Revised Draft Water Resources Management Plan

2020-2080

March 2019

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Contents

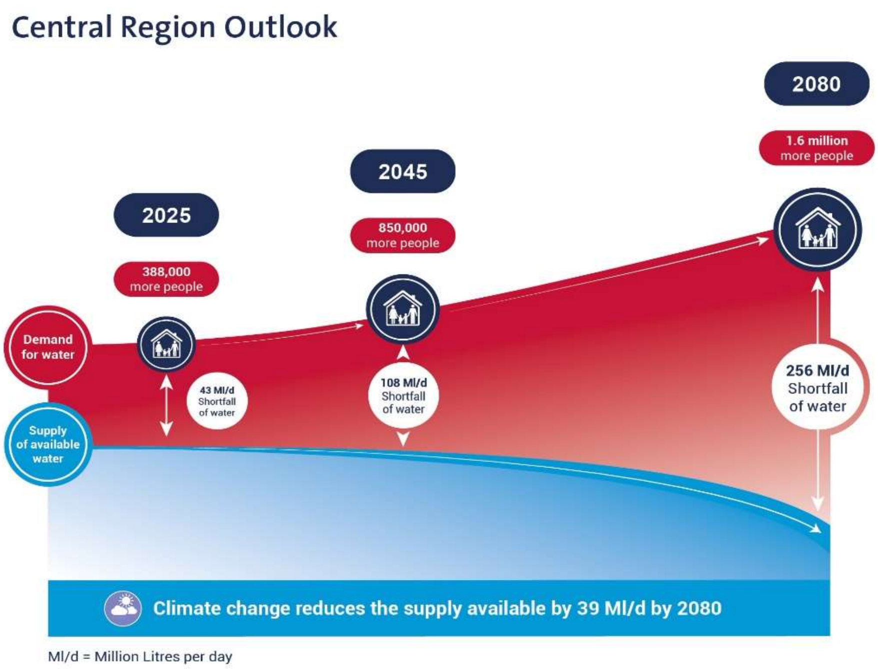
Executive Summary

This document presents our revised draft Water Resources Management Plan 2019 (rdWRMP19). It should be read in conjunction with our Statement of Response (SoR) which summarises feedback on our draft WRMP (dWRMP) and states how we intended to revise our plan in light of the feedback received. A separate summary document is available providing a non-technical overview of our plan. www.affinitywater.co.uk/haveyoursay

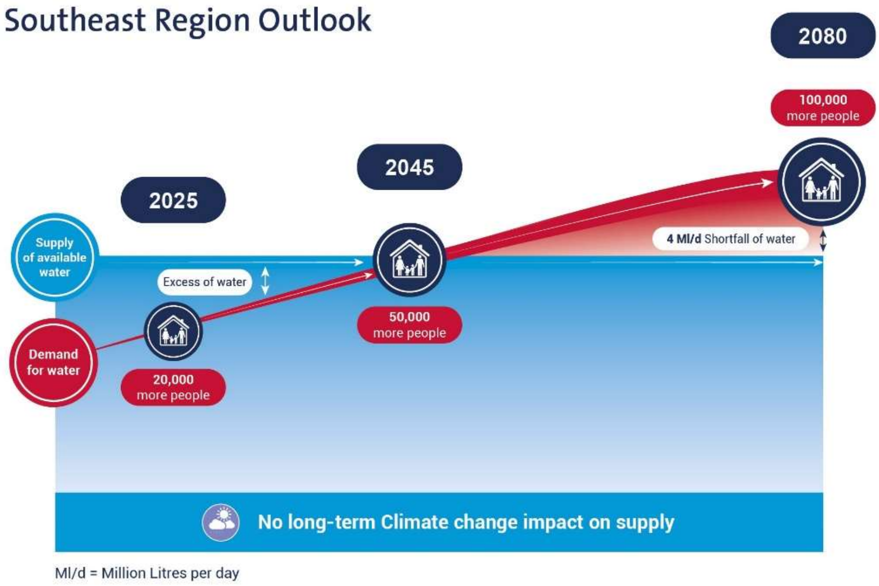
Our rdWRMP sets out how we plan to provide a reliable, resilient, efficient and affordable water supply to customers from 2020 to 2080, whilst protecting the environment. At the core of this is the need to balance the amount of water available for supply with the demand for water.

Our plans for balancing water supply with demand include a commitment to increase our resilience to droughts which we will deliver by supporting customers to reduce demand, reducing leakage and investing in supply side capacity improvements. This will also improve the resilience of our water supply to support other non-drought challenges that put a strain on the distribution of water such as freeze-thaw and flooding events. This rdWRMP also includes the measures identified by the Environment Agency's Water Industry National Environment Programme, and our habitat and river restoration programmes, that contribute to improvements in Chalk stream habitats.

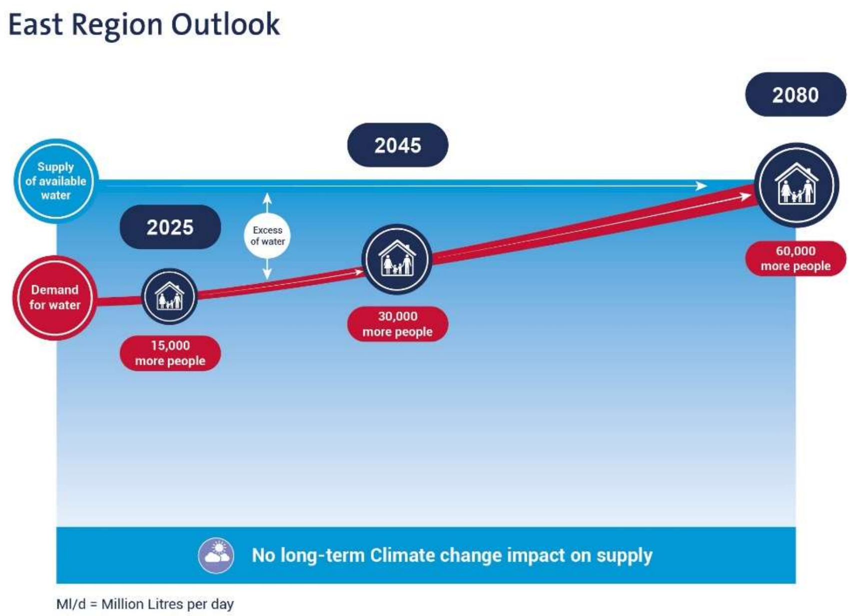
We operate in three geographically separate regions, Central, Southeast and East. In our Central region, as a result of planning to reduce abstraction from Chalk catchments and to improve our resilience to drought events, we face a shortfall in supply under drought conditions of 43 Ml/d by 2025, rising to 256 Ml/d in 2080. Available water supplies continue to fall throughout this time due to the impacts of climate change and demand increases due to population growth. We expect approximately 1.6 million more people in our Central region by 2080. The scale of the challenge that we face in our Central region is illustrated in the following graphic.



In our Southeast region a small surplus of water exists in 2020 of 1.3 Ml/d. This moves into a small deficit of 0.1 Ml/d by 2045, increasing to 4.3 Ml/d by 2080 due to an increasing population.



Under our current planning estimates, even after we have accounted for improvements in drought resilience, our East region is in surplus under both average and peak conditions for the duration of the planning period. The balance comes close to zero by 2080 due to an increasing population in the order of 41% by 2080, equivalent to approximately 62,000 more people in our East region. Although the region is in surplus, we do face some uncertainties over the availability of water supplies as a result of ongoing environmental investigations, which could significantly affect the supply-demand balance even in the short-term.



Without investment, we face the risk of a significant shortfall of water during future drought events within our largest Central supply region, and longer-term risks within our Southeast supply region. The scale of the challenge in our Central region and the fact that it is driven by a combination of uncertain future risks (growth in demand, reductions in abstraction and climate change) means that there is a great deal of uncertainty about the exact timing and scale of the risk. If our abstractions in the East region are reduced beyond our current expectations then this would also trigger potentially significant investment.

In response to the challenge that we face we have developed a planning process and investment programme that is both flexible to future uncertainties and ensures that we will maintain the balance between supply and demand through investments that represent the best value to customers. For the Central region that means we have adopted an 'adaptive planning' approach. As with conventional WRMPs, such an approach contains a preferred set of investments that will allow us to meet the challenge. However, our Plan also shows how and when we might need to adapt in response to the uncertainties that we face, and makes sure that we investigate and invest in a timely fashion to allow us to make those adaptations. For the Southeast and East regions, we have sufficient time and control over the risks involved to allow us to maintain a more 'conventional' approach to investment planning.

The planning process that we have used to develop our investment programme is transparent, structured and clearly accounts for customer and stakeholder feedback, with a specific customer and stakeholder analysis stage built into the process. This concluded that there is a:

- Preference for reducing abstractions from Chalk catchments to the full level proposed in the EA National Environment Programme, and a desire to move to a higher (1 in 200 year return period) level of drought resilience in our supply system.

- Preference for investments that will improve information for customers, helping them to reduce their demand whilst at the same time allowing us to identify and reduce leakage within customers' properties.

- Preference for us to include 'stretching' ambitions for demand management and leakage reduction as part of our Plan, whilst at the same time ensuring that we can maintain future drought resilience if it is not possible to affordably achieve these ambitions.

- Lack of support for variable tariff options.

- Preference for strategic supply-side schemes that use existing infrastructure, and support for strategic reservoir development.

- Expectation that further reductions in abstraction on Chalk rivers should be considered.

Environmental considerations were also integral to the investment planning process. Within this Plan we have clearly set out how the findings from our Strategic Environmental Assessment (SEA), Habitats Risk Assessment (HRA) and Water Framework Directive (WFD) assessments shaped the nature of the options that we considered and our planning approach.

Our resulting investment programme proposes a 'twin track' strategic approach, whereby demand management and leakage reduction measures are introduced first, supported by improvements in our ability to import water from other water companies and schemes that strengthen our network to make best use of our existing supplies. In the longer term for the Central Region we then propose to develop large strategic supply schemes, which we will develop in collaboration with other water companies and the Canal & River Trust.

For the Central region, our Plan also includes a detailed ‘adaptive strategy’, which identifies how we will monitor and respond to the uncertainties that we face, along with up-front investigative activities and investments that we will undertake to ensure we can deliver any adaptations in a timely manner. We have economically tested the costs associated with those up-front investments to make sure that our adaptive approach represents the best long-term strategy for customers. The main focus of the adaptive strategy is on the timing and nature of the strategic options that we will need in the medium and long term. We anticipate we will require the first strategic development by 2038, but our adaptive strategy will allow us to defer that investment and hence save customers’ money, if our monitoring of likely future risks concludes that it is prudent to do so.

Our identification of supply side options has been carried out in collaboration with regional water industry groups such as Water Resources in the South East and Water Resources in the East, and in liaison with third party partners such as the Canal & River Trust. As part of our adaptive strategy we will continue to work with those partners to ensure that our plans are complementary to the wider strategic needs within the south east of England.

Summary of our Demand Management Strategy

- **Leakage** - Our plan provides for 18.5% leakage reduction within the 2020 to 2025 period through increasing intensity of leakage activities, innovation, efficiency and reducing customer side leakage. This represents an overall reduction of 30% leakage compared to our 2015 position. In the longer-term we will aim to achieve an overall level of 50% leakage reduction by 2045, through further innovation and efficiencies in distribution network leakage control and customer supply pipe leakage reduction.

- **Per Capita Consumption (PCC)** - Our plan sets a PCC target of 129 l/h/d by 2025 compared to our 2016/17 average consumption of 152 l/h/d, taking us towards industry leading levels. We then propose to continue to further reduce PCC through concerted action on water efficiency and smart metering. This ‘concerted action’ is aimed at developing wider collaboration. It includes aspirations to reduce this further (potentially as low as 110l/h/d), depending on industry wide and policy support for demand management.

