ambitions under different circumstances. Through scenario testing, we have been able to prioritise low regrets activities in the short term, preparing ourselves for future needs without investing unnecessarily or prematurely, but taking action where it is clearly necessary and good value.

We have created a best value adaptive plan, which details how we will respond to changing external influences on our supply and demand. It is impossible to plan in detail for every possible outcome, however we have created three adaptive plan diagrams which demonstrate the range of alternative futures, using the scenarios we describe in Section 5. In the following sections, we present adaptive plan diagrams for climate change, water transfer, demand and technology. We have also created one whole adaptive plan diagram, Figure 31 Our adaptive plan as a whole, to demonstrate how these plans fit together.

In each adaptive plan, we set out how our plan may change including differences in option selection, and the resulting costs and benefits to each pathway. Each of the plans starts on a common pathway until 2030, which is the start of our preferred (most likely) plan, and branches into different pathways over time. In the following sections, we set out the impacts of alternative futures on our preferred plan, and in Section 11.10 we provide further detail on each of our adaptive plan pathways.

11.1 Low regret expenditure in our preferred (most likely) plan

In Section 3.5, we define low regret for our decision making approach. We used alternative scenarios, as set out in Section 5, and adaptive planning to identify low regret options for our preferred plan. These options meet needs in a wide range of plausible future scenarios alongside short-term requirements for our most likely scenario.

In particular, our demand management plan is designed to meet the stretching targets set out in the Government's Environmental Improvement Plan (2023). In benign scenarios, these options are still required in the short term to ensure that we meet these targets, and in more stretching adverse scenarios, they provide value to by helping us to meet our levels of service. Our chosen supply options for the NWT support all transfers in the long term and are best value in all scenarios.

One of our key objectives for the preferred plan is to improve our level of service for TUBs from 1 in 20 years to 1 in 40 years on average, and led by the updated Water Resources Planning Guideline and other consultation feedback, we have now represented this an option in our preferred plan. The TUBs improvement remains to be a low regret option from the draft plan, as in the case of more adverse futures we can return this level of service to 1 in 20 years and maintain the supply-demand balance. Therefore, 1 in 40 year TUBs is a low regret option which features on our adaptive plan diagrams, and notably is reverted in order to maintain our resilience in the high climate pathway.

Our preferred plan therefore aligns with the definition of the 'core' scenario under the final guidance on long-term delivery strategies[35].

11.2 Ofwat low scenario

As detailed in Table 10, the 'benign' scenarios from the final guidance on long-term delivery strategies for PR24 were combined to create an Ofwat low scenario. This scenario has an initial supply-demand balance which is more favourable than our WRMP baseline. It is important to note that we consider this scenario very unlikely, however it provides a useful understanding of an assumed optimistic level of expenditure.

As with all of our alternative future scenarios, we are unable to know whether we are following this pathway until at least 2030, by which point we will have begun our investment in demand reduction programmes to meet our targets in the most likely future. It is for this reason that the Ofwat low scenario results in the same overall plan to our preferred (most likely) plan. There is one small exception to this, as WR659a Free water efficiency devices is no longer required in Carlisle RZ due to the introduction of water labelling with minimum standards. This is explained further through the demand adaptive plan in Section 11.7. The pathway assumes that water labelling with minimum standards is not only introduced in 2025-26, but that it results in the expected benefits. This is a significant assumption, which we consider unlikely in these timescales, and therefore it does not form part of our core planning assumptions.

The Ofwat low scenario has the same option selection due to our stretching demand targets in the short- and long-term and water transfer needs. However, supply-demand balances are much more favourable which may allow us to guarantee improved levels of service in the longer term. This is due to underlying planning assumptions such as low climate change and population growth.

11.3 Ofwat high scenario

Similarly to Section 11.2, the 'adverse' scenarios from the final guidance on long-term delivery strategies for PR24 were combined to create an Ofwat high scenario. The Ofwat high scenario is also unlikely, given that it combines adverse futures, alongside their uncertainties, into a particularly stretching future. However, this is a useful scenario to understand alternative action in particularly adverse futures.

The largest impacts on the plan for this pathway are due to the lack of water labelling, which was excluded as per the Ofwat high demand definition, and the high impacts of climate change in a 4 degree world. In this pathway, the bulk of the initial investment remains the same, as we begin to reduce our demand towards our key targets. However, further into the future investment increases into demand options such as metering of common supply pipes and rainwater harvesting, in order to stretch ourselves towards the PCC target. This offsets the challenge of no introduction of water labelling, as without this, the per capita consumption target of 110 l/p/d is not achievable. This is the case for the company target as a whole, but also applies to Strategic and Carlisle resource zones individually.

The increased demand combined with a high climate futures leads to additional investment in supply options for Strategic RZ where these is a supply-demand balance need, and as described earlier, the low regret option to revert the level of service to 1 in 20 years would be utilised. Later into the future, options such as WR065b Whiteholme and WR144 River Tame are used to provide resilience to the high climate.

11.4 Environmental destination scenarios

We have high and low scenarios constructed around the environmental destination enhanced and BAU+ scenarios. As part of the Enhanced scenario for environment destination, additional licence reductions (over and above BAU+) are applied to SSSI's and other protected areas in specific waterbodies we abstract from. This scenario leads to an overall further total reduction in licence volume of over 10% compared to the BAU+ scenario. However, the impact on system deployable output (DO) is very similar to the BAU+ scenario. This is due to further licence reductions, under the enhanced scenario, being applied to sources where the additional lost water from the licence can be mostly made up from water in other parts of the resource zone.

Most of our resilience planning centres around the 2030s, before demand management policies can take effect. The timing of the abstraction reductions for the environmental destination falls after our short-term investment needs and, once these needs are met, the benefits provided outweigh the difference in environmental destination between scenarios. Consequently, our preferred (most likely) plan is expected to deliver outcomes under both of the environmental destination scenarios.

However, in order to consider the uncertainty in the benefits, we carried out sensitivity testing and included alternative pathways in our adaptive plan which assume water efficiency benefits are not as effective as predicted. We have also demonstrated the alternative investment and action required should our plan be less beneficial than anticipated.

For completeness, we have shown the environmental destination scenarios alongside our preferred plan on our whole adaptive plan diagram in Figure 31.

11.5 Climate change adaptive plan

We have included high and low climate change scenarios in our adaptive plan, as described in Section 5. Due to the implications of a high climate change scenario in the short term, we have produced a dedicated adaptive plan centred on climate change, to understand the impact of the decisions we make now on our future resilience if the climate doesn't change as we are assuming. In each scenario, we could plan for an alternative climate future by either implementing more options in good time to maintain our levels of service, or adjusting our levels of service following an impact on our supply-demand balance.

For North Eden and Carlisle RZ, the scenario analysis was carried out, however both zones could still meet their levels of service in the case of a high climate future. Therefore, the detail on this adaptive plan focuses on the Strategic RZ.

Adaptive planning for climate change supported our decision on low regrets activities in the preferred plan. We tested the plan against 3 scenarios:

(a) Investing in no options further to demand management and leakage, not aiming to meet demand targets (this scenario would also prevent us from transferring water), and not improving our TUBs level of service to 1 in 40 years;

(b) Investing in the preferred plan options, allowing us to reduce demand and meet our targets, transfer water to other water companies, and improve our level of service to TUBs only under our baseline planning assumptions. In this case we would revert the level of service in the case of a high climate future; or

(c) Investing in the preferred plan options, achieving the same aims as in (b), and some additional options to increase our resilience now to a high climate future. In the case of a high climate future, this option would allow us to retain the TUBs level of service improvement to 1 in 40 years from 2031.

We used the adaptive planning approach to understand the amount of investment required in options (a), (b) and (c), and the amount of regret should we undertake that investment and the scenario isn't realised.

If a high climate future was realised, we would not be able to maintain our current level of service for TUBs without any investment at all (i.e. option (a)). This is unacceptable, as we should not plan for a future in which we are not resilient, especially when there is a desire from customers to improve levels of service for TUBs.

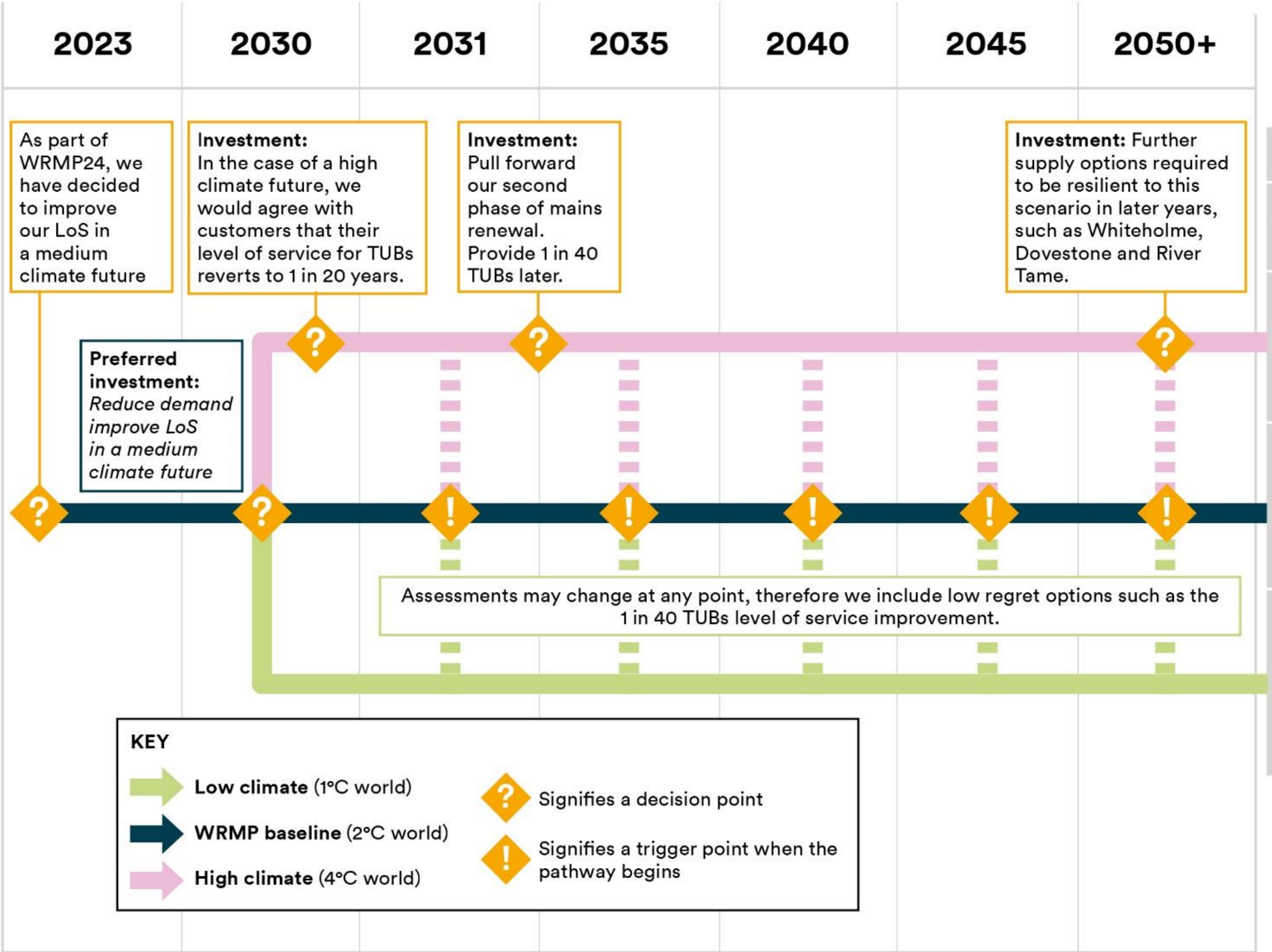
Were we to invest beyond the preferred plan, reducing demand and introducing enough new sources to provide the level of service increase in a high climate future, there would be a significant amount of investment required. In this case, if a low or medium climate future was realised, it would lead to a significant amount of regret, having improved our level of service to better than 2.5 per cent annual chance at significant cost.

In case (b), where we invest to improve the level of service for TUBs to 2.5 per cent in 2031 in a medium climate future, we are provided with the option to adaptively revert the level of service to 5 per cent annual chance should a more adverse future arise. This preferred plan is therefore affordable and low regret, as it provides us with additional resilience. The TUBs improvement option allows us to maintain our current levels of service in a high climate future, while improving them in a medium or low climate future as per customer expectations. It does this at a low cost to customers, while allowing us to transfer water to water-stressed regions.

On Figure 23Figure 23 Climate change adaptive plan, following the investment in (b), our preferred plan, we demonstrate how our plan would change if an alternative climate future were to take place.

It is also important to note that we consider a 1 degree world highly unlikely, and a 4 degree world a likely future scenario. For the high climate pathway, we have deferred investment in options that aren't needed until later in the planning period, and our preferred plan will deviate to this pathway at the trigger point. More detail on our monitoring plan and trigger points can be found in Section 11.8.

Figure 23 Climate change adaptive plan



Outcomes

Climate future	Resilience?	Potential TUBs LoS in 2031	Investment compared to preferred plan
RCP8.5	Yes, if we retain our 1 in 20 years TUBs LoS	5% annual chance	+ £200m 80 yr NPV
RCP6.0	Yes	2.5% annual chance	Preferred plan
RCP2.6	Yes	< 2.5% annual chance	Same as preferred plan

11.6 Water transfer adaptive plan

Over the course of three regional reconciliation periods we have observed significant uncertainty around transfer requirements due to the sensitivity of the investment models of other water companies. Strategic Resource Options, as well as other water company options, are also being continuously developed, which can make transfer options more or less attractive to recipients depending on the outcomes of their investigations or, in other cases, rule options out altogether.

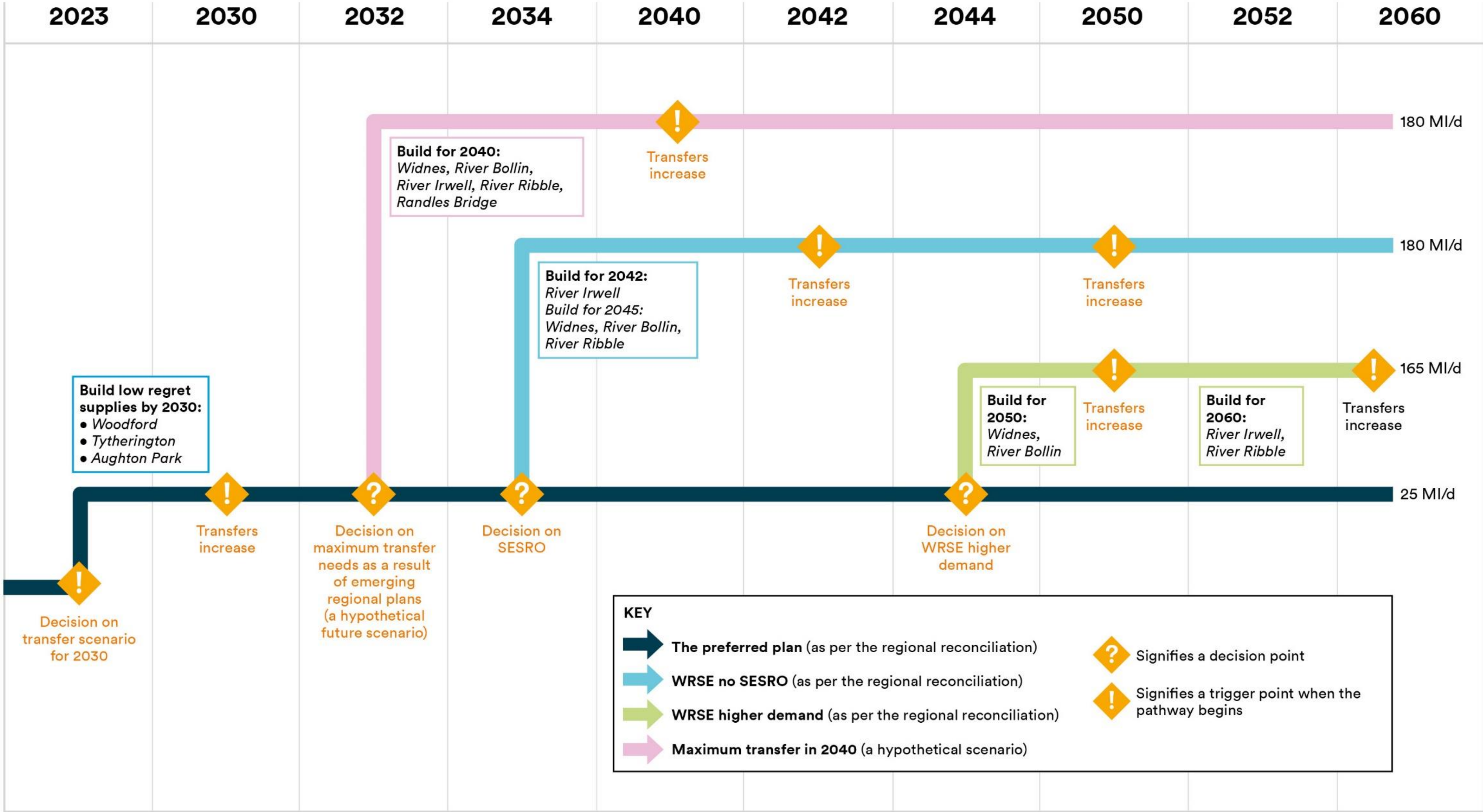
As a result of our consultation on the draft plan, we received feedback requesting alignment on water transfers between regional groups and water companies at each end of water transfers. We have worked closely with our transfer partners to ensure alignment on key planning assumptions, however, due to the timescales of WRMPs and conflicting timescales with Strategic Resource Option planning, this has not always been possible. Our plan reflects the latest information available to us at this point in time, aligning to the Inter-regional Reconciliation Report[6], and includes a feasible and stretching alternative scenario in the case that needs change.

We have therefore included a number of transfer scenarios in our adaptive plan, including the agreed outputs of the regional reconciliation process. All of the transfer scenarios included in the adaptive plan are detailed in Section 5.2.4.

We consider all of the transfer scenarios that we have set out to be plausible scenarios and it is therefore appropriate to build a plan which can satisfy all of these scenarios in the short term. We have therefore decided to build Woodford, Tytherington and Aughton Park options by 2030. These options are best value in all of our alternative transfer scenarios, therefore we consider these to be ‘low regrets’ options, and have built the transfer adaptive plan around their implementation by 2030.Whilst these scenarios are based on reconciliation 3, there will be the opportunity to review, discuss and agree later decision points in the adaptive plan.

Two reasonable alternative scenarios were agreed with WRSE for future transfers. These hinge on key decisions such as permission for the South East Strategic Reservoir Option (SESRO) and deliverables on their demand reduction plan. We have created an adaptive plan which defers investment in further transfer sub-options until a decision is made by WRSE. In AMP7, we undertook a low regrets assessment of these options, however, we will pause the RAPID process for these options and will be ready to begin when a decision for the pathway is made. Decision points are detailed on Figure 24, our water transfer adaptive plan.

Figure 24 Water transfer adaptive plan[37]



11.7 Demand and technology adaptive plan

We have created a number of scenarios relating to demand for water and the assumptions around these are explained in Section 5.2. The assumptions include different forecasts for population growth, outcomes of government intervention through water labelling, outcomes of our preferred demand management programme, and the pace of implementation of certain technologies. They have also been informed by the framework provided in Water UK's 'A Leakage Routemap to 2050[38].

The Ofwat demand scenarios include assumptions not only around population growth, but also around the introduction of water labelling with minimum standards. The high and low scenarios form two extremes, with the high scenario assuming no government intervention, and the low scenario assuming the introduction of water labelling with minimum standards by 2025 (FY26). We have assumed that the low scenario is very unlikely, given the timescales required for introducing new legislation, and the high scenario to also be unlikely, given the statements made by Defra announcing the intention to introduce water labelling[44] and the recent instructions in consultation feedback and the updated WRPG to include the benefits of water labelling from 2025. In our most likely scenario, for our revised draft plan, we have therefore updated our preferred plan to include the benefits of water labelling from 2025-26, expecting limited benefits in the first 5 years of the planning period, as guided by the WRPG[4]. Our preferred plan counts on the benefits of this option to meet long term targets for reduction in consumption.

We also evaluated the impacts of the Company High and WRW higher demand scenarios. Both of these scenarios consider adverse outcomes of the preferred plan for PCC reduction. In the case of the Company High scenario, there are further adverse impacts such as alternative outcomes for leakage, a high climate future and water quality impacts, as explained in Table 10. This in particular is a highly stretching future, demonstrating the potential additional options which may need to be introduced, however it is considered a highly unlikely scenario and therefore no short-term options are included in the core plan as low regret.

11.7.1 Impact of population in our demand adaptive plan

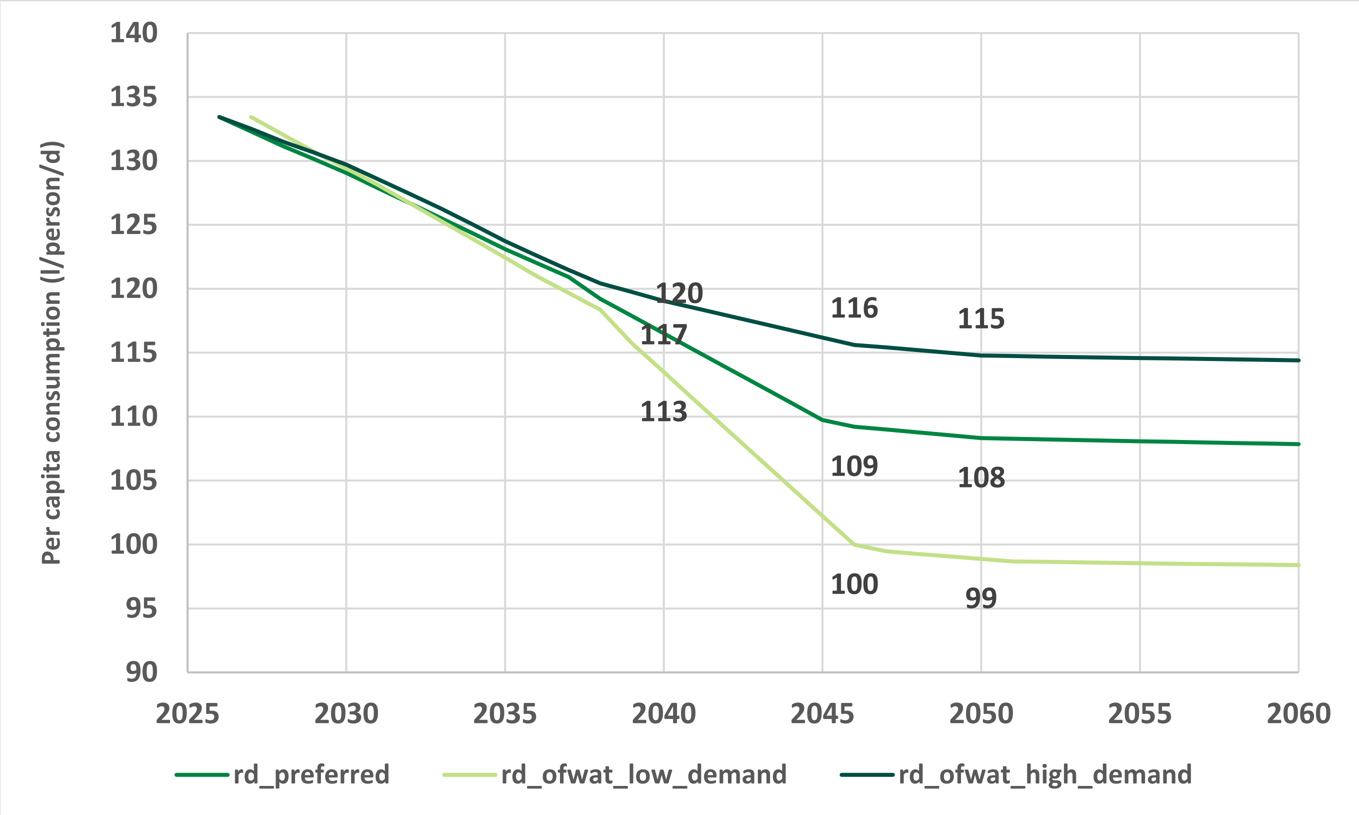
In the case that population growth is lower than we are forecasting, there would be little impact on our proposed plan. This is because our PCC and leakage targets are partially independent of changes in population. While we still need to commit to the same programmes to improve water efficiency, the population difference will have an impact on the total demand, improving the supply-demand balance position. We will monitor population growth according to our monitoring plan detailed in Section 11.8.3, however if the population is lower than expected, then the preferred plan would deliver our outcomes.