Summary of our Supply Strategy

Central region

- **Smaller Resource Options**: We have included Lower Greensand abstractions, which we are currently in the process of developing to a total of 5Ml/d by 2022, and have included a potential 9Ml/d of further development in the medium term (between 2025 and 2035). We have also identified that the existing Canal & River Trust reservoir in Brent can be utilised to deliver up to 7.5Ml/d into the west of the region.

- **Import from Anglian Water**: Currently we are only able to make use of around 50Ml/d of our shared resource with Anglian Water. We will install a conditioning plant and network storage to allow us to increase that to its full capacity of 91Ml/d by 2025 (pre impact of climate change).

- **Internal transfers** – as well as facilitating the Anglian Water import, our Supply 2040 programme allows us to build better inter-connectivity throughout our Central region to remove constraints within our distribution network that will allow us to 'unlock' and transfer 17Ml/d of existing capacity from the south west of our Central region by 2025.

- **Strategic supply options –** the nature and timing of strategic options is a key part of our adaptive planning process. Our main focus is on ensuring that we progress with investigations and investment in a timely manner. Our 'best value plan' includes joint development of the South East Strategic Reservoir option with Thames Water in 2038. We intend to utilise 100Ml/d of the yield capacity of the reservoir, which we will abstract and treat for supply into the south and west of the region through staged network and treatment developments. Our Plan also includes the Grand Union Canal import option, which will transfer 50Ml/d of treated waste water from the Birmingham area for treatment and supply into the west of our region. Under our current 'best value' plan we anticipate needing this resource by 2065.

Southeast region

- The majority of the deficit for the Southeast region can be managed through the demand management measures. On the supply-side we will only need to agree continuation of our bulk supply arrangements with our neighbouring water companies and make relatively low cost network improvements to make best use of two of our existing sources.

East region

- Under our current plan we do not require any supply side investments in this region.

Our Board has been actively engaged with the development of this rdWRMP throughout the process. It has commissioned and been provided with assurance that our rdWRMP represents the most cost effective and sustainable long-term solution for managing and developing water resources.

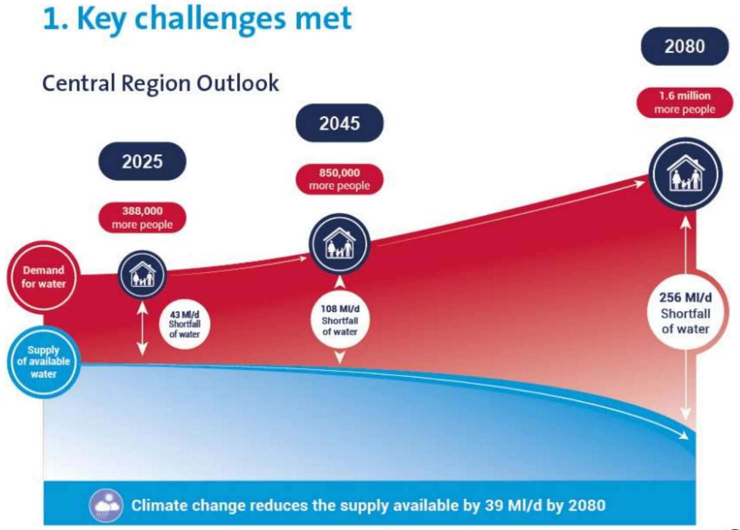
Affinity Water

Our Plan for the Central region

Our Plan sets out how we will provide a reliable, resilient, efficient and affordable water supply to customers from 2020 to 2080, whilst helping to protect the environment.

1. Key challenges met

Central Region Outlook

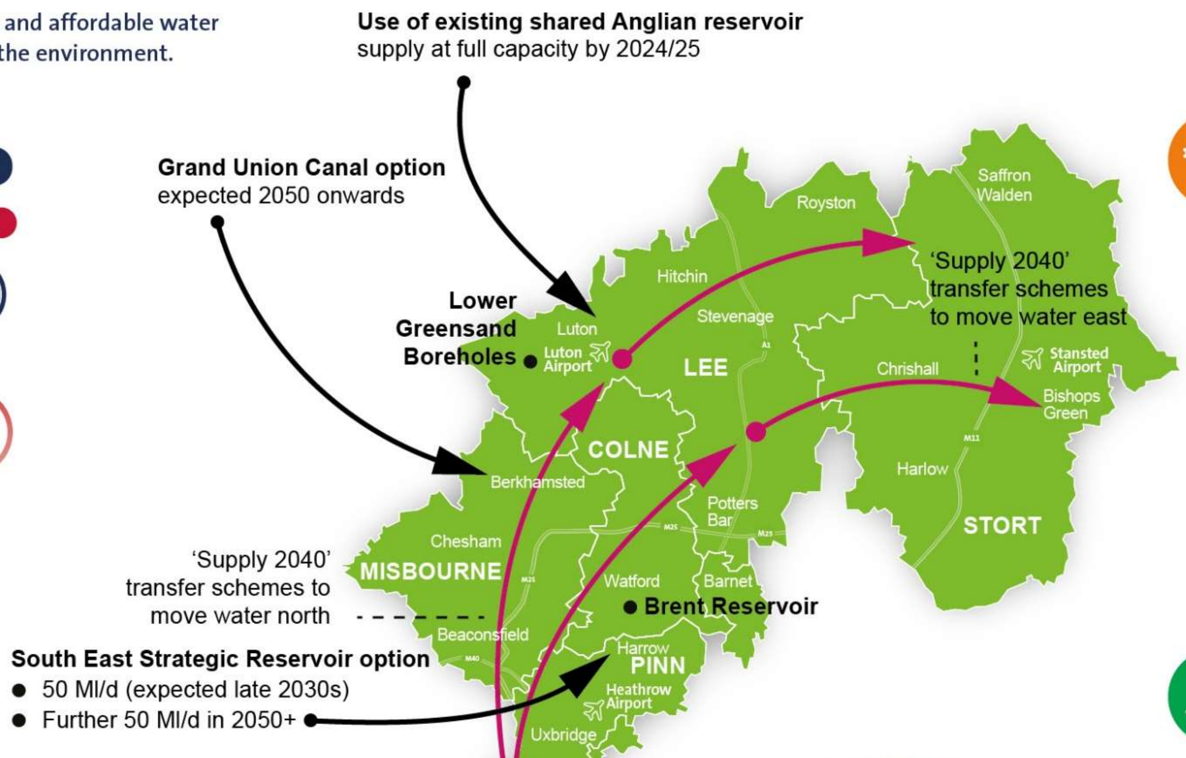


Our Plan addresses the need to balance the availability of water supply with the demand for water from customers. Without action, we face the risk of a significant shortfall of water in the future in this region due to population growth and climate change. We also want to help protect the environment and improve the resilience of our water supplies to droughts and other challenges.

2. Our Plan:

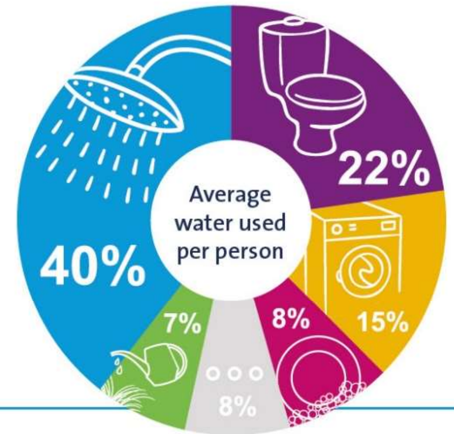
- Is adaptive, flexible and supported by customers and stakeholders
- Improves drought resilience of water supplies for customers
- Contributes to the protection of rare Chalk stream habitats by reducing abstraction from Chalk sources
- Prioritises reducing demand and is innovative
- Ensures timely delivery of the appropriate strategic supply infrastructure
- Remains affordable to ensure the best value for customers now and in the long term for future generations.

Ml/d = million litres of water per day



3. Protecting the environment

We will reduce the amount of water we take from existing Chalk sources and not develop any new Chalk groundwater sources in our Central region.



5. Our proposals to increase supply for water

Developing strategic supply options and resilience

- **'Supply 2040'** – a programme that delivers network infrastructure improvements that will help us to move water to where and when it is needed
- Maximise use of our existing sources of water, including full use of imports of water
- Building a new reservoir in Oxfordshire, which we refer to as the South East Strategic Reservoir, to provide an extra 100 Ml/d by the late 2030s
- A transfer of water via the Grand Union Canal which could provide an additional 50 Ml/d in the longer term or as an alternative to the reservoir development
- An alternative strategic transfer solution from South Lincolnshire that could provide up to 100 Ml/d if required in the longer term.

Collaboration with neighbouring water companies

We will continue to collaborate with neighbouring water companies and other parties to secure the additional resources needed. We have ensured with our partners, that these strategic options form part of a coherent long term regional strategy for the South East of England.

Improving resilience to droughts

We estimate that without taking action, there is around a 60% chance over the next 60 years we would have to resort to exceptional drought management measures, such as standpipes. We propose investing to reduce this to around a 25% chance (1 in 200 year drought event).

4. Our proposals to reduce the demand for water

Leakage

We are committed to reducing leakage. In 2015, leakage was around 21% (189 Ml/d) of the water we put into supply. By 2025 we plan to have reduced this to 15%. We will continue to reduce this to between 11% and 13% of the water we put into supply by 2045, in an affordable way for customers. Overall this means a reduction of nearly 50%.

Water use per person (Per Capita Consumption – PCC)

We will put in place actions to help customers reduce their water use from an average of 152 litres of water per person per day to 129 litres by 2025. We aim to reduce water use to between 110 and 120 litres per person per day by 2045, if this is affordable for customers and delivered in a way that is acceptable to them.

Our actions will include:

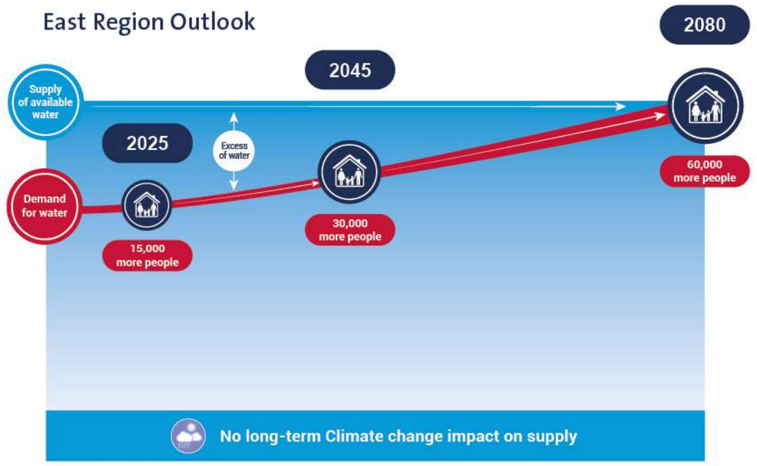
- Installing more water meters in homes and businesses
- Providing customers with more regular information on how much water they are using
- Providing customers and communities with water audits to encourage them to become more water efficient
- Supporting a national water efficiency campaign and work with Government to introduce new policies to reduce consumption
- Working with retailers to improve water efficiency of businesses.

Our Plan for the East region (Brett Community)

Our Plan sets out how we will provide a reliable, resilient, efficient and affordable water supply to customers from 2020 to 2080, whilst helping to protect the environment.

1. Key challenges met

East Region Outlook



Ml/d = Million Litres per day

Our Plan addresses the need to balance the availability of water supply with the demand for water from customers. Our East region has sufficient water for the duration of the planning period by only focusing on reducing the demand for water. There is no need to take action to increase the supply of water for this area. However, we do want to help protect the environment and improve the resilience of our water supplies to droughts and other challenges.