11.7.2 Water efficiency impacts on our demand adaptive plan

The introduction of water labelling, with or without minimum standards, has a significant impact on the deliverability of our PCC target. As can be seen in the demand adaptive plan diagram in Figure 30 on a pathway with no government intervention through water labelling such as the Ofwat high demand pathway, or if water labelling doesn't have the expected benefits, we are unable to meet our long-term PCC target. However, the more extensive the government intervention becomes, the more achievable the PCC target by 2050.

In the Ofwat low demand scenario, water labelling with minimum standards is introduced by 2025. As part of our monitoring plan we will monitor government intervention, however the introduction of these measures alone does not provide us with the opportunity to reduce the demand programme we include in our preferred (most likely) plan. It is important that we also monitor how effective the intervention has been and adjust our plans as necessary. Evidence that the intervention is or isn't working may take years to gather, and therefore we are including our demand programme as low regret intervention, preparing us for our most likely scenario. If we find that water labelling is effective after a number of years, our plan will continue to prepare us for other adverse futures. If we find that it is not effective, we could consider further alternative measures, such as metering properties on common supply pipes.

Figure 25 Impact of preferred (most likely) demand plan, low demand plan and high demand plan



The Company High and WRW Higher Demand pathways allow us to understand the alternative measures that we might take in the case that our options are not as effective as we were expecting. These pathways go above and beyond the sensitivity testing we carried out on demand glidepaths, which is detailed in Section 10. The WRW Higher Demand pathway, where only half of the water efficiency and non-household reduction measures we make are successful in the long-term, demonstrates how we may change our plan. For example, we would look to revert our TUBs level of service to 1 in 20 years, and in the long term we would need to invest in further supply and demand options to maintain our supply-demand balance. In the case of the Company High scenario, where water efficiency does not improve, alongside other adverse impacts, we would need to invest in more demand options such as common supply pipe metering and a larger mains renewal programme. We would also need to build more supply options to maintain our levels of service in the short and long-term. In future adaptive plans, we may also consider using tariffs or adjustments to billing practice, and supply pipe adoption.

We consider the WRW Higher Demand pathway to be a plausible future scenario, and it is therefore important that we monitor demand closely. The Company High is an extreme scenario combining multiple areas where predictions vary from future outcomes, and therefore we consider this scenario highly unlikely, especially in the short-term. However, it is important to include these scenarios to understand the range of alternative futures we may face.

In the future, it is also possible that innovation may bring about cheaper costs and more beneficial options. However, it is important to understand the plan we are following now and the uncertainty around it. Therefore, to solve most of our scenarios we have only considered feasible options, around which we have confidence in our estimates of costs and benefits. In order to explore alternative possibilities, we also have considered some the potential for improved operationalisation of technology in our Ofwat ‘Technology’ scenarios.

The demand adaptive plan demonstrates that it is vital there is government intervention such as water labelling. The earlier and more extensive this intervention, the more time we have for this to take effect and to monitor its efficacy, and the more potential we have to reduce the long-term bill impact to customers of demand management measures. It is clear however, that there is uncertainty around the impact of these measures and without action in the short-term, we are also at risk of not achieving targets. We have therefore chosen to invest in options as per the preferred plan as low regret options, and to monitor their effectiveness over coming years.

11.7.3 Ofwat 'Technology' scenarios

In our preferred (most likely) demand plan, we are investing in mains renewal, in-pipe repairs and lining technologies to ensure that our interventions continue to provide benefit and improve asset health over the long term. Technology offers an important opportunity to accelerate performance in parts of our plan. We have included these scenarios to understand how they could potentially impact our chosen programme of options.

The Ofwat 'Technology' scenarios have a wide-ranging definition in the Final guidance on long-term delivery strategies[35], and this will be explored further as part of our price review (PR24) submission. For the adaptive plan within the WRMP, the direct impact of these scenarios on water resources have been considered.

More detail on the assumptions behind these scenarios can be found in Table 10. As per the other adaptive planning scenarios, North Eden RZ is not impacted by the scenario, given that it does not have as stretching demand targets or any supply-demand need.

11.7.3.1 The Ofwat Faster Technology scenario

Figure 26 The Ofwat Faster Technology scenario

Faster technology scenario

1) Smart water supply network by 2035:
   - automatic detection of potential leaks; and
   - robust real-time asset condition information – including telemetry, robotic and drone inspection – enabling a risk-based maintenance approach across the business.
2) Full smart meter penetration by 2035.[46]

This scenario assumes that we can implement full smart metering at a quicker pace than our estimations (by 2035 rather than by 2040). We have explored this scenario to understand how it could reduce our costs in meeting demand targets and level of service improvements. However, this level of operationalisation of metering is not currently considered to be realistic due to the limitations of our Free Meter Option (FMO) programme and because we are not classed as a 'water-stressed' area, hence don't have the ability to implement compulsory metering.

This scenario also assumes that options such as Dynamic Network Management and Permanent Network Sensors are better value options. Our leakage strategy focuses on proactively preventing leakage, while the technology options, network sensors and dynamic network management, are designed to respond reactively to identify leaks. The resulting plan from the technology scenario was therefore a smaller mains renewal programme, due to the selection of alternative smart water network options, and pressure management was no longer required in Strategic RZ in 2049. For Carlisle RZ. Water efficiency investment was reduced overall due to the faster pace of metering providing a benefit for a larger part of the planning period. Largely, in the short term, investment is not changed in this pathway. This is because the pathway is not due to branch for the next 5 years, and in the short term we need to invest in a large part of our demand programme to meet targets in a wide range of scenarios.

Our option to increase our TUBs level of service is delivered through demand intervention, and this scenario could would help to deliver that sooner. In the short term, supply options are not impacted by this scenario due to the improvement in the supply-demand balance, and the fact that our preferred supply options are delivered to meet water transfer needs.

11.7.3.2 The Ofwat Slower Technology scenario

Figure 27 The Ofwat Slower Technology scenario

Slower technology scenario

1) Smart water supply network by **2040**:
   - automatic detection of potential leaks; and
   - robust real-time asset condition information – including telemetry, robotic and drone inspection – enabling a risk-based maintenance approach across the business.
2) Full smart meter penetration by **2045**.

This scenario assumes that we meter at a much slower pace than we believe is necessary to meet our targets. In this scenario, despite our alternative investments, we are unable to meet our long-term water efficiency targets in neither Strategic nor Carlisle RZ. This scenario demonstrates that we need to begin a smart metering programme immediately in order to realise enough benefit to meet our long-term PCC target.

For Strategic RZ, we would need to look for alternative methods to meet short term leakage and PCC targets, such as pressure management, rainwater harvesting and flow regulators, which are all selected in the first 5 years. In adaptive planning, we would not invest in these options at this point as they are not required to meet a wide range of futures, and in particular are not selected for the most likely scenario. In Carlisle RZ, the result is similar: flow regulators are chosen earlier and mains renewal is brought forward to help achieve targets in the shorter term.

Figure 28 Kilometres of mains renewed in preferred (most likely) plan and Ofwat Technology scenarios

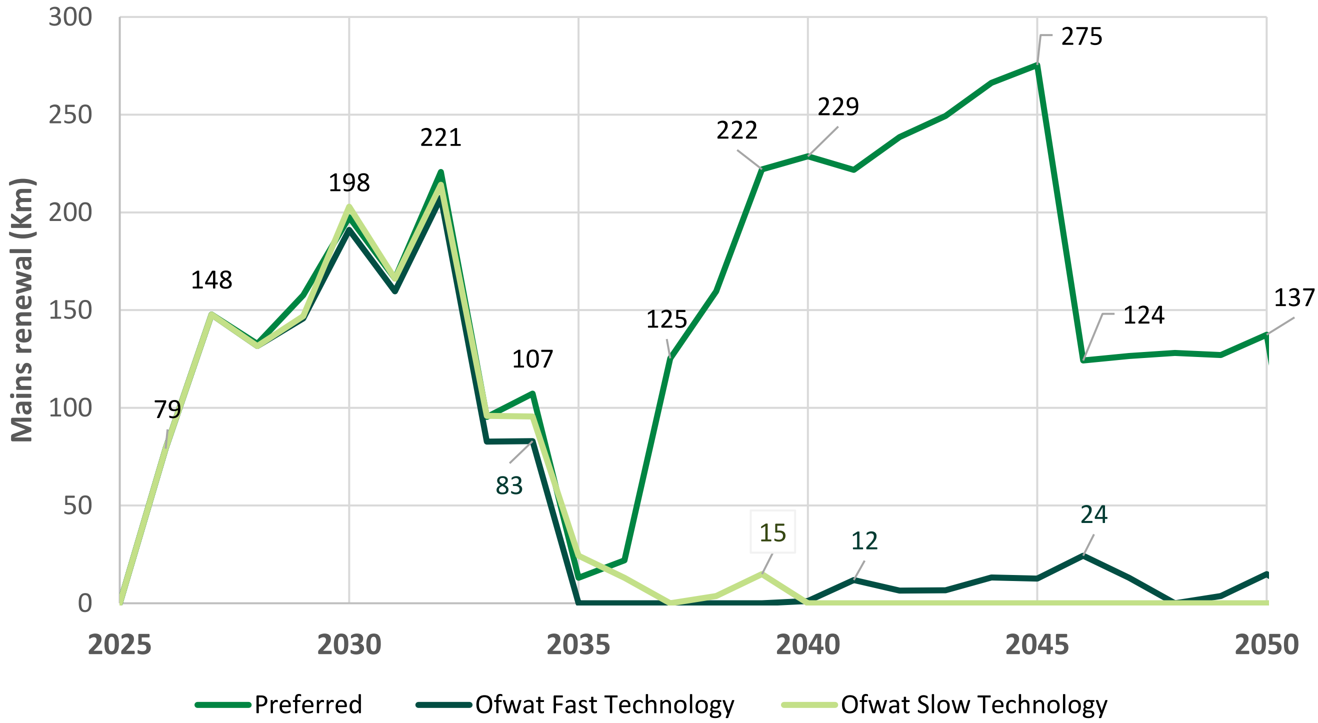
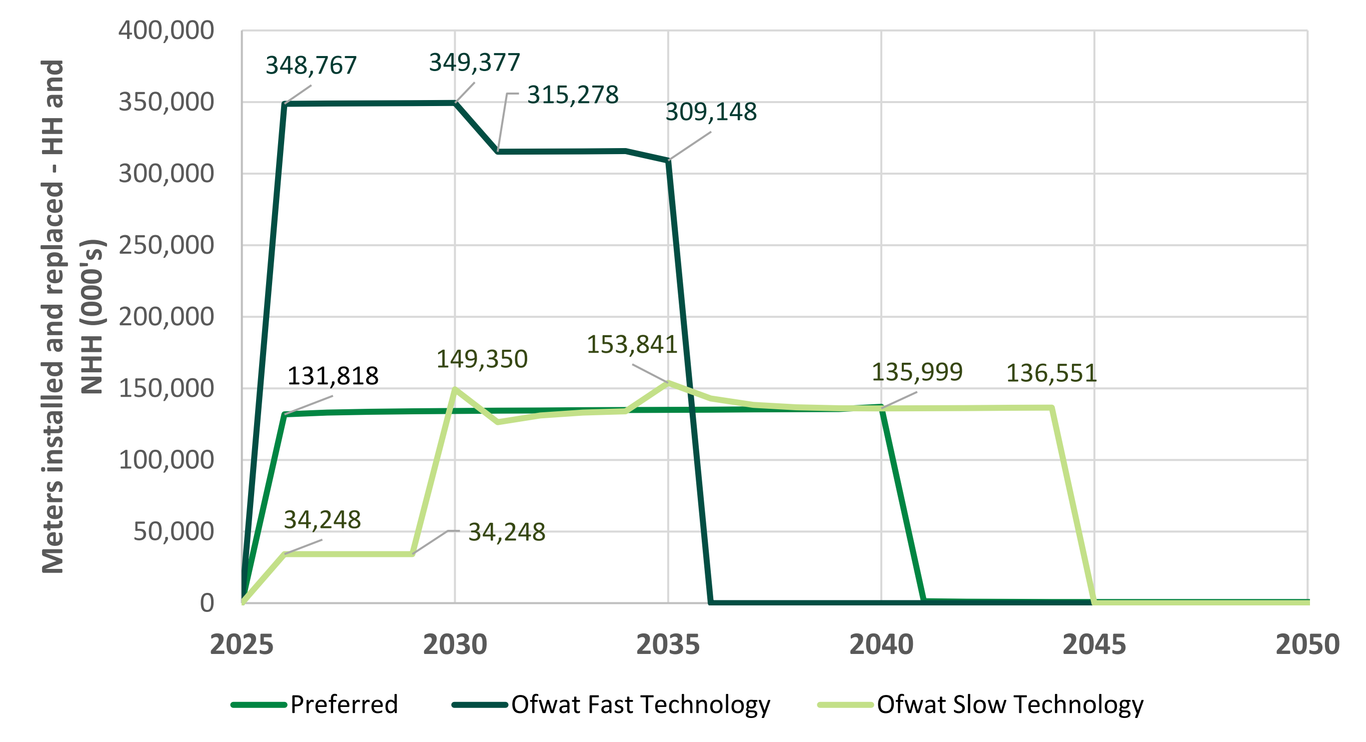