2. Our Plan:

- Is adaptive, flexible and supported by customers and stakeholders
- Improves drought resilience of water supplies for customers
- Contributes to the protection of rare Chalk stream habitats by reducing abstraction from Chalk sources
- Prioritises reducing demand and is innovative
- Ensures timely delivery of the appropriate strategic supply infrastructure
- Remains affordable to ensure the best value for customers now and in the long term for future generations.

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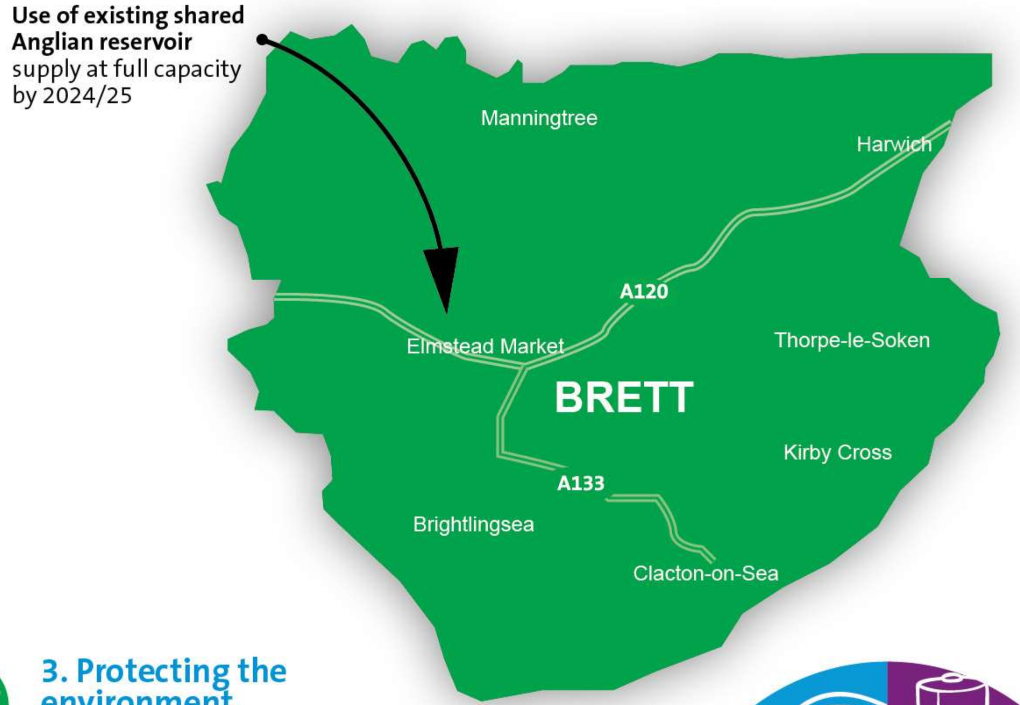

3. Protecting the environment

Our Plan includes an allowance for reduction of the amount of water we take from Chalk catchments in our East region.

4. Our proposals to reduce the demand for water

Leakage

We are committed to reducing leakage. In 2015, leakage was around 21% (189 Ml/d) of the water we put into supply. By 2025 we plan to have reduced this to 15%. We will continue to reduce this to between 11% and 13% of the water we put into supply by 2045, in an affordable way for customers. Overall this means a reduction of nearly 50%.

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- Supporting a national water efficiency campaign and work with Government to introduce new policies to reduce consumption
- Working with retailers to improve water efficiency of businesses.

5. Our proposals to increase supply for water

Developing strategic supply options and resilience

We will manage the water resources available to us more efficiently, reducing any potential impacts on the environment and enhance our ability to cope with different types of weather and climatic events, such as severe drought. Under our Plan for our East region we are able to do this primarily based on our demand management activities alone.

There is a risk that we will face substantial (up to 15-20 Ml/d) reductions in abstraction for our sources within the River Brett catchment in the near term. If that does occur then we would need to construct a desalination plant on the East coast, or if the timing and the volumetric reduction changes, a shared alternative option. We will work closely with the Environment Agency to protect supplies and the environment.

Collaboration with neighbouring water companies

We will continue to collaborate with neighbouring water companies or other parties to ensure that these strategic options form part of a coherent long term regional strategy for the East of England.

Improving resilience to droughts

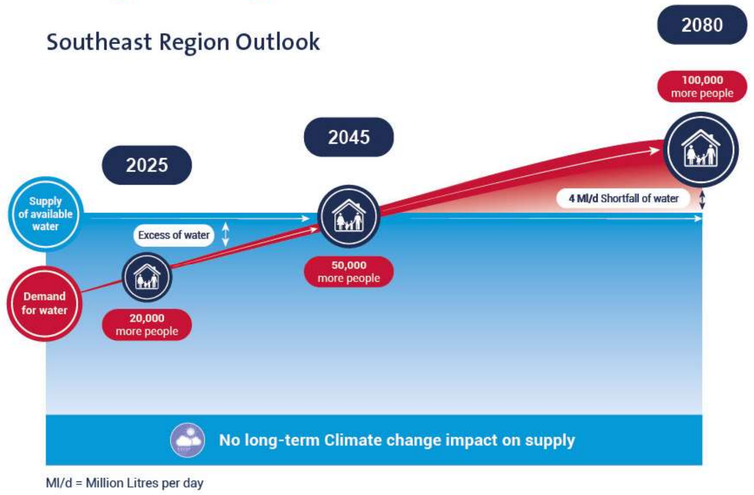
We estimate that without taking action, there is around a 60% chance over the next 60 years we would have to resort to exceptional drought management measures, such as standpipes. We propose investing to reduce this to around a 25% chance (1 in 200 year drought event).

Our Plan for the Southeast region (Dour Community)

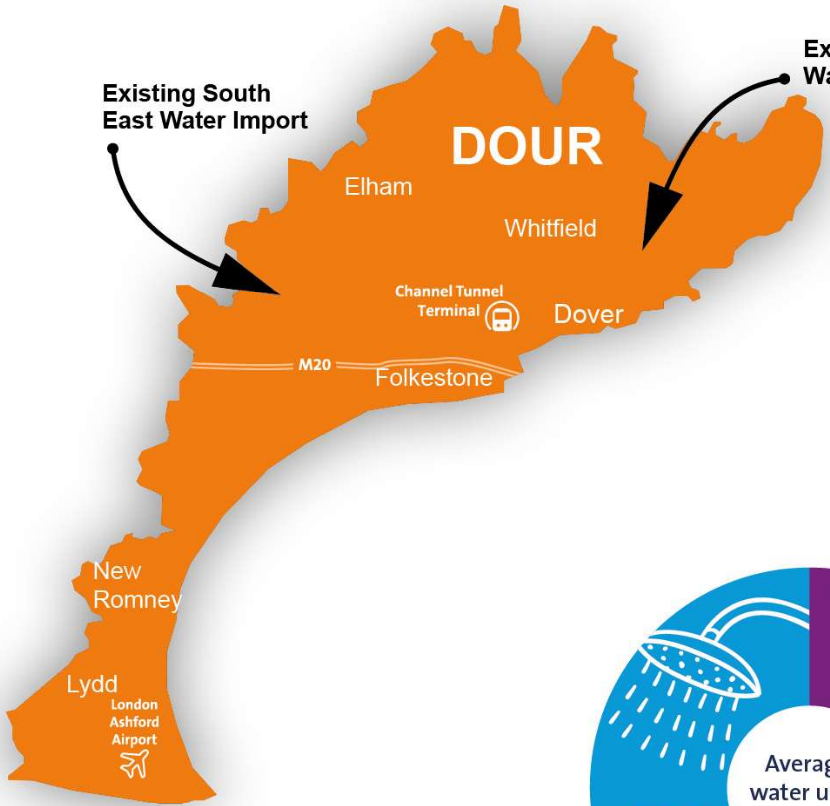
Our Plan sets out how we will provide a reliable, resilient, efficient and affordable water supply to customers from 2020 to 2080, whilst helping to protect the environment.

1. Key challenges met

Southeast Region Outlook



Our Plan addresses the need to balance the availability of water supply with the demand for water from customers. Without action, we face the risk of a shortfall of water in the future in our Southeast region due to population growth and climate change. We also want to help protect the environment and improve the resilience of our water supplies to droughts and other challenges.



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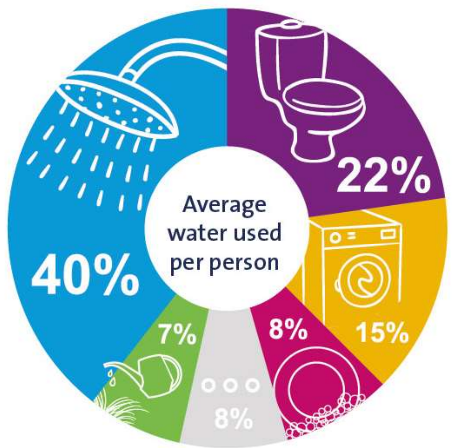
- Ensures timely delivery of the appropriate strategic supply infrastructure
- Remains affordable to ensure the best value for customers now and in the long term for future generations.

3. Protecting the environment

We are stopping the reliance on drought permits for additional abstraction to meet our 1 in 200 year drought resilience commitment from March 2024.



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5 . Our proposals to increase supply for water

Developing strategic supply options and resilience

We will manage the water resources available to us more efficiently, reducing any potential impacts on the environment and enhance our ability to cope with different types of weather and climatic events, such as severe drought. Under our Plan for our Southeast region we are able to do this mainly based on our demand management activities, plus extension of our supply arrangements with our neighbouring water companies. Some licence changes and infrastructure schemes are required to improve smaller supply and enables us and enables us to address needs during periods of peak demand.

Collaboration with neighbouring water companies

We will continue to collaborate with neighbouring water companies or other parties to ensure that these options form part of a coherent long term regional strategy for the South East of England.

Improving resilience to droughts

We estimate that without taking action, there is around a 60% chance over the next 60 years we would have to resort to exceptional drought management measures, such as standpipes. We propose investing to reduce this to around a 25% chance (1 in 200 year drought event).

Ml/d = million litres of water per day

1 Setting the scene

1.1 Introduction

1.1.1 This document presents our revised draft Water Resources Management Plan 2019 (rdWRMP19). It should be read in conjunction with our Statement of Response (SoR) dated 31 October 2018 and addendum to our SoR published with this plan, which summarise feedback on our draft WRMP 2019 (dWRMP19) and our response to that feedback. A separate summary document is available providing a non-technical overview of our plan. www.affinitywater.co.uk/haveyoursay

1.1.2 Our rdWRMP sets out how we plan to deliver a reliable, resilient, efficient and affordable water supply to customers from 2020 to 2080, whilst protecting the environment. At the core of this task is the need to balance the availability of water supply with the demand[1] for water from customers. Delivering resilient water supplies is a priority for us and for government.

1.1.3 This Chapter sets the scene. In this Chapter, we describe our supply area (section 1.2) and the challenges we face (section 1.3). We then provide an overview of the stages of work involved in developing our rdWRMP (section 1.4). Finally, we explain the process we are following and where in the process we are (section 1.5).

1.1.4 Chapters 2-5 provide the detail of the work involved in developing our rdWRMP. The rdWRMP is presented in Chapter 6. Chapter 6 also sets out our future supply and demand and our levels of service in a drought if we implement our rdWRMP. We explain how we have collaborated with other water companies at the regional level in developing our rdWRMP and links to other plans, including the WRMPs of other water companies in Chapter 7. In Chapter 8, we describe how our Board has overseen the preparation of our rdWRMP.

1.2 Our supply regions

1.2.1 We have three geographically separate supply regions: Central, Southeast and East. Our Central region is split into six areas known as 'communities'. Each has a name: Wey, Pinn, Colne, Misbourne, Lee and Stort. Our East region is named the Brett community and our Southeast region named our Dour community. Each community is also a Water Resource Zone (WRZ) for water resources planning purposes and is allocated a number, WRZ1 to WRZ8, as illustrated in Figure 1.

[1] The volume of water both household and non-household customers draw from the supply system and therefore demand from a water company, is known as the demand for water.

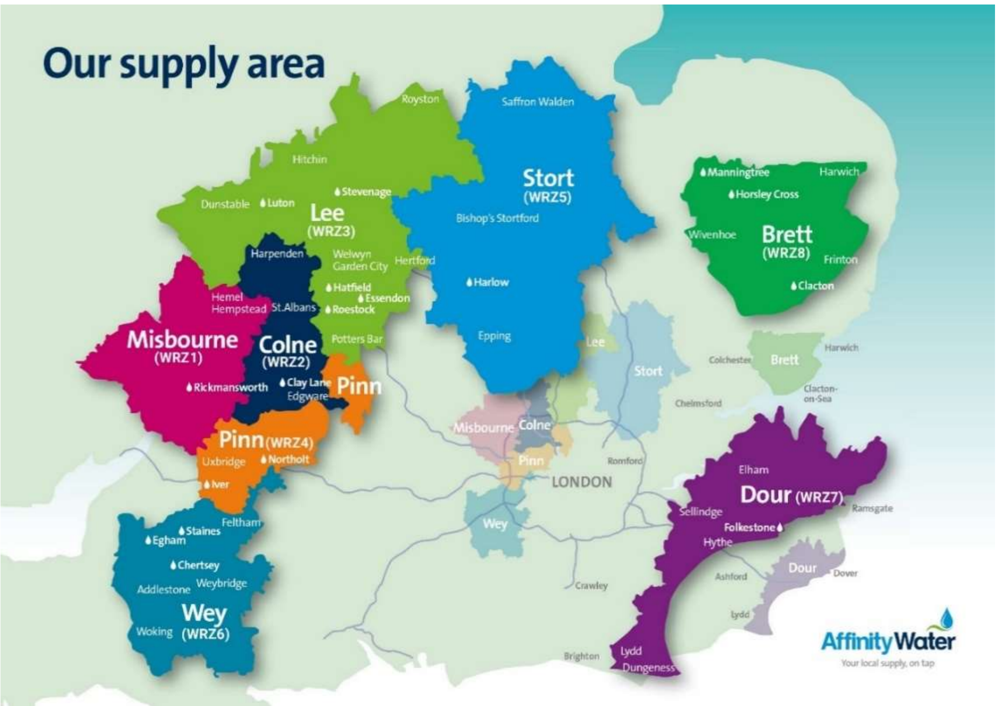


Figure 1: The Affinity Water Supply Area

1.2.2 We abstract approximately 65% of water from groundwater sources and the remainder is from surface water, principally from the River Thames. We also receive water from and provide water to neighbouring water companies (known as "bulk supplies"). In our East region we obtain water from a reservoir that that we jointly own with Anglian Water.

1.3 Challenges and issues

1.3.1 We have a number of key challenges and issues that we need to address through our rdWRMP. The first of these is that substantial, continued housing growth is planned for our supply area, particularly in our Central region. The population is predicted to increase by 12% over the next 25 years and by over 50% by 2080 (the equivalent of an additional 1.8 million people living in our supply area).

1.3.2 Until recently we had one of the highest per capita consumption ("PCC") levels in the UK. PCC measures the amount of water each person uses each day. This has reduced but we still have an average PCC of 152 litres per head per day (l/h/d).

1.3.3 Our supply area is located in one of the driest parts of the UK. The Thames Valley and London normally receive less than 650 mm of rain per year[2], which is less than Rome, Sydney or New York, and among the lowest in the UK for total annual average rainfall per person. Climate change is predicted to bring warmer wetter winters and hotter drier summers, reducing the overall available supply of water and increasing the demand for water.

1.3.4 Our supply area has 8 to 9% of globally rare Chalk streams. We recognise the environmental pressures that Chalk catchments are facing and we continue to work with partnership organisations to protect water ecosystems, improve river habitats for wildlife and enhance biodiversity at our sites.

[2] Source: https://www.metoffice.gov.uk/climate/uk/regional-climates/so#rainfall

1.3.5 There are several major infrastructure projects planned in our supply area, all of which could encourage population growth or an increased number of tourists, business travellers or commuters. These include a third runway at Heathrow Airport, the expansion of Luton Airport, the Oxford to Cambridge corridor development, High Speed Rail (HS2), Crossrail and a new rail link from Slough to Heathrow.

1.3.6 We have several significant water quality pressures in our catchment as a result of historic and current polluting activities, which we need to manage to safeguard the quality of the water that we abstract.

1.4 Developing our rdWRMP

1.4.1 The purpose of our water resources planning is to ensure that we are able to balance the supply of water with the demand for water notwithstanding these challenges. We assess this within our three geographically separate regions - Central, Southeast and East - and then more widely in the context of the southeast of England. Our approach is based upon standard best practice, following the Environment Agency's Water Resources Planning Guidelines (WRPG)[3].

1.4.2 Figure 2 illustrates at a high level, the process we took to develop our strategy and highlights the components which make up the supply and demand forecasts.

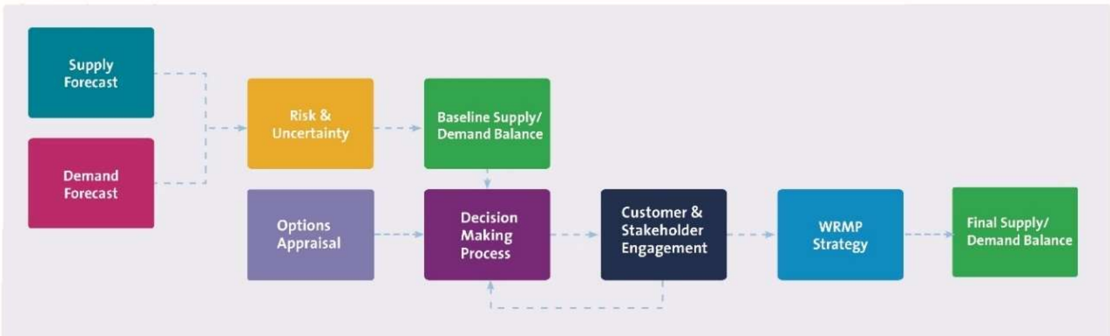


Figure 2: High level WRMP process

1.4.3 We first calculated a 'baseline' supply-demand balance, which tells us how much water we have available (supply) and how much water we need (demand), now and into the future (see Chapter 3 for further information).

1.4.4 We then carried out an options appraisal to work out what options we have available to us to balance our supply and demand into the future (see Chapter 4 for further information). We also engaged with customers and stakeholders to understand the features they would like to see in our plan (see Chapter 2 for further information).

1.4.5 We developed a decision-making process to choose between the different options taking into account our options appraisal and customer and stakeholder feedback (Chapter 5). This allowed us to decide on our rdWRMP for each of our three supply regions. In each case, our primary objective was to ensure we had sufficient water to meet the needs of customers. We also needed to achieve resilience to a 1 in 200-year drought without the use of drought options after 2024, achieve leakage reduction of 18.5% during AMP7 and aim for further

[3] Water Resources Planning Guideline: Interim update, Environment Agency, July 2018

future reductions. In the case of our Central and East Regions we planned to deliver sustainability reductions to decrease the amount of water we abstract from the environment.

1.4.6 Our rdWRMP for our East and Southeast Regions include demand management options and some supply-side options (Chapter 6). The scale of the challenge in our Central Region is much greater and requires us to take large-scale action. Our rdWRMP adopts a "twin track" approach of extensive demand management to reduce demand, supported by large-scale schemes to increase supply. We cannot be certain how these challenges and risks will emerge in the future. For this reason, our rdWRMP is an "adaptive plan" that is able to respond in a structured way to future changes in supply and demand.

1.4.7 An "adaptive plan" adapts; how it does this is shown in Figure 3. We analysed key future uncertainties to develop four future scenarios. We then worked out the best way to invest to meet those futures. In some cases, we need to deliver schemes with long lead-in times. We therefore worked out when we needed to start construction of these schemes and what enabling actions we need to take before then to ensure we can deliver them when they are needed. Finally, our adaptive plan includes a monitoring plan so that we can make key decisions on the basis of objective evidence. We explain this in detail in Chapters 5 and 6.

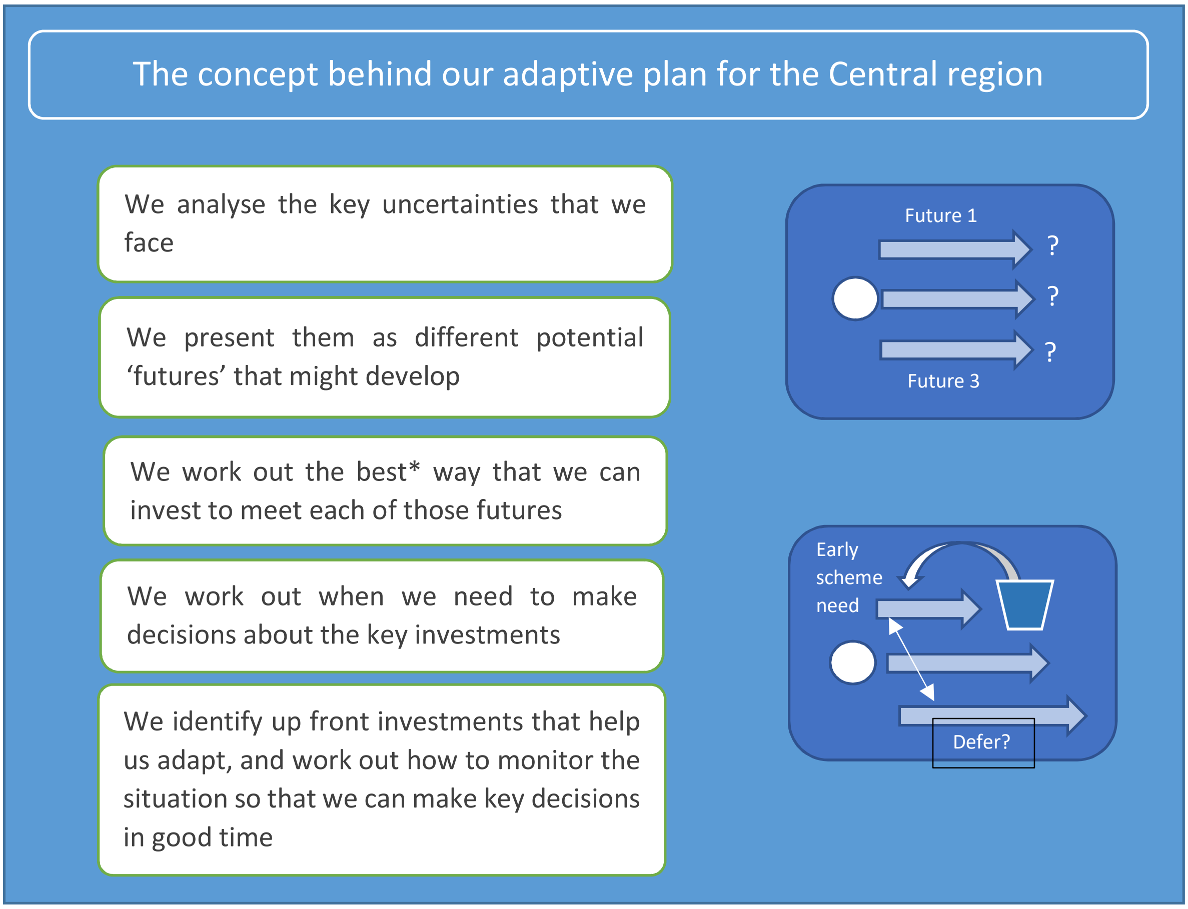


*Figure 3: Concept behind our Adaptive Plan (*In this case "best" represents the combination of investments that are both cost-effective and reflect customer and stakeholder expectations).*

1.4.8 We have formally assessed the environmental impacts of our rdWRMP. We have done this through carrying out:

- A Strategic Environmental Assessment ("SEA") – this was carried out under the Environmental Assessment of Plans and Programmes Regulations 2004, which requires the environmental impacts of certain plans and programmes likely to have significant effects on the environment to be assessed.