Figure 29 Meters installed (replacements and new) for households and non-households due to WRMP options



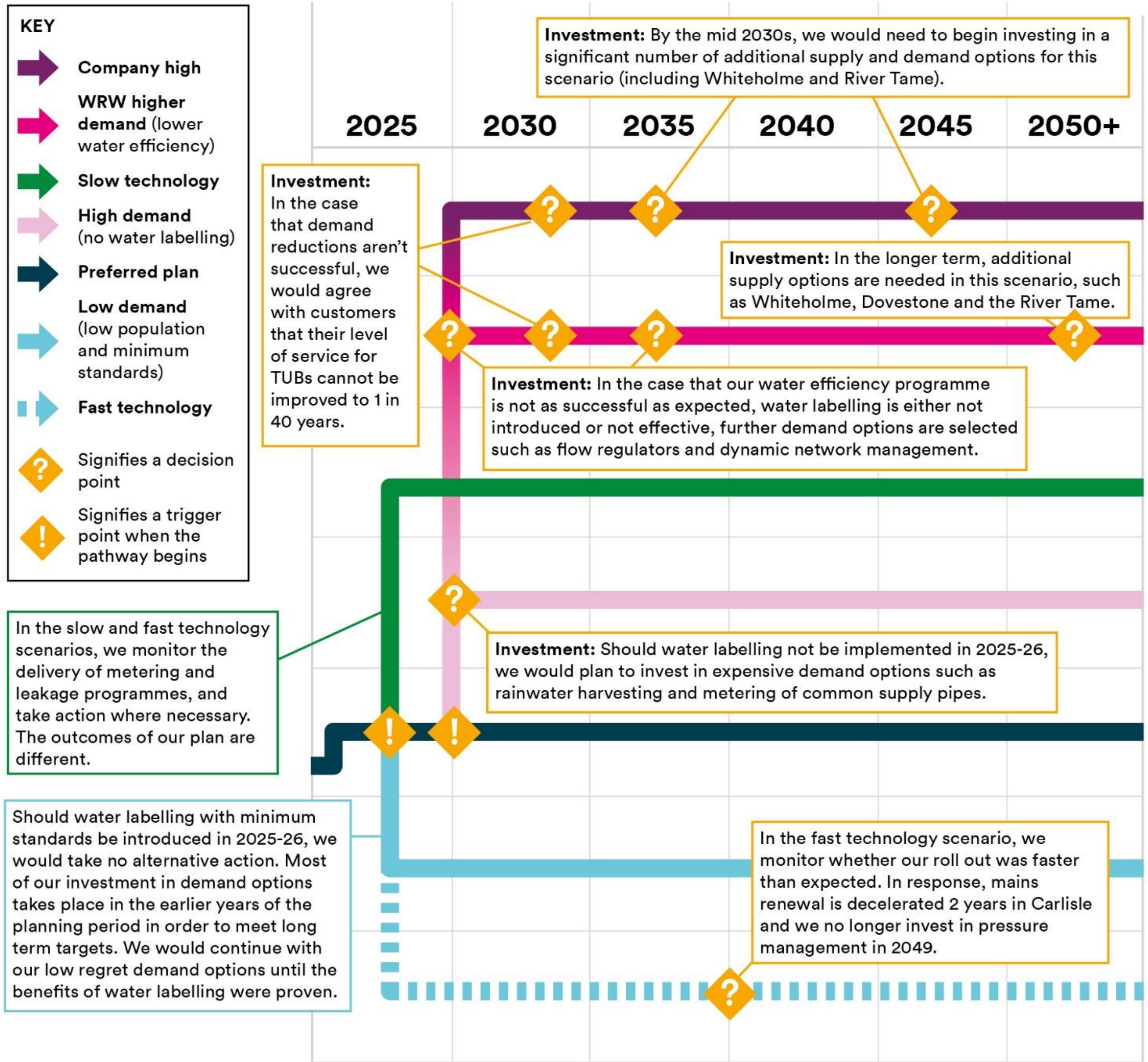
11.7.4 Our 'Company High' scenario

Our Company High scenario is stretching, hypothetical and unrealistic alternative future which demonstrates an upper example of an extremely adverse outcome of our plan.

In considering this extremely unlikely scenario, we found that our 1 in 20 TUBs level of service could not be met in the shorter term as a result of reduced benefits of demand management and leakage options (i.e. seeing no reduction in PCC, and only half the expected reduction in leakage), and the impact of high climate change. There are also some water quality impacts as described in Section 5.2. We have used this scenario in our adaptive planning to demonstrate the type of options we would need to deliver in the long-term in such a future. Our decision point for this scenario happens in 2030, however from the start alternative demand options are selected to attempt meet the supply-demand balance.

Our demand and technology adaptive plan is shown in Figure 30.

Figure 30 Demand and technology adaptive plan



Outcomes

PCC in 2050 (l/p/d)	Leakage reduction by 2050	NHH reduction by 2050	Potential TUBs LoS in 2031	Investment compared to preferred plan
134	53% (significantly larger leakage options are selected early)	15%	> 5% annual chance	+ > £5bn 80 yr NPV
117	51%	12%	5% annual chance	+ £150m 80 yr NPV
106	52%	15%	2.5% annual chance	> £1bn 80 yr NPV if the scenario is no more cost effective
115	52%	15%	2.5% annual chance	+ £700m 80 yr NPV
110	50%	15%	2.5% annual chance	Preferred plan
99	50%	15%	< 2.5% annual chance	- £7m 80 yr NPV
104	52%	15%	< 2.5% annual chance	£1bn 80 yr NPV if the scenario is no more cost effective

11.8 Monitoring our plan

In this section we detail how elements of the adaptive plan will be monitored. A broader understanding of our company adaptive plan and how we will monitor it will be found in Price Review documents on our Long-term delivery strategy. This will include common factors impacting more than one area of the business such as climate change.

Throughout our water resources adaptive plan, we have identified a number of metrics which should be monitored to understand whether we are following an alternative scenario and how we may need to move onto an alternative pathway. These include:

- Climate change;
- Transfer requirements of other water companies;
- Population growth;
- The introduction and efficacy of government intervention through water labelling; and
- The efficacy of our demand management and water efficiency options on per-capita consumption.

The following sub-sections detail how we will monitor each metric. Section 11.9 details how these then influence our trigger points and how we manage a change from one pathway to the next.

11.8.1 Monitoring climate change

Climate change is being monitored by a community of scientists and climatologists. If the community recommends that we plan for a more severe climate change scenario in the next 15 years (i.e. if the RCP8.5 emissions pathway and a 4°C world becomes our new assumption), then we need to start investing in options now to either maintain our current five per cent annual chance of TUBs, or improve our level of service for TUBs to a 2.5 per cent annual chance.

We have a number of sources to help us monitor climate change:

- Annual assessments by WMO, UNFCCC and other international organisations, of atmospheric carbon and methane concentrations and global warming;
- Annual update by the Met Office on State of the Climate, indicating UK rates of warming on a national and regional basis; and
- Assessments on the expected rate of warming if international commitments are met, such as the Paris Climate Accords.

These assessments will inform our planning assumptions every five years (i.e. in line with the WRMP planning process) on the most appropriate emissions pathway to assume, alongside recommendations from the government and regulators.

11.8.2 Monitoring transfer requirements

Water companies and regional groups are following adaptive planning processes and detailing their future needs for water transfers. As the source region for the NWT SRO, we are in regular contact through regional groups with recipients of transfers and we are regularly updated on future needs; therefore our monitoring is continuous. The NWT SRO is a flexible and scalable transfer option, which includes a wide range of support options of varying lead times.

11.8.3 Monitoring population growth

We periodically monitor population through changes to local authority plans and update our forecasts annually if they need to change, and for each WRMP annual review. The WRPG states that local authority plans must underpin population forecasts and we have found that these forecasts are also more accurate when compared to ONS (trend-based forecast) in the last five years.

The alternative scenario for population growth assumes an ONS-based forecast which is traditionally lower than the plan-based forecast, however it is highly unlikely that our assumption basis would change as this is a key requirement from the WRPG. In addition to this, the lower population scenario results in an almost identical programme, due to the demand reduction targets and water transfer needs.

11.8.4 Monitoring water efficiency

We continuously monitor customer usage and report on this annually through our annual performance reporting. This will continue and we will use this monitoring to understand whether we need to consider a change in our plan to one of our adaptive pathways.

We will also report annually on our household and non-household demand reduction performance and water efficiency activity undertaken. Internally, we will monitor performance on a minimum of a monthly basis (frequency increases during periods of dry weather).

During a non-household water efficiency visit leak flows will be measured before and after they are fixed. Meter readings allow us to see if savings are sustained. The frequency of meter reads is variable depending on the type of meter. The roll out of smart metering in AMP8 will increase our frequency of reads and ability to measure effectiveness. We will also utilise control groups to measure effectiveness of demand reduction interventions.

We will monitor the success of our demand reduction programme over the coming years. This includes our smart metering roll out for households and non-households and the success of our interventions on leakage. Should we find that our metering programme is much faster than anticipated, or innovation occurs such that metering common supply pipes should be cost beneficial, we shall review this and consider a change in intervention.

11.9 Trigger points, decision points and managing a change in pathway

Our WRMP is monitored regularly using the Annual Review process. During this process, we report on the progress and delivery of our WRMP and highlight any changes made to the plan. As we have an adaptive plan, we will include information regarding monitoring of the current pathway and what this monitoring demonstrates. The annual review will also include a forward look to highlight challenges, risks, milestones, decision points and any changes to our planned outcomes that might affect delivery of our WRMP. If there have been any changes in regard to our supply, demand, or target headroom forecasts, we will monitor these and verify our resulting supply-demand balance position with respect to our scenarios.

In our adaptive plan, we have considered a range of alternative futures. In our preferred plan, we have included low regrets decisions which help us to maintain water supply resilience should some of these futures arise, and deferred investment where it is unnecessary unless that future is realised. If we reach a decision point in our plan which puts us onto one of our defined alternative pathways, and this requires additional investment, we will discuss the implications of this with regulators and stakeholders. Our decision points align well with the WRMP process, and at these points we will consult on any changes that deviate from our current adaptive plan. Through the WRMP process, we will ensure that adaptive plans we have chosen now remain to be the best decision at that point in the future, and revise these according to any future regulatory expectations.

11.9.1 Sensitivity testing of decision points

11.9.1.1 Water transfer adaptive plan

For our transfer adaptive plan, our decision points are linked to the transfer needs of Water Resources South East, and therefore the sensitivity testing around these needs is a requirement for their Water Resources Management Plan and/or Regional Plan.

In order to sensitivity test this ourselves, we have considered the possibility of moving the year of implementation of our trade. We have found that due to the delivery timescales of our larger NWT options, any larger transfer needs would need to be confirmed at least 8 years in advance of the transfer start date.

In addition to this, we carried out sensitivity testing on the availability of preferred plan options to understand the next best value option to implement in a number of scenarios. The results of this test can be found in Section 10.4.