- A Habitats Regulations Assessment ("HRA") – this was carried out in accordance with the Conservation of Habitats and Species Regulations 2017. It assessed the impact of our proposals on European Sites, being Special Areas of Conservation ("SACs"), Special Protection Areas ("SPAs") and Ramsar sites. We considered whether a plan or project is likely to have a significant effect on one of these sites and if so requires an appropriate assessment to be carried out to ensure that it will not have an adverse effect on the integrity of the European Site.

- A Water Framework Directive ("WFD") Assessment – the WFD sets environmental objectives for water bodies, which for most water bodies includes achieving "good status". Our WFD Assessment considered whether our proposals would impact on achievement of these environmental objectives, by causing a risk of deterioration in its statement or of failure to achieve "good status".

1.4.9 We used the information we obtained from these assessments in our options appraisal (see Section 4.6) and our decision-making (see Section 5.8). We also assessed our rdWRMP as a whole (see Section 6.7).

1.5 The process we are following

1.5.1 We started our WRMP19 process by understanding the scale of the challenge we face in the future through our assessment of need and problem characterisation in 2016. Whilst developing the technical components of our dWRMP we undertook a pre-consultation with our stakeholders and customers.

1.5.2 Our dWRMP19 was submitted to the Secretary of State on 1 December 2017 and published on 19 March 2018. We then ran a public and stakeholder consultation on our dWRMP19 between 19 March and 23 May 2018.

1.5.3 All the feedback received on our dWRMP was considered and we published our Statement of Response (SoR) on 31 October 2018. This set out the main topics upon which customers and stakeholders provided feedback, along with an outline of the changes we proposed to make in our rdWRMP as a result. We provide an individual response to every representation made in Appendix 1 of our SoR which is available on our website at: https://stakeholder.affinitywater.co.uk/water-resources.aspx.

1.5.4 During the development of our rdWRMP we ran a pre-consultation with stakeholders, regulators and customers, through focus groups, to inform and shape decisions taken in our rdWRMP. This feedback shaped our Plan, which is demonstrated in Chapter 5.

1.5.5 We will undertake further consultation with customers and stakeholders on our rdWRMP in March / April 2019. This consultation will focus on aspects of the Plan which have changed. We will, however, also consider any comments made about any aspects of the rdWRMP.

1.5.6 We plan to publish our final WRMP in June 2019, subject to approval from the Secretary of State. Details of our WRMP19 timeline are shown in Figure 4.

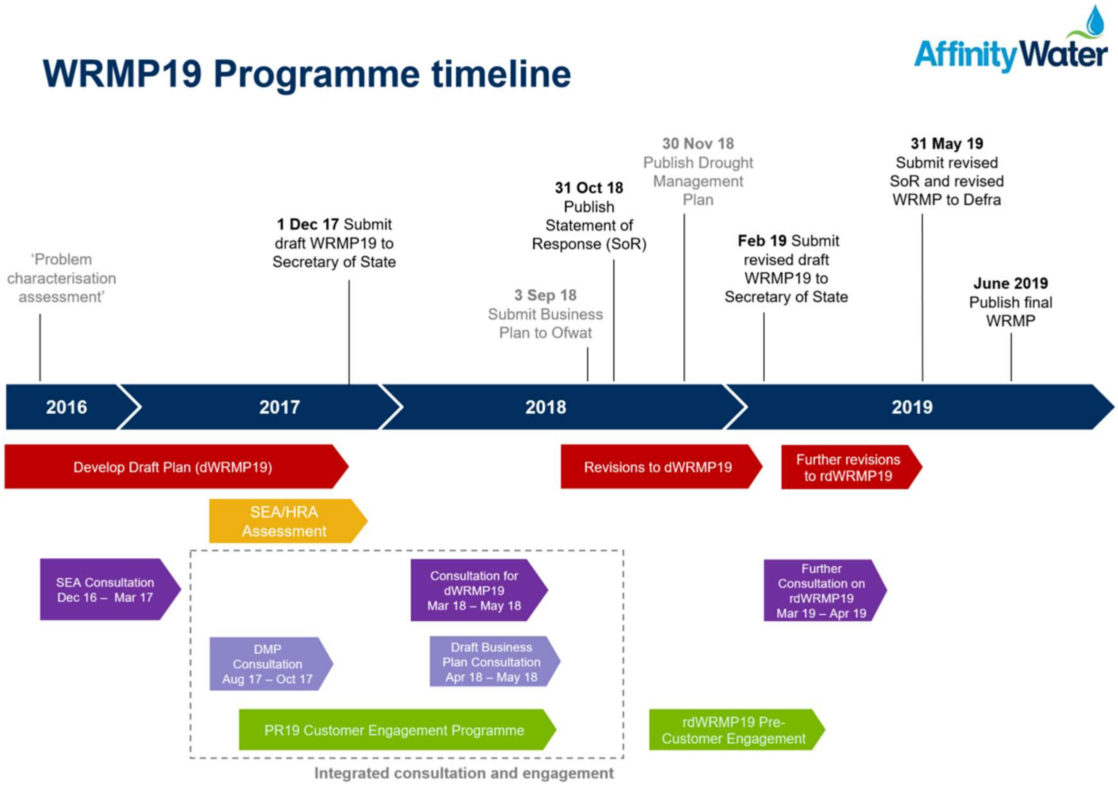


Figure 4: Our WRMP19 Programme Timeline

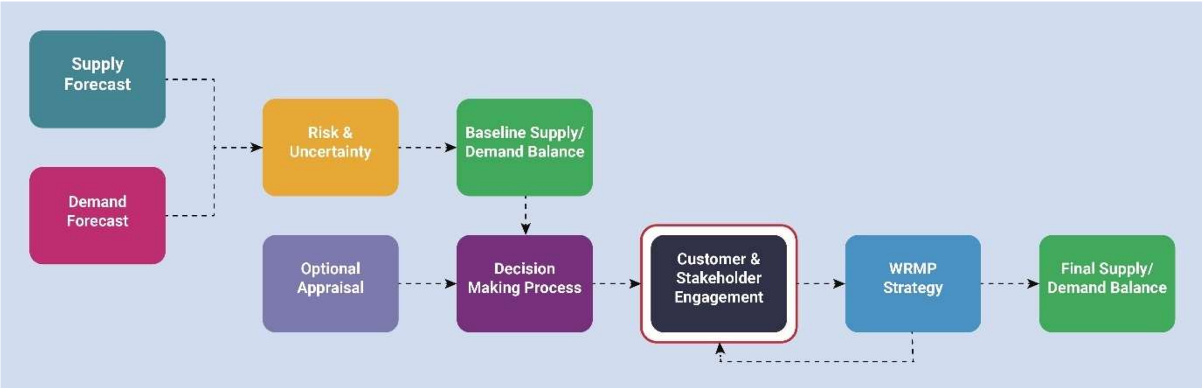
1.5.7 The suite of documents making up our rdWRMP19 comprises:

- A non-technical summary of our rdWRMP19 main Plan document (published).
- **This document** - our rdWRMP19 main Plan document (published).
- Our Statement of Response on our dWRMP and an addendum (published).
- Our Water Resource Planning data tables (published).
- A series of supporting Technical Reports. These include full results and conclusions from the detailed studies undertaken to produce this Plan as listed in the Appendix (available on request).
- Our Strategic Environmental Assessment Report and Habitats Regulations Assessment (published).

2 Consulting with Customers and Stakeholders

2.1 Introduction

2.1.1 Throughout the preparation of our WRMP19 and our PR19 Business Plan we have been committed to listening and acting on the feedback received from both customers and stakeholders regarding the direction of our plans. We needed to understand their priorities to decide on what our WRMP should look like.



2.1.2 Our programme of engagement has enabled us to set out and shape our overall approach and provide customers, regulators and stakeholders with an opportunity to tell us what they expect from our WRMP and our Business Plan for 2020-25. We used an enabling phase to map out a profile for our consultation activities that ensured both dWRMP and Business Plan consultation periods tracked one another cohesively and effectively.

2.1.3 To support and deliver our customer engagement programme, we appointed the UK's second largest market research agency, Ipsos MORI. Our programme included bespoke market research, recommendations for customer segmentation, analysis of operational customer contact data and triangulation[4].

2.2 Consultation on our draft WRMP

2.2.1 Prior to submitting our draft WRMP to the Department for the Environment, Food and Rural Affairs (Defra) in early 2018, we undertook a pre-consultation with our stakeholders and customers. We wrote to over 2,000 stakeholders asking for their views on our draft WRMP proposals and direction of travel. Customer views were captured via a variety of market research findings through our PR19 Customer Engagement programme, the engagement programme for development of our Business Plan 2020-25. These views were subsequently used to develop follow up areas of focus for the quantitative and qualitative market research during the draft WRMP public consultation.

2.2.2 From 19 March 2018 to 23 May 2018 we undertook a public consultation on our draft WRMP. We used a variety of methods within our draft WRMP and PR19 Business Plan customer engagement programme such as face to face interviews, online surveys, customer focus groups, stakeholder forums and other methods to ensure all customers and stakeholders

[4] Triangulation is a technique that facilitates validation of data through cross verification from two or more sources. It refers to the application and combination of several research methods in the study of the same phenomenon.

were given the opportunity to respond. We utilised customer profiling and segmentation to target customers appropriately to ensure results were robust and in line with the feedback received from our Customer Challenge Group ("CCG").

2.2.3 The public consultation on our draft WRMP was circulated to statutory consultees as well as any other persons and organisations with an interest in our plans. In addition, the draft WRMP was published on our website and made publicly available to any person wishing to review it. We published and promoted a non-technical consultation document alongside the draft WRMP to encourage and provide customers and stakeholders a platform to respond.

2.2.4 We received a total of 82 responses to our draft WRMP consultation including responses from customers, the EA, Ofwat, Natural England, the Canal & River Trust, the Consumer Council for Water, local authorities and environmental groups. In addition, 65 stakeholders attended eight stakeholder forums held across our three regions.

2.2.5 During Phase 2 of our customer engagement programme on our Business Plan we sought both quantitative data and qualitative opinion on our draft WRMP. Existing and new channels of engagement were utilised to facilitate customer and stakeholder representation and feedback through a broad range of activities including ethnographic and in-depth customer interviews, establishment of an on-line customer community, a non-technical consultation document, on-line and face to face customer surveys, customer focus groups, delivery of bill acceptability studies and stakeholder forums.

2.2.6 Each piece of research was carefully scoped to ensure we defined the objectives and considered the materiality and significance of the issues to be addressed. This informed the approach we took to ensure the sample and methodology chosen were both appropriate and proportionate to the importance of the issue. Findings were consolidated into key themes and against performance commitments. These were validated through external triangulation and assurance to ensure robustness of both the interpretation and the process we followed.

2.2.7 Overall, 15,300 individual pieces of feedback were received from customers as part of the PR19 Customer Engagement process which informed and aligned our dWRMP19 and Business Plan consultations. We evaluated the responses we received and have taken account of customer and stakeholder views in preparing our rdWRMP.

2.3 Pre-consultation for the rdWRMP

2.3.1 To support our decision making and development of the rdWRMP, we enhanced our customer consultation through a series of rdWRMP pre-consultation focus groups independently held in November 2018 and January 2019. These were aimed at refining our understanding of customer preferences in a number of areas, including demand management options and options for longer term strategic supply side schemes. During this phase of pre-consultation we also held a number of meetings with external stakeholders, to help us shape our decision making for the rdWRMP.

2.3.2 We ran eight pre-consultation focus groups exploring with customers a number of demand management options, per capita consumption, drought resilience and long term strategic supply options to inform our rdWRMP. This research focused on areas we had not fully explored with customers to date, and provided valuable insight into customer preferences.

2.3.3 Our pre-consultation with stakeholders targeted several key organisations. This included the EA, Defra, Ofwat, Drinking Water Inspectorate (DWI), Natural England, Group Against Reservoir Development (GARD), Local Authorities, river and environmental groups, Canal & River Trust, Anglian Trust, neighbouring water companies, Water Resources South East (WRSE) and water retailers.

2.3.4 We have also taken on board the results of Thames Water's customer research for the South East Strategic Reservoir (SESR), a potential scheme which we would need to develop jointly with Thames Water. The findings are from Thames Water's further engagement on their revised WRMP19 from October to November 2018 and are relevant to our rdWRMP19 and have therefore been included in our pre-consultation.

2.4 How customers have shaped our Plan

2.4.1 We selected the elements of our draft WRMP that received endorsement from customers, stakeholders and regulators and built on these in developing our rdWRMP. We published our Statement of Response (SoR) on 31 October 2018 which documents how we have responded to feedback on our draft WRMP and is available on our website at: https://stakeholder.affinitywater.co.uk/water-resources.aspx.

2.4.2 Feedback from customers, stakeholders and regulators has strongly shaped our rdWRMP. We have taken all our customer and stakeholder consultation and developed a formal analysis of their preferences – Customer and Stakeholder Analysis ("CSA"). This fundamentally shaped our decision-making process as described in Section 5.3 of this document.

2.4.3 We will undertake further consultation with customers and stakeholders on our rdWRMP. The consultation questions we ask focus on the aspects of the Plan which have changed between our draft WRMP and the rdWRMP. We will, however, also consider any comments made about any aspects of the rdWRMP.

2.4.4 Throughout the process we welcomed the feedback and participation of our Customer Challenge Group ("CCG") in all aspects of our engagement activities. Further detail of the consultation process, as well as the findings, is provided in the rdWRMP Technical Report 7.1: Engaging with Customers, Communities and Stakeholders. An overview of our PR19 customer engagement process is illustrated in Figure 5.

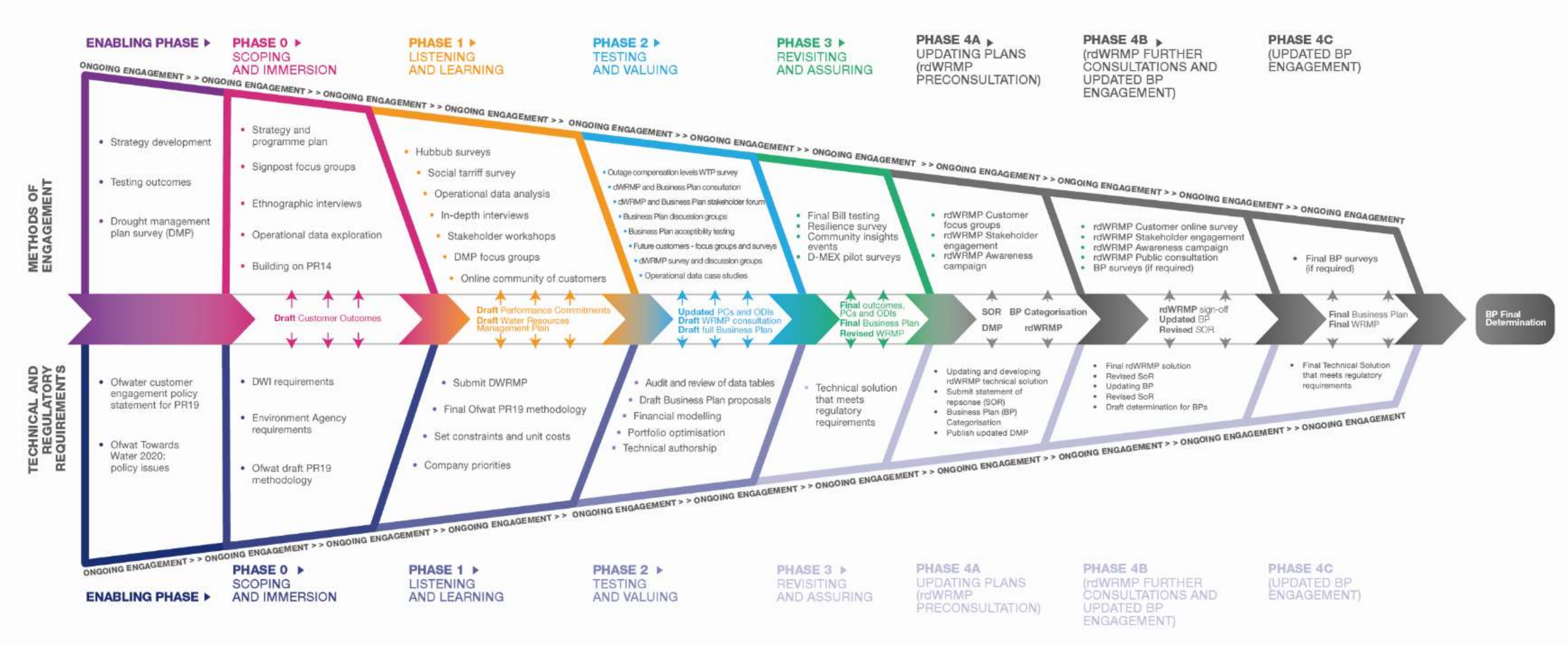


Figure 5: Overview of our PR19 customer engagement process

3 The scale of the challenge – baseline supply-demand balance

3.1 Introduction

3.1.1 This Chapter explains our forecasts of how much water we will have available to supply and how much water we need between 2020-2080. This gives us our baseline supply-demand balance, which is the position that we plan from. If it tells us that demand will outstrip supply in the future, then we need to plan to take action to close the gap between demand and supply and maintain the supply-demand balance. The WRMP process is outlined in Figure 6.

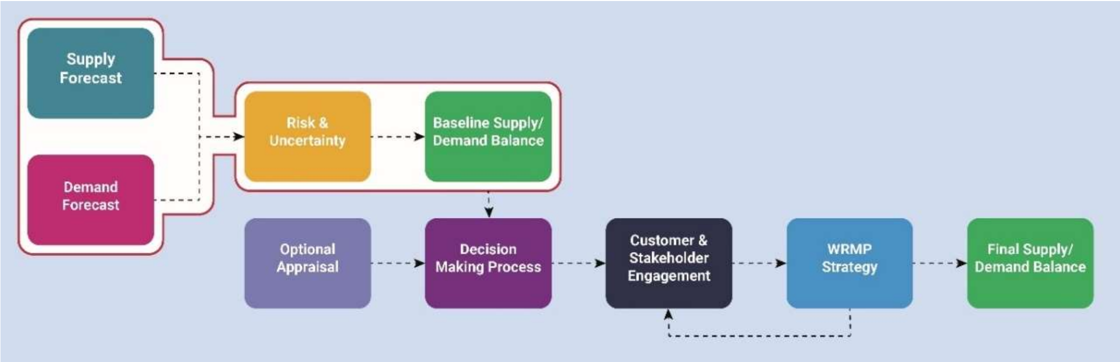


Figure 6: Detailed WRMP process

3.1.2 The steps calculating our baseline supply and demand balance are:

- Identify water resource zones, which we will use to build up our baseline supply and demand balance for each of our three supply regions (Section 3.2).
- Forecast baseline demand (Section 3.3 and Technical Reports 2.1 to 2.7).
- Forecast baseline supply (Section 3.4 and Technical Reports 1.1 to 1.5 and 3.1).
- Provide for uncertainty in the forecasts (Section 3.5 and Technical Report 3.2).
- Calculate the baseline supply-demand balance – the gap between the amount of water we have to supply and the predicted demand for that water (Section 3.6).

3.1.3 Our baseline supply-demand balance needs to reflect the level of drought resilience we wish to achieve which is resilience to a 1 in 200-year drought.

3.2 Water Resource Zones

3.2.1 We forecast the baseline supply-demand balance for each of our three supply regions. We build up the supply-demand balance for each region by calculating the supply-demand balance for each water resource zone following each of the steps above.

3.2.2 A water resource zone (WRZ) is the largest possible zone in which all water resources, including external transfers, can be shared, and hence an area in which all customers experience the same risk of supply failure from a water resource shortfall.

3.2.3 Each WRZ is given a number and name and are also known as our 'communities' as illustrated in Figure 1. Our Central region has six WRZs or communities; Misbourne (WRZ1), Colne

(WRZ2), Lee (WRZ3), Pinn (WRZ4), Stort (WRZ5) and Wey (WRZ6). Our East and Southeast regions represent one WRZ each, Brett (WRZ8) and Dour (WRZ7) communities respectively, resulting in a total of eight WRZs across the company area.

Our Central region

3.2.4 The WRZs in our Central Region are shown in more detail in the schematic map in Figure 7 below. The map shows the major demand centres, typically a town, labelled with a two letter code. It also shows how water can move between and within the WRZs via major pipelines known as trunk mains. Finally, it shows how our Central Region receives water from outside of our supply area from neighbouring water companies.

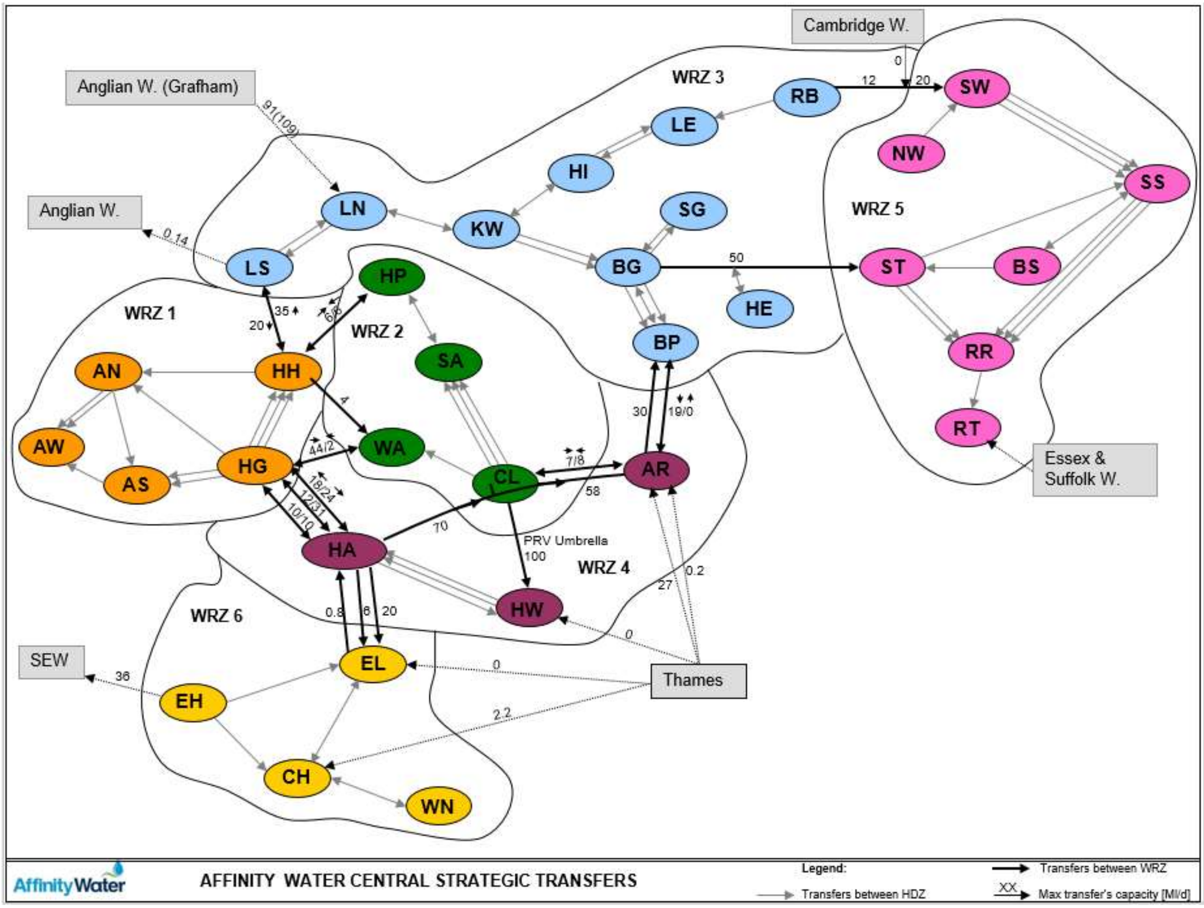


Figure 7: Map of the Water Resource Zone, connectivity and transfers in our Southeast region