11.9.1.2 Climate and demand adaptive plans

For other alternative scenarios, such as the Ofwat scenarios on demand and climate change, we have tested the sensitivity of our plan to alternative decision points. Our monitoring points align closely to the timescales of the WRMP cycle, including the Annual Review process. Outside of the transfer adaptive plan, most of the options we are intending to implement are either in the short term and are included as part of our core (Preferred) pathway, or they are much longer term, which gives us time to revise our adaptive plan and time estimates for delivery.

In the short to medium term, we have included our preferred plan option to improve our resilience to TUBs as a low regret option. This option is inherently flexible, and so on an annual basis, as part of the review, we will understand whether this should continue to be implemented according to supply-demand balance needs. The sensitivity test demonstrated that the plan was resilient to the decision point for the TUBs level of service change, as this could be implemented or reverted within one year if necessary.

Where additional demand options are required, as long as funding was available, these were also resilient to alternative decision points. This is because they begin to provide benefit as soon as they are implemented and can be deployed in a modular way if necessary[57].

In pathways where supply options are selected, such as in the Ofwat high climate future, the sensitivity test demonstrated that most supply options take four to six years to be implemented. Decision points therefore align well with WRMPs, as it allows for a robust assessment in the WRMP process and implementation over the upcoming AMP. This is particularly the case for Whiteholme and Dovestone, two common options introduced in alternative futures, as they both have an estimated four year implementation time.

11.10 Key information on our adaptive plan as a whole

Figure 31 shows our whole adaptive plan diagram, with all of the key pathways.

Table 36 details trigger and decision points for our adaptive plan.

Table 37 demonstrates how the individual pathways deviate from the preferred plan, including: option selection, investment, best value cost, monitoring points and decision points. For a detailed, yearly and Asset Management Period (AMP) by AMP breakdown, please refer to our WRMP Tables, which are published alongside our WRMP Main Report and Technical Reports.

[57] While demand options can be introduced in a modular way, it is better value to progress with larger planned programmes as this helps to introduce cost efficiencies.

Figure 31 Our adaptive plan as a whole

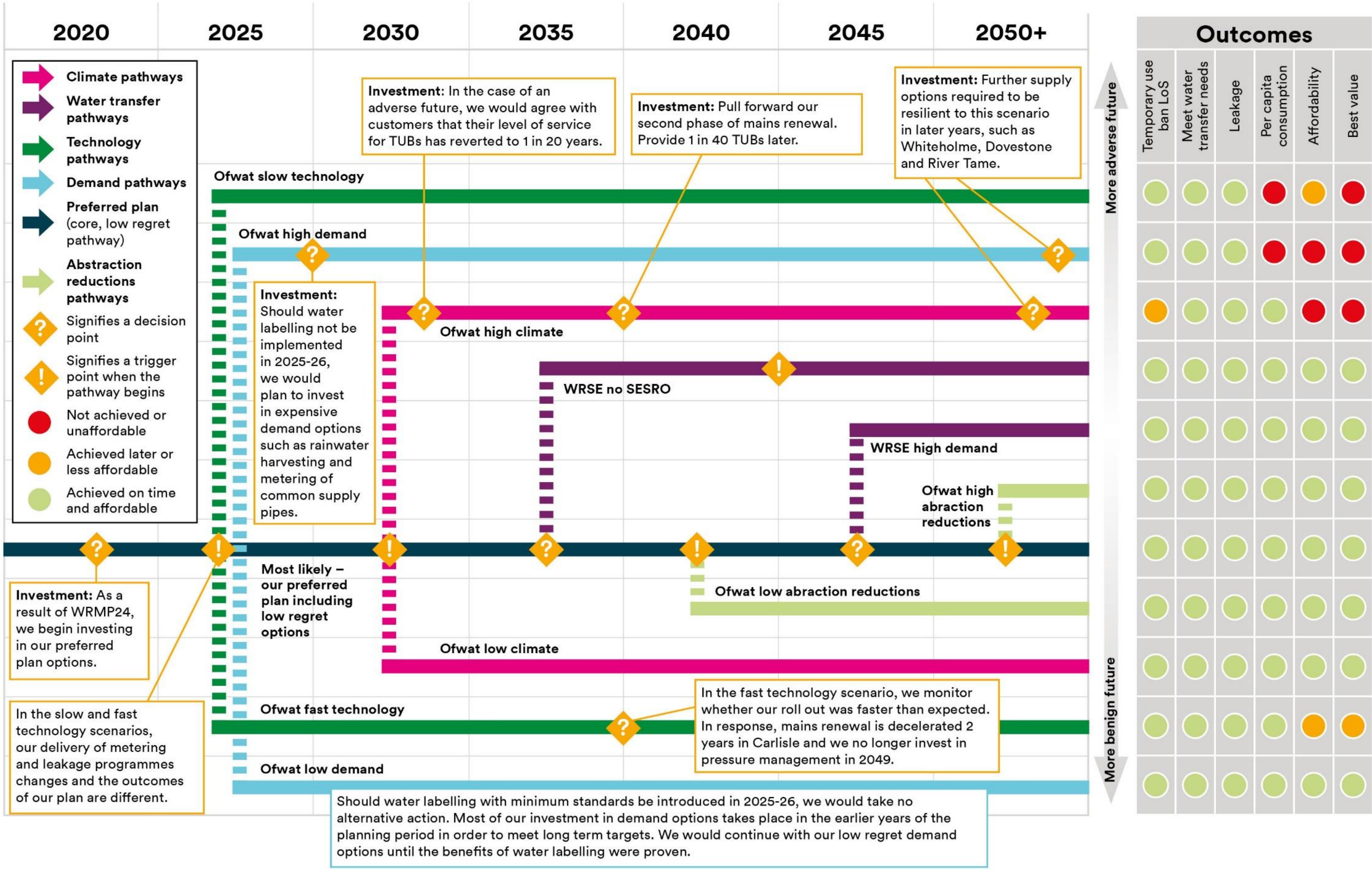


Table 36 Trigger and decision points for our adaptive plan

Pathway (scenario) name	Corresponding monitoring plan/metric(s)	Trigger point	How a trigger point is defined	First decision point	Decision to be taken
Ofwat high (based on Ofwat scenarios)	WRMP Annual Review and water efficiency monitoring, IPCC climate change review	2026	IPCC report warming commensurate with the high climate pathway. Water labelling is not introduced in 2025 (FY26).	2028	Investment is required in rainwater harvesting for additional water efficiency benefit. Later in 2031, metering common supply pipes and reverting the TUBs level of service are utilised.
Ofwat low (based on Ofwat scenarios)	WRMP Annual Review and water efficiency monitoring, IPCC climate change review	2030	IPCC report warming commensurate with the high climate pathway. Water labelling with minimum standards is introduced in 2025 and is found have the anticipated impact.	2048	WR659a is no longer required in Carlisle RZ, therefore the decision would be made to no longer invest in this option.
Ofwat high climate	IPCC climate change review	2030	IPCC report warming commensurate with the high climate pathway.	2031	We agree with customers that their level of service would revert to 1 in 20 years for TUBs.
Ofwat low climate	IPCC climate change review	2030	IPCC report warming commensurate with the high climate pathway.	N/A - no alternative decision	
Ofwat high abstraction reductions	WINEP	2040	Alternative abstraction reductions are undertaken as part of WINEP.	N/A - no alternative decision	
Ofwat low abstraction reductions	WINEP	2040	Alternative abstraction reductions are undertaken as part of WINEP.	N/A - no alternative decision	

Pathway (scenario) name	Corresponding monitoring plan/metric(s)	Trigger point	How a trigger point is defined	First decision point	Decision to be taken
Ofwat high demand	WRMP Annual Review and water efficiency monitoring	2026	Water labelling is not introduced in 2025.	2028	Investment is required in rainwater harvesting for additional water efficiency benefit. Later in 2031, metering common supply pipes and reverting the TUBs level of service are utilised.
Ofwat low demand	WRMP Annual Review and water efficiency monitoring	2030	Water labelling with minimum standards is introduced in 2025 and is found have the anticipated impact.	2048	WR659a is no longer required in Carlisle RZ, therefore the decision would be made to no longer invest in this option.
Ofwat faster technology	We monitor the roll out of our demand reduction programme	2030	Our metering programme is more successful than anticipated and metering common supply pipes became cost effective, such that we fully metered by 2035.	2037	In this scenario, a number of options were delivered differently in the scenario definition. In addition to this, the first alternative decision is to no longer complete WR516h2, the second phase of mains renewal in Strategic RZ.
Ofwat slower technology	We monitor the roll out of our demand reduction programme	2026	Our metering programme is delayed or ineffective.	2026	In this scenario we would need to act differently from the beginning. Should metering be much slower, we would call on other leakage reduction activities from 2026.
WRW demand scenario (which replaces the 'RCG PCC' scenario from Draft WRMP24)	WRMP Annual Review and water efficiency monitoring	2030	Water efficiency does not improve in line with our expectations, as a result of customer behaviour or ineffectiveness of water labelling.	2031	In this scenario, we would agree with customers that their level of service for TUBs would not be improved as a result of the lower demand reduction.

Pathway (scenario) name	Corresponding monitoring plan/metric(s)	Trigger point	How a trigger point is defined	First decision point	Decision to be taken
Company high	WRMP Annual Review and water efficiency monitoring, IPCC climate change review	2026	This hypothetical scenario is used for illustrative purposes only to understand the scale of investment it would require.	2030 (for illustrative purposes only)	We begin to invest in much larger programmes for mains renewal and begin metering common supply pipes. We agree with customers that their level of service will not be improved. In the 2030s, we begin investment in a significant number of supply and demand options.
WRSE no SESRO transfer pathway	5 yearly WRMP, regional planning and SRO gated process	2042	Transfers become available to WRSE.	2034	At WRMP34, WRSE updates us on its transfer needs. Our decision point aligns to WRMPs and the lead time of sub-options.
WRSE higher demand transfer pathway	5 yearly WRMP, regional planning and SRO gated process	2050	Transfers become available to WRSE.	2044	At WRMP44, WRSE updates us on its transfer needs. Our decision point aligns to WRMPs and the lead time of sub-options.
Maximum transfer by 2040	5 yearly WRMP, regional planning and SRO gated process	2040	Transfers become available to other water companies.	2032	By 2032, or at WRMP29, other water companies update us on their transfer needs as part of regional planning. Our decision point aligns to WRMPs and the lead time of sub-options.

Table 37 Alternative investments in adaptive plan pathways

Pathway (scenario) name	Difference in financial investment (£m 80 year NPV)	Difference in best value cost to preferred plan (£m 80 year NPV)	Change in year of selection for preferred plan options (new year of selection indicated)	Additional options beyond preferred plan	Preferred plan options not in this pathway
Ofwat high (based on Ofwat scenarios)	1465	1621	WR516h2 2036 WR659a 2038 WR516a1 2040	WR010 2082 WR065b 2050 WR074 2084 WR077a 2050 WR105b2 2069 WR122 2066 WR141 2065 WR144 2051 WR187 2077 WR817 2076 WR825 2085 STT041b 2080 WR502f 2047 WR511h 2028 WR532 2067 WR669a 2034 WR685c 2028 WR601c_Incremental 2031 WR601a_Incremental 2031	WR502c 2035 WR511g 2049 WR694f 2026 WR694d 2026 WR694e 2026
Ofwat low (based on Ofwat scenarios)	-7	-7	No change	WR694c 2026 WR694a 2026 WR694b 2026	WR694f 2026 WR694d 2026 WR659a 2048 WR694e 2026

Pathway (scenario) name	Difference in financial investment (£m 80 year NPV)	Difference in best value cost to preferred plan (£m 80 year NPV)	Change in year of selection for preferred plan options (new year of selection indicated)	Additional options beyond preferred plan	Preferred plan options not in this pathway
Ofwat high climate	199	294	WR516h2 2036	WR065b 2056 WR074 2076 WR077a 2057 WR102e 2068 WR105b2 2084 WR106b 2085 WR122 2069 WR127 2071 WR141 2072 WR144 2060 WR187 2067 WR191 2084 WR800 2075 WR532 2078 WR669a 2070	WR511g 2049
Ofwat low climate	0	0	No change	None	None
Ofwat high abstraction reductions	0	0	No change	None	None
Ofwat low abstraction reductions	0	0	No change	None	None
Ofwat high demand	751	823	WR502c 2040 WR516h2 2036 WR659a 2038 WR516a1 2040	WR065b 2078 WR077a 2080 WR144 2085 WR669a 2034 WR685c 2028 WR601c_Incremental 2031 WR601a_Incremental 2031	WR511g 2049 WR694f 2026 WR694d 2026 WR694e 2026
Ofwat low demand	-7	-7	No change	WR694c 2026 WR694a 2026 WR694b 2026	WR694f 2026 WR694d 2026 WR659a 2048 WR694e 2026

Pathway (scenario) name	Difference in financial investment (£m 80 year NPV)	Difference in best value cost to preferred plan (£m 80 year NPV)	Change in year of selection for preferred plan options (new year of selection indicated)	Additional options beyond preferred plan	Preferred plan options not in this pathway
Ofwat faster technology	1713	1722	WR502a 2026 WR516a1 2040	WR502d 2026 WR532 2030 WR601c_Tech 2026 WR619c_Tech 2026 WR601a_Tech 2026 WR619a_Tech 2026 WR502b 2026 WR601b_Tech 2026 WR619b_Tech 2026	WR502c 2035 WR511g 2049 WR619c 2026 WR603e 2026 WR516h2 2037 WR603a 2026 WR619a 2026 WR659a 2048 WR603b 2026 WR619b 2026
Ofwat slower technology	1017	950	WR511g 2026 WR502a 2030 WR619a 2035 WR516a1 2029 WR659a 2030 WR619b 2035	WR502d 2030 WR532 2035 WR619d 2030 WR669a 2026 WR685c 2026 WR601e 2030 WR601a 2035 WR502b 2030 WR601b 2035	WR502c 2035 WR619c 2026 WR603e 2026 WR516h2 2037 WR603a 2026 WR603b 2026
WRW higher demand scenario (which replaces the ‘RCG PCC’ scenario from the draft plan)	111	81	WR511g 2038 WR516h2 2041 WR516a1 2034	WR065b 2072 WR077a 2075 WR144 2079 WR532 2034 WR669a 2027	WR502c 2035

Pathway (scenario) name	Difference in financial investment (£m 80 year NPV)	Difference in best value cost to preferred plan (£m 80 year NPV)	Change in year of selection for preferred plan options (new year of selection indicated)	Additional options beyond preferred plan	Preferred plan options not in this pathway
Company high	5497	6386	WR516a1 2031	WR006 2050 WR010 2050 WR017 2058 WR026b 2051 WR049d 2050 WR065a 2050 WR065b 2035 WR074 2050 WR076 2050 WR077a 2045 WR077c 2050 WR102b 2050 WR102e 2035 WR105b2 2050 WR106b 2050 WR107b 2051 WR122 2045 WR127 2045 WR140 2050 WR141 2047 WR144 2035 WR185 2057 WR187 2035 WR188a1 2052 WR191 2035 WR800 2049 WR817 2050 WR820 2052 WR825 2050 STT041b 2035 WR812c 2059 WR502f 2026 WR511j 2034 WR516m 2026 WR532 2034	WR502c 2035 WR511g 2049 WR516h1 2026 WR516h2 2037 WR659a 2048

Pathway (scenario) name	Difference in financial investment (£m 80 year NPV)	Difference in best value cost to preferred plan (£m 80 year NPV)	Change in year of selection for preferred plan options (new year of selection indicated)	Additional options beyond preferred plan	Preferred plan options not in this pathway
				WR601c_Incremental 2046 WR524a 2034 WR601a_Incremental 2031	

Pathway (scenario) name	Difference in financial investment (£m 80 year NPV)	Difference in best value cost to preferred plan (£m 80 year NPV)	Change in year of selection for preferred plan options (new year of selection indicated)	Additional options beyond preferred plan	Preferred plan options not in this pathway
WRSE no SESRO transfers pathway	681	942	No change	STTA4 2042 WR015 2042 WR049d 2045 WR076 2045 WR102b 2045 WR107b 2050	None
WRSE higher demand transfers pathway	436	600	No change	STTA4 2050 WR015 2060 WR076 2050 WR102b 2050 WR049d 2060	None
Maximum transfer by 2040	785	1095	No change	STTA4 2040 WR015 2040 WR049d 2040 WR076 2040 WR102b 2040 WR107b 2040	None

12. Conclusions

We have developed a best value, low regret, adaptive plan, which meets the objectives set out in Section 1.2. We have completed this using a decision making approach, which aligns with WRMP guidance on decision making and Ofwat's guidance on long-term delivery strategies. The resulting plan provides additional benefit to customers, the environment and national resilience.

12.1 How we engaged with the board during this process

The board was engaged on multiple occasions during the production of the report. On the first occasion, the board conducted a WRMP "Deep Dive". This process provided the board with information to challenge and give guidance on, for all the reports produced.

On the second occasion, the board signed off on the Board Assurance statement, prior to the WRMP regulatory submission. This statement declared the confidence of the board in the adherence of assurance and governance processes to the requirements set out by the guidance, the application of governance during the WRMP development, and the robust customer research which underpins the best value plan for customers and the environment. In this statement the board identified where uncertainty exists in the report, and the approach to managing such uncertainties, and declared their belief that the WRMP is of a high quality and meets the requirements of the Water Resources Planning Guideline.

Appendix A Programme appraisal tables and figures

Table 38 Preferred plan options (costs discounted depending on year of option selection)

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR107a2	GWE_AUGHTON PARK a2	Strategic RZ	2030	10.00	71.46	42.48
WR111	GWE_WOODFORD	Strategic RZ	2030	9.00	74.38	35.37
WR113	GWE_TYTHERINGTON	Strategic RZ	2030	3.00	26.43	12.41
WR510	LEA-SRZ15_In-pipe repairs and lining technologies	Strategic RZ	2026	4.47	-19.95	3.97
WR516h1	LEA-SRZ10_Mains rehabilitation/renewal/replacement	Strategic RZ	2026	49.12	160.55	191.09
WR603e	EMT-SRZ15_Enhanced metering of households on single supplies (smart meters)	Strategic RZ	2026	60.46	469.63	572.84
WR615c	EMT-SRZ5_Replace existing non-household meters with smart meters	Strategic RZ	2026	10.44	-14.85	18.49
WR619c	EMT-SRZ10_Replace existing household meters with smart meters	Strategic RZ	2026	10.24	-4.08	39.03
WR658c	WSD-SRZ10_Free water efficiency devices (inside/internal)	Strategic RZ	2026	4.60	-20.83	1.70
WR659c	WER-SRZ15_Free water efficiency devices (outside/external)	Strategic RZ	2026	4.00	-3.94	10.33
WR661c	WUA-SRZ15_Free water efficiency visits (households)	Strategic RZ	2026	12.98	-5.79	9.10
WR677c	WUA-SRZ10_Non-household water efficiency programme	Strategic RZ	2026	12.94	-21.91	6.18
WR694f	WSA-SRZ15_Government intervention (e.g. water labelling)	Strategic RZ	2026	36.27	-54.55	-6.31
WR524d	LEA-SRZ10_Upstream tile optimisation	Strategic RZ	2027	5.78	12.53	33.69
WR520c	LEA-SRZ5_DMA optimisation	Strategic RZ	2030	2.00	-1.74	9.10
WR502c	LEA-SRZ5_Permanent network sensors	Strategic RZ	2035	20.00	215.32	244.41
WR516h2	LEA-SRZ25_Mains rehabilitation/renewal/replacement	Strategic RZ	2037	50.80	265.79	271.86
WR511g	LEA-SRZ5_Pressure management	Strategic RZ	2049	1.00	5.63	13.01
WR511a	LEA-CRZ5_Pressure management	Carlisle RZ	2026	0.10	-1.25	3.91
WR603a	EMT-CRZ5_Enhanced metering of households on single supplies (smart meters)	Carlisle RZ	2026	0.83	8.27	17.80
WR615a	EMT-CRZ5_Replace existing non-household meters with smart meters	Carlisle RZ	2026	0.20	0.26	0.53

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR619a	EMT-CRZ10_Replace existing household meters with smart meters	Carlisle RZ	2026	0.15	-1.16	0.59
WR658a	WSD-CRZ10_Free water efficiency devices (inside/internal)	Carlisle RZ	2026	0.11	-3.87	0.05
WR669b	ISD-CRZ15_Flow regulators	Carlisle RZ	2026	0.15	-4.62	0.12
WR677a	WUA-CRZ10_Non-household water efficiency programme	Carlisle RZ	2026	0.39	-4.60	0.16
WR685a	WER-CRZ5_Rainwater harvesting and water reuse (new builds)	Carlisle RZ	2026	0.06	-1.23	2.47
WR694d	WSA-CRZ15_Government intervention (e.g. water labelling)	Carlisle RZ	2026	0.60	-11.56	-0.22
WR520a	LEA-CRZ5_DMA optimisation	Carlisle RZ	2027	0.48	0.45	4.88
WR661a	WUA-CRZ15_Free water efficiency visits (households)	Carlisle RZ	2028	0.27	-3.50	0.19
WR502a	LEA-CRZ10_Permanent network sensors	Carlisle RZ	2029	0.51	4.66	8.38
WR516a1	LEA-CRZ15_Mains rehabilitation/renewal/replacement	Carlisle RZ	2038	1.19	11.78	12.68
WR659a	WER-CRZ15_Free water efficiency devices (outside/external)	Carlisle RZ	2048	0.08	-0.01	0.11
WR603b	EMT-NERZ5_Enhanced metering of households on single supplies (smart meters)	North Eden RZ	2026	0.27	1.60	1.98
WR615b	EMT-NERZ5_Replace existing non-household meters with smart meters	North Eden RZ	2026	0.09	-0.19	0.11
WR619b	EMT-NERZ10_Replace existing household meters with smart meters	North Eden RZ	2026	0.02	-1.53	0.08
WR694e	WSA-NERZ15_Government intervention (e.g. water labelling)	North Eden RZ	2026	0.06	-3.84	0.00

Table 39 Least cost plan options (costs discounted depending on year of option selection)

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR107a2	GWE_AUGHTON PARK a2	Strategic RZ	2030	10.00	71.46	42.48
WR111	GWE_WOODFORD	Strategic RZ	2030	9.00	74.38	35.37
WR113	GWE_TYTHERINGTON	Strategic RZ	2030	3.00	26.43	12.41
WR661c	WUA-SRZ15_Free water efficiency visits (households)	Strategic RZ	2026	12.98	-5.79	9.10
WR694f	WSA-SRZ15_Government intervention (e.g. water labelling)	Strategic RZ	2026	36.27	-54.55	-6.31
WR603e	EMT-SRZ15_Enhanced metering of households on single supplies (smart meters)	Strategic RZ	2026	60.46	469.63	572.84