3.2.5 In our Central region around 60% of water supply comes from groundwater sources. The remaining 40% is abstracted from surface water sources on the River Thames or is imported from neighbouring water companies. We treat the water we abstract from the River Thames at four locations along the river. These treatment works are also fed by some groundwater sources, mainly from the gravels. When combined, these are capable of providing reliable quantities of raw water following prolonged dry spells. Thames Water has carried out an investigation of the flows in the River Thames [5] that included our abstractions and on the basis of this investigation, we conclude that our abstractions are environmentally sustainable.

[5] AMP4 Thames Water investigation into the impact of abstraction on the Lower Thames and AMP5 Options Appraisal.

3.2.6 We export water to neighbouring water companies. We currently have the capability to import up to 10% of our water supply from Anglian Water on a short-term basis (around one week), and 3% to 4% on a longer-term basis.

Our Southeast region

3.2.7 In our Southeast region we abstract 90% of water supply from Chalk boreholes, with the remaining 10% supplied from the shallow gravel aquifer of the Dungeness peninsula. We have no surface water abstractions in this area. Our internal transfers and transfers from Southern Water and South East Water can be seen in Figure 8.

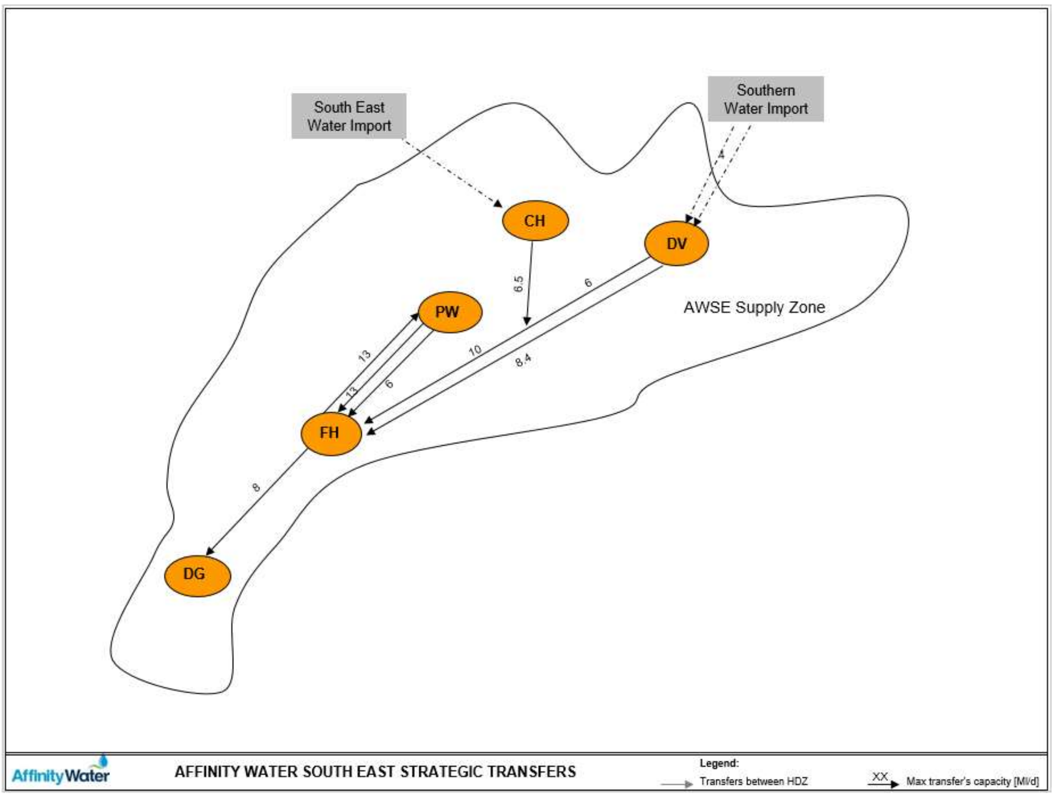


Figure 8: Map of the Water Resource Zone, connectivity and transfers in our Southeast region

Our East region

3.2.8 In our East region, 80% of supply comes from groundwater, drawn from confined Chalk aquifer boreholes in the River Stour and River Brett valleys in Essex and Suffolk. The boreholes proved robust and reliable during the groundwater drought conditions of 1990-1992, 1996-1998, 2006-2007 and more recently in 2011-2012. The remaining 20% is sourced from the River Colne and stored in a reservoir which is jointly owned with Anglian Water. Our internal connections can be seen in Figure 9.

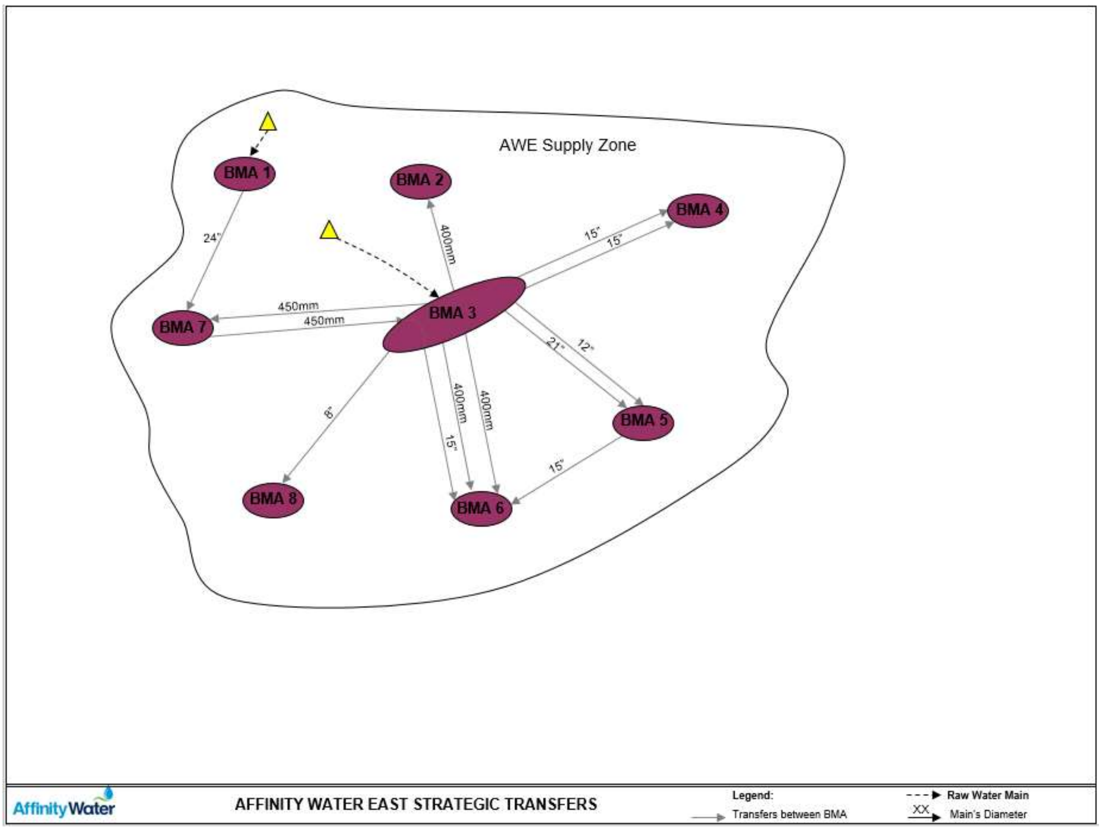


Figure 9: Map of the Water Resource Zone, connectivity and transfers in our East region

3.3 Baseline demand forecast

Introduction

3.3.1 As part of the WRMP, a baseline demand forecast is required that calculates the demand for water in the chosen base year (2016/17) and forecasts it across the planning period (2020 to 2080). Our demand forecasting process has been undertaken in line with the latest EA WRPG and UKWIR technical guidance and uses the latest industry best practice methods. The detail of how we forecast demand is in the Overarching Demand report, Technical Report 2.7.

3.3.2 The resulting demand forecast represents the demand in an average dry year i.e. when demand for water is at its highest. A critical period scenario is also assessed; this is a short period of peak demand, for example during very hot weather.

3.3.3 The demand for water is made up of a number of components as illustrated in Figure 10. We calculate our demand (distribution input) and each of these components for our chosen base year (see paragraphs 3.3.5 to 3.3.19 below).

3.3.4 We then assess how future water demand may change over the next 25 years and beyond up until 2080 by reviewing how each component of demand in the base year may change in future years: this sets our baseline demand forecast (see paragraphs 3.3.20 to 3.3.44 below).

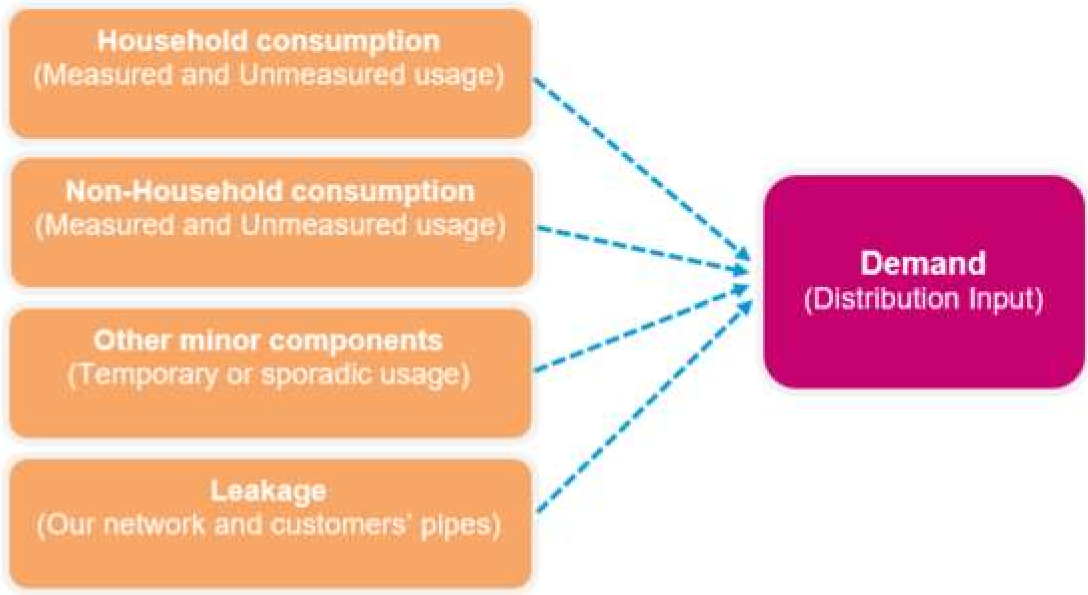


Figure 10: Components of demand

Base year

3.3.5 We selected 2016/17 as the base year for our rdWRMP. The decision to use this base year, as opposed to 2015/16 at draft WRMP, was primarily made because 2016/17 was reflective of a 'normal' year (i.e. not particularly wet or dry, so demand from customers was around our average expectations).