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR516h	LEA-SRZ10_Mains rehabilitation/renewal/replacement	Strategic RZ	2026	100.00	586.56	597.21
WR658c	WSD-SRZ10_Free water efficiency devices (inside/internal)	Strategic RZ	2027	4.60	-20.13	1.64
WR510	LEA-SRZ15_In-pipe repairs and lining technologies	Strategic RZ	2031	4.47	-16.80	3.34
WR619c	EMT-SRZ10_Replace existing household meters with smart meters	Strategic RZ	2033	10.24	-3.21	30.68
WR677c	WUA-SRZ10_Non-household water efficiency programme	Strategic RZ	2034	12.94	-16.64	4.69
WR524d	LEA-SRZ10_Upstream tile optimisation	Strategic RZ	2041	5.78	7.74	20.82
WR615c	EMT-SRZ5_Replace existing non-household meters with smart meters	Strategic RZ	2043	10.44	-8.27	10.30
WR502c	LEA-SRZ5_Permanent network sensors	Strategic RZ	2046	20.00	147.48	167.41
WR520a	LEA-CRZ5_DMA optimisation	Carlisle RZ	2026	0.48	0.47	5.05
WR603a	EMT-CRZ5_Enhanced metering of households on single supplies (smart meters)	Carlisle RZ	2026	0.83	8.27	17.80
WR694d	WSA-CRZ15_Government intervention (e.g. water labelling)	Carlisle RZ	2026	0.60	-11.56	-0.22
WR516a1	LEA-CRZ15_Mains rehabilitation/renewal/replacement	Carlisle RZ	2031	1.19	14.99	16.14
WR677a	WUA-CRZ10_Non-household water efficiency programme	Carlisle RZ	2034	0.39	-3.49	0.12
WR661a	WUA-CRZ15_Free water efficiency visits (households)	Carlisle RZ	2035	0.27	-2.75	0.15
WR619a	EMT-CRZ10_Replace existing household meters with smart meters	Carlisle RZ	2036	0.15	-0.83	0.42
WR669b	ISD-CRZ15_Flow regulators	Carlisle RZ	2036	0.15	-3.28	0.09
WR658a	WSD-CRZ10_Free water efficiency devices (inside/internal)	Carlisle RZ	2037	0.11	-2.65	0.03
WR502a	LEA-CRZ10_Permanent network sensors	Carlisle RZ	2045	0.51	2.69	4.83
WR615a	EMT-CRZ5_Replace existing non-household meters with smart meters	Carlisle RZ	2047	0.20	0.12	0.26
WR659a	WER-CRZ15_Free water efficiency devices (outside/external)	Carlisle RZ	2049	0.08	-0.01	0.11
WR694e	WSA-NERZ15_Government intervention (e.g. water labelling)	North Eden RZ	2026	0.06	-3.84	-0.001
WR615b	EMT-NERZ5_Replace existing non-household meters with smart meters	North Eden RZ	2026	0.09	-0.19	0.11
WR502b	LEA-NERZ10_Permanent network sensors	North Eden RZ	2027	0.35	-6.58	1.15
WR677b	WUA-NERZ10_Non-household water efficiency programme	North Eden RZ	2032	0.07	-3.10	0.03

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR520b	LEA-NERZ5_DMA optimisation	North Eden RZ	2038	0.20	-0.94	1.14

Table 40 Best environment and society plan options (costs discounted depending on year of option selection)

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR065b	RES_WHITEHOLME	Strategic RZ	2030	2.30	1.49	5.30
WR107a2	GWE_AUGHTON PARK a2	Strategic RZ	2030	10.00	71.46	42.48
WR111	GWE_WOODFORD	Strategic RZ	2030	9.00	74.38	35.37
WR113	GWE_TYTHERINGTON	Strategic RZ	2030	3.00	26.43	12.41
WR185	SSO_STOCKPORT PH II	Strategic RZ	2030	11.50	0.96	15.12
WR191	PRO_NORTH LANCASHIRE	Strategic RZ	2030	3.50	13.04	10.16
WR502e	LEA-SRZ12_Permanent network sensors	Strategic RZ	2026	48.00	955.16	1026.65
WR510	LEA-SRZ15_In-pipe repairs and lining technologies	Strategic RZ	2026	4.47	-19.95	3.97
WR511j	LEA-SRZ15_Pressure management	Strategic RZ	2026	10.00	225.38	261.52
WR516h1	LEA-SRZ10_Mains rehabilitation/renewal/replacement	Strategic RZ	2026	49.12	160.55	191.09
WR520c	LEA-SRZ5_DMA optimisation	Strategic RZ	2026	2.00	-2.00	10.44
WR524d	LEA-SRZ10_Upstream tile optimisation	Strategic RZ	2026	5.78	12.97	34.87
WR532	LEA-SRZ15_Dynamic Network Management	Strategic RZ	2026	31.15	400.75	469.69
WR603e	EMT-SRZ15_Enhanced metering of households on single supplies (smart meters)	Strategic RZ	2026	60.46	469.63	572.84
WR615c	EMT-SRZ5_Replace existing non-household meters with smart meters	Strategic RZ	2026	10.44	-14.85	18.49
WR619d	EMT-SRZ15_Replace existing household meters with smart meters	Strategic RZ	2026	15.36	11.64	55.90
WR658c	WSD-SRZ10_Free water efficiency devices (inside/internal)	Strategic RZ	2026	4.60	-20.83	1.70
WR659c	WER-SRZ15_Free water efficiency devices (outside/external)	Strategic RZ	2026	4.00	-3.94	10.33
WR661c	WUA-SRZ15_Free water efficiency visits (households)	Strategic RZ	2026	12.98	-5.79	9.10
WR669a	ISD-SRZ15_Flow regulators	Strategic RZ	2026	7.40	3.96	15.69

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR677c	WUA-SRZ10_Non-household water efficiency programme	Strategic RZ	2026	12.94	-21.91	6.18
WR685c	WER-SRZ15_Rainwater harvesting and water reuse (new builds)	Strategic RZ	2026	5.77	195.63	196.10
WR694f	WSA-SRZ15_Government intervention (e.g. water labelling)	Strategic RZ	2026	36.27	-54.55	-6.31
WR516h2	LEA-SRZ25_Mains rehabilitation/renewal/replacement	Strategic RZ	2036	50.80	275.10	281.38
WR502a	LEA-CRZ10_Permanent network sensors	Carlisle RZ	2026	0.51	5.17	9.29
WR511c	LEA-CRZ15_Pressure management	Carlisle RZ	2026	0.50	11.16	17.80
WR516a1	LEA-CRZ15_Mains rehabilitation/renewal/replacement	Carlisle RZ	2026	1.19	17.81	19.16
WR520a	LEA-CRZ5_DMA optimisation	Carlisle RZ	2026	0.48	0.47	5.05
WR601a	EMT-CRZ10_Enhanced metering of households (smart meters)	Carlisle RZ	2026	1.38	23.90	33.46
WR615a	EMT-CRZ5_Replace existing non-household meters with smart meters	Carlisle RZ	2026	0.20	0.26	0.53
WR619a	EMT-CRZ10_Replace existing household meters with smart meters	Carlisle RZ	2026	0.15	-1.16	0.59
WR658a	WSD-CRZ10_Free water efficiency devices (inside/internal)	Carlisle RZ	2026	0.11	-3.87	0.05
WR659a	WER-CRZ15_Free water efficiency devices (outside/external)	Carlisle RZ	2026	0.08	-0.02	0.24
WR661a	WUA-CRZ15_Free water efficiency visits (households)	Carlisle RZ	2026	0.27	-3.75	0.21
WR669b	ISD-CRZ15_Flow regulators	Carlisle RZ	2026	0.15	-4.62	0.12
WR677a	WUA-CRZ10_Non-household water efficiency programme	Carlisle RZ	2026	0.39	-4.60	0.16
WR685a	WER-CRZ5_Rainwater harvesting and water reuse (new builds)	Carlisle RZ	2026	0.06	-1.23	2.47
WR694d	WSA-CRZ15_Government intervention (e.g. water labelling)	Carlisle RZ	2026	0.60	-11.56	-0.22
WR502b	LEA-NERZ10_Permanent network sensors	North Eden RZ	2026	0.35	-6.81	1.19
WR511f	LEA-NERZ15_Pressure management	North Eden RZ	2026	0.50	7.36	14.44
WR520b	LEA-NERZ5_DMA optimisation	North Eden RZ	2026	0.20	-1.43	1.72
WR524b	LEA-NERZ5_Upstream tile optimisation	North Eden RZ	2026	0.02	-1.32	5.47
WR601b	EMT-NERZ10_Enhanced metering of households (smart meters)	North Eden RZ	2026	0.38	1.93	3.72
WR615b	EMT-NERZ5_Replace existing non-household meters with smart meters	North Eden RZ	2026	0.09	-0.19	0.11
WR619b	EMT-NERZ10_Replace existing household meters with smart meters	North Eden RZ	2026	0.02	-1.53	0.08

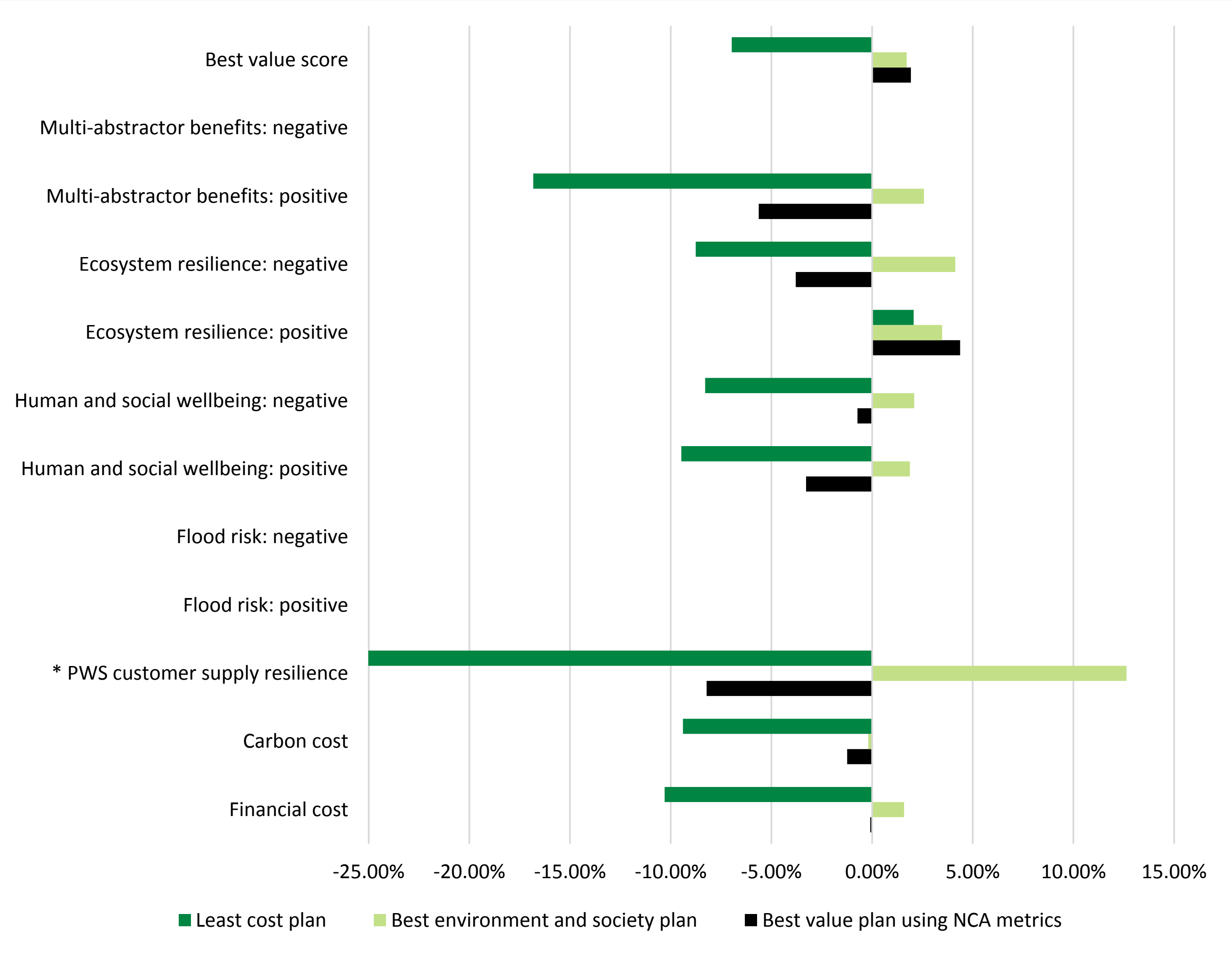
Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (80 yr £m NPV)	Financial cost (80 yr £m NPV)
WR658b	WSD-NERZ10_Free water efficiency devices (inside/internal)	North Eden RZ	2026	0.01	-0.08	0.01
WR661b	WUA-NERZ15_Free water efficiency visits (households)	North Eden RZ	2026	0.03	-3.84	0.02
WR669c	ISD-NERZ15_Flow regulators	North Eden RZ	2026	0.01	-7.59	0.01
WR677b	WUA-NERZ10_Non-household water efficiency programme	North Eden RZ	2026	0.07	-3.81	0.04
WR685b	WER-NERZ15_Rainwater harvesting and water reuse (new builds)	North Eden RZ	2026	0.01	-3.33	0.48
WR694e	WSA-NERZ15_Government intervention (e.g. water labelling)	North Eden RZ	2026	0.06	-3.84	-0.001

Table 41 Best value plan using NCA metrics options (costs discounted depending on year of option selection)

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (£m NPV)	Financial cost (£m NPV)
WR102b	GWE_WIDNES	Strategic RZ	2030	17.00	179.58	93.41
WR107a2	GWE_AUGHTON PARK a2	Strategic RZ	2030	10.00	71.46	42.48
WR510	LEA-SRZ15_In-pipe repairs and lining technologies	Strategic RZ	2026	4.47	-19.95	3.97
WR516h1	LEA-SRZ10_Mains rehabilitation/renewal/replacement	Strategic RZ	2026	49.12	160.55	191.09
WR603e	EMT-SRZ15_Enhanced metering of households on single supplies (smart meters)	Strategic RZ	2026	60.46	469.63	572.84
WR615c	EMT-SRZ5_Replace existing non-household meters with smart meters	Strategic RZ	2026	10.44	-14.85	18.49
WR661c	WUA-SRZ15_Free water efficiency visits (households)	Strategic RZ	2026	12.98	-5.79	9.10
WR694f	WSA-SRZ15_Government intervention (e.g. water labelling)	Strategic RZ	2026	36.27	-54.55	-6.31
WR524d	LEA-SRZ10_Upstream tile optimisation	Strategic RZ	2027	5.78	12.53	33.69
WR658c	WSD-SRZ10_Free water efficiency devices (inside/internal)	Strategic RZ	2027	4.60	-20.13	1.64
WR520c	LEA-SRZ5_DMA optimisation	Strategic RZ	2031	2.00	-1.68	8.79
WR677c	WUA-SRZ10_Non-household water efficiency programme	Strategic RZ	2031	12.94	-18.45	5.20
WR619c	EMT-SRZ10_Replace existing household meters with smart meters	Strategic RZ	2033	10.24	-3.21	30.68
WR502c	LEA-SRZ5_Permanent network sensors	Strategic RZ	2035	20.00	215.32	244.41

Option ID	Option name	Resource zone	Year selected	Capacity (Ml/d)	Best value cost (£m NPV)	Financial cost (£m NPV)
WR516h2	LEA-SRZ25_Mains rehabilitation/renewal/replacement	Strategic RZ	2036	50.80	275.10	281.38
WR603a	EMT-CRZ5_Enhanced metering of households on single supplies (smart meters)	Carlisle RZ	2026	0.83	8.27	17.80
WR694d	WSA-CRZ15_Government intervention (e.g. water labelling)	Carlisle RZ	2026	0.60	-11.56	-0.22
WR520a	LEA-CRZ5_DMA optimisation	Carlisle RZ	2027	0.48	0.45	4.88
WR615a	EMT-CRZ5_Replace existing non-household meters with smart meters	Carlisle RZ	2028	0.20	0.24	0.49
WR516a1	LEA-CRZ15_Mains rehabilitation/renewal/replacement	Carlisle RZ	2031	1.19	14.99	16.14
WR661a	WUA-CRZ15_Free water efficiency visits (households)	Carlisle RZ	2035	0.27	-2.75	0.15
WR619a	EMT-CRZ10_Replace existing household meters with smart meters	Carlisle RZ	2036	0.15	-0.83	0.42
WR669b	ISD-CRZ15_Flow regulators	Carlisle RZ	2036	0.15	-3.28	0.09
WR658a	WSD-CRZ10_Free water efficiency devices (inside/internal)	Carlisle RZ	2037	0.11	-2.65	0.03
WR677a	WUA-CRZ10_Non-household water efficiency programme	Carlisle RZ	2037	0.39	-3.15	0.11
WR502a	LEA-CRZ10_Permanent network sensors	Carlisle RZ	2045	0.51	2.69	4.83
WR659a	WER-CRZ15_Free water efficiency devices (outside/external)	Carlisle RZ	2049	0.08	-0.01	0.11
WR615b	EMT-NERZ5_Replace existing non-household meters with smart meters	North Eden RZ	2026	0.09	-0.19	0.11
WR694e	WSA-NERZ15_Government intervention (e.g. water labelling)	North Eden RZ	2026	0.06	-3.84	-0.001
WR502b	LEA-NERZ10_Permanent network sensors	North Eden RZ	2027	0.35	-6.58	1.15
WR677b	WUA-NERZ10_Non-household water efficiency programme	North Eden RZ	2032	0.07	-3.10	0.03
WR603b	EMT-NERZ5_Enhanced metering of households on single supplies (smart meters)	North Eden RZ	2038	0.27	1.06	1.31

Figure 32 Metric cost differences for common options relative to the preferred plan[58]



[58] Change in the least cost plan for PWS customer supply resilience is -96% however the graph is capped at -25% to provide better perspective.

Figure 33 Net impact of option exceptions relative to the preferred plan

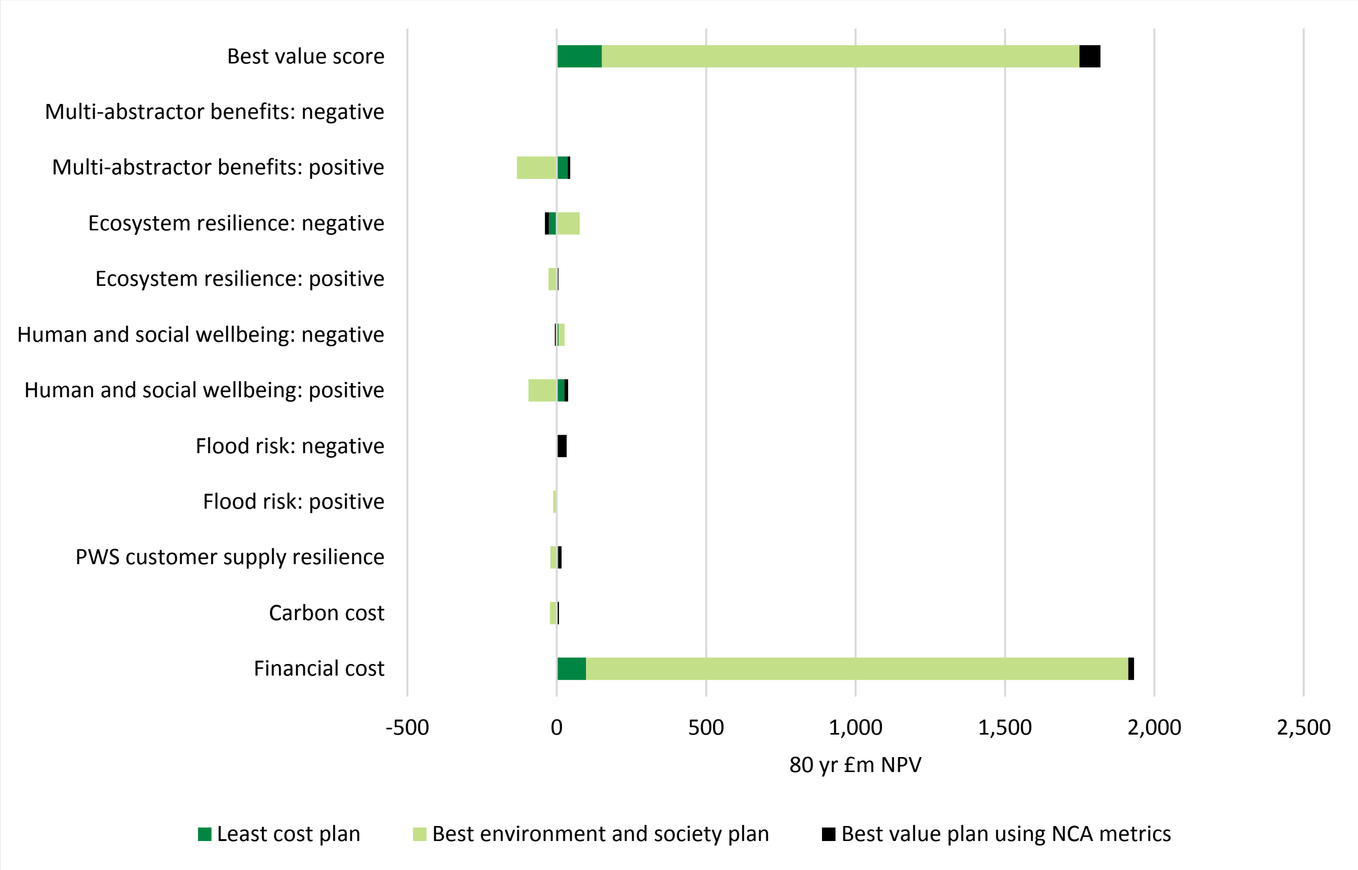
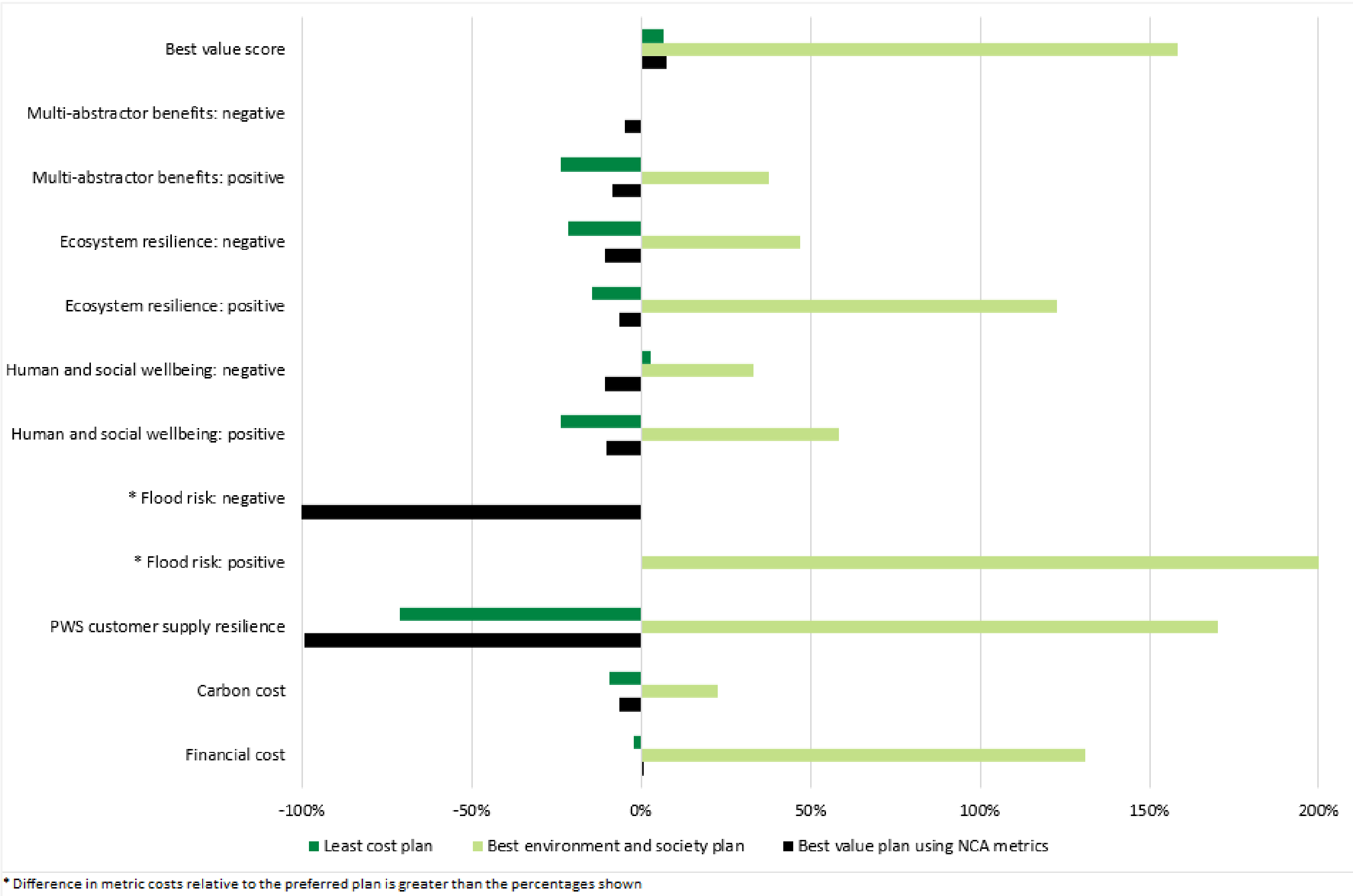


Figure 34 Metric cost differences relative to the preferred plan



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