Total Demand – Distribution Input

3.3.6 We measure the quantity of water supplied from all our water treatment works into our pipe network using flow meters; this is known as our distribution input (DI). Within our pipe network we also measure flows going into specific areas known as district metered areas (DMAs), which are effectively local zones covering urban areas, towns and villages, where each DMA generally covers a few thousand homes. DMA flows are monitored continuously and enable us to assess daily changes in demand and consumption at a detailed level. This in turn allows us to vary our source outputs if needed and helps us to identify and tackle leaks on our network.

Household consumption

3.3.7 Some household properties are metered while others do not have meters and consumption is unmeasured. We calculate the annual consumption of measured households from meter readings logged on our billing system. We divide the total annual consumption by the number of measured households to work out how much water an average household uses. We deduct an amount to represent estimated leakage from customers' pipes i.e. customer side leakage. This gives us the amount of water used by each house – per household consumption ("PHC").

3.3.8 We then use this to calculate the amount of water used by each person by dividing the average household consumption by an average household occupancy rate. This is known as per capita consumption ("PCC") and is expressed in litres per head per day.

3.3.9 We produce estimates of current average unmeasured household for each of our WRZs using our "unmeasured consumption monitor". Our unmeasured consumption monitor operates only in our Central Region because meter penetration rates in our Southeast and East regions is much higher than that of our Central region. Therefore, we do not have unmeasured consumption monitors in those regions.

3.3.10 This monitor comprises a group of around 1,500 customers in our Central region who have had meters installed for our survey purposes but which are not used for charging. It has been in operation since 1995 and includes a wide range of property types (flats / apartments, terraced houses, semi-detached and detached properties) across the region to better understand how water use differs for different properties. For example, we would expect to see garden watering to be lower for those living in flats than for those living in detached properties. This information allows us to work out PHC and PPC for customers on unmeasured tariffs.

Non-household consumption

3.3.11 Non-household properties may also be measured or unmeasured. We calculate non-household consumption by summing measured non-household consumption and an estimate of unmeasured non-household consumption.

Leakage

3.3.12 We use information obtained from meters on our network to calculate leakage using the approach outlined in leakage reporting guidance produced by Ofwat and Water UK. Leakage includes both leakage on our network and customer side leakage. It also includes leakage from empty properties.

Minor components of demand

3.3.13 Other minor components of demand include usage such as builders' temporary supplies from standpipes, water for fire-fighting purposes and water we use for operational purposes such as flushing of hydrants. We use a fixed estimate for these.

Water balance in our base year and our Annual Return 2017

3.3.14 We are required to submit information about DI and its components as part of our annual return to Ofwat about our water balance. The WRMP base year is largely based on the water balance submitted as part of the Annual Return 2017.

3.3.15 Some adjustments to the Annual Return water balance were made to reflect improvements in our understanding of some components of the water balance. The main changes involved:

- Occupancy rates and population estimates: a new occupancy model was created which more accurately represents the current occupancy rates.
- Baseline leakage calculations: the latest Water Resource Planning Guideline prescribes that water companies should determine their base year leakage using the approach outlined in

leakage reporting guidance (Ofwat and Water UK, March 2018). Leakage in the base year was reviewed to accommodate the introduction of this 'convergence' method. The end of AMP6 forecast value was also adjusted to account for this change.

- PCC calculations in Southeast and East regions: unmeasured per capita consumption (uPCC) from our consumption monitor 'Watcom', was applied to unmeasured customers in our Southeast and East regions.

"Peak" and "Dry Year" factors

3.3.16 We made adjustments to our 2016/17 base year water balance to tell us what the water balance would have looked like if:

- the weather in 2016/17 had been normal – this is known as normal year dry average ("NYAA")
- the weather in 2016/17 had been dry – this is known as dry year annual average ("DYAA").

3.3.17 We calculated the adjustments we needed to reflect NYAA and DYAA in accordance with best practice guidance using the following data:

- a historic record of annual measured and unmeasured PCC for each region for the period 2005/06 to 2017/18
- monthly weather data for temperature and rainfall for Central, Southeast and East regions from the MET Office website
- daily weather data for the Central region from our MET Office model.

3.3.18 We also considered what demand would have been for a critical peak period, dry year critical peak ("DYCP"), when demand is high for a short period of time, for example because of warm weather. This is calculated on the basis of a rolling seven-day average.

3.3.19 In our modelling of the supply-demand balance we assume that demand restrictions allowing the temporary restriction of certain non-essential uses of water (Temporary Use Bans and Non-Essential Use Bans), would be in place at both DYAA and DYCP given our adoption of a 1 in 200 year design scenarios. These are assumed to reduce household demand by 3% while they are in place.

Forecasting demand

3.3.20 We forecasted total demand (DI), following UKWIR best practice guidance, by first forecasting each of the components separately from the base year as described below. We then summed them in our spreadsheet-based Hub model to provide total demand. We produced forecasts for normal year annual average ("NYAA"), dry year annual average ("DYAA") and critical peak ("CP").

Household demand forecast

3.3.21 We forecast future household demand using a multi-linear regression ("MLR") computer model. The model uses information relating to historic household consumption and forecasts population, property numbers and occupancy rates to predict how household demand will change in the future from its level in our base year. Our dWRMP Technical Report 2.1: Household Demand Forecast – MLR modelling, explains the various steps undertaken to test and validate our MLR model.

3.3.22 The MLR model predicts demand from different types of household property likely to have different patterns of water usage:

- **Optants** – these are customers who were previously on unmeasured tariffs and choose to have a meter installed; they will receive a bill based on their metered use straight away

- **New builds** – these are new properties built in our supply area and the number of these was forecast to increase year on year

- **WSP customers** – these are customers subject to compulsory metering; they receive a bill based on their metered use after two years unless they choose to opt for metered billing earlier

- **Social tariff customers** – these are customers (measured and unmeasured) that are eligible for a lower tariff because of economic circumstances and/or health conditions that mean their water use is higher

- **Existing metered customers** – these are customers that have a meter.

3.3.23 Two key inputs to the MLR model were population and property forecasts. To update our population and property forecast, we participated in a group project with four other water companies in January 2017 aimed at developing a range of different housing and population forecasts. The group commissioned Experian to produce a set of four different forecasts for the period 2020-2045:

- trend-based forecast

- plan-based forecast

- econometric forecast

- hybrid forecast

3.3.24 Based on our review and taking into account the latest EA and UK Water Industry Research (UKWIR) guidelines, plan-based forecasts have been selected and used in the rdWRMP19 ((see further Technical Report 2.3). Experian plan-based forecasts have been adjusted to take account of knowledge of historic trends in housing formation and our billing system). We also added into the forecasts, properties that, prior to the opening of the retail market in April

2017, were classified as commercial properties that since April 2017 are recognised as household properties.

3.3.25 Population figures were produced by applying the same Experian trend to the base year population, adjusted using new occupancy rates up to 2044/45. The population figures were extrapolated in a linear manner after 2045. All property, occupancy and population figures have been thoroughly checked and audited.

3.3.26 We have compared our revised property forecast (revised as set out above) with detailed information gathered from local authority plans to ensure alignment with those plans. In respect of the London Plan, which is currently at draft stage, we understand that the housing targets will not be finalised until 2020. The GLA confirmed during pre-consultation that the draft housing forecasts are too uncertain to incorporate into our rdWRMP at this stage. As a result, they have not formed part of our baseline assessment, but we have used them to test the robustness of our plan to risks (see section 5.7).

3.3.27 The comparison between our rdWRMP19 and other recently produced local plans shows that we are broadly aligned with local authorities' figures in the first 15 years of our forecast. The difference between our forecast and local plans housing targets is very small, ranging between 0.07% and 1.94% of our total property count of approximately 1.4 million properties and therefore the difference is not material. Our forecast tends to diverge from local plans after approximately 15 years when local plans' figures become less consistent or, for some local authorities, not available. Table 1 and Table 2 below set out our current and forecast population and property numbers.

Table 1: Current and forecast population numbers

Water Resource Zone	Base Year Population (2016/17)	Total population forecast by 2024/25	% increase by 2024/25	Total population forecast by 2044/45	% increase by 2044/45	Total population forecast by 2079/80	% increase by 2079/80
1	354,284	383,869	8%	373,898	6%	346,014	-2%[6]
2	426,325	467,045	10%	513,652	20%	589,529	38%
3	699,038	796,455	14%	931,333	33%	1,155,194	65%
4	902,477	1,015,827	13%	1,184,769	31%	1,477,507	64%
5	288,591	334,520	16%	397,864	38%	503,498	74%
6	525,261	586,740	12%	644,758	23%	736,887	40%
Central region	3,195,976	3,584,457	12%	4,046,274	27%	4,808,631	50%
7 (Southeast region)	160,115	180,540	13%	210,832	32%	263,330	64%
8 (East region)	150,426	165,185	10%	183,050	22%	212,831	41%
Company total	**3,506,516**	**3,930,182**	12%	**4,440,157**	27%	**5,284,792**	51%

N.B: Totals in this table are subject to rounding.

[6] The long-term population decrease in WRZ1 is due to the method used to extended the forecast by applying a linear extrapolation. The methodology used is consistent with the that followed in all other zones and the decrease reflects consistent application of this methodology. Population estimates after 2045 contain significant uncertainties and we will monitor any new evidence as it becomes available.

Table 2: Current and forecast number of households

Water Resource Zone	Base Year number of properties (2016/17)	Total number of properties forecast by 2024/25	% increase by 2024/25	Total number of properties forecast by 2044/45	% increase by 2044/45	Total number of properties forecast by 2079/80	% increase by 2079/80
1	131,390	138,044	5%	153,338	17%	180,102	37%
2	167,829	179,530	7%	206,574	23%	253,901	51%
3	271,176	304,200	12%	384,117	42%	523,971	93%
4	331,554	367,482	11%	453,383	37%	603,710	82%
5	116,139	131,864	14%	169,236	46%	234,636	102%
6	195,508	217,393	11%	269,578	38%	360,901	85%
Central region	1,213,596	1,338,514	10%	1,636,225	35%	2,157,221	78%
7 (Southeast region)	70,050	79,733	14%	102,578	46%	142,557	104%
8 (East region)	67,811	73,707	9%	87,626	29%	111,984	65%
Company total	**1,351,457**	**1,491,954**	10%	**1,826,430**	35%	**2,411,762**	78%

N.B: Totals in this table are subject to rounding.

3.3.28 The resulting population and property forecasts are then fed into our occupancy rate model, which generates expected occupancy rates for both measured and unmeasured properties. These occupancy rates then feed into the MLR model to generate the PCCs, and generate the split between measured and unmeasured populations in the demand forecast model.

3.3.29 The result of modelling is a household consumption forecast, providing PHC and PCC values per year, per zone, for both measured and unmeasured populations as shown in Figure 11. All consumption outputs are given as NYAA, with climate change effects being added (see later for further details of climate change impacts on demand).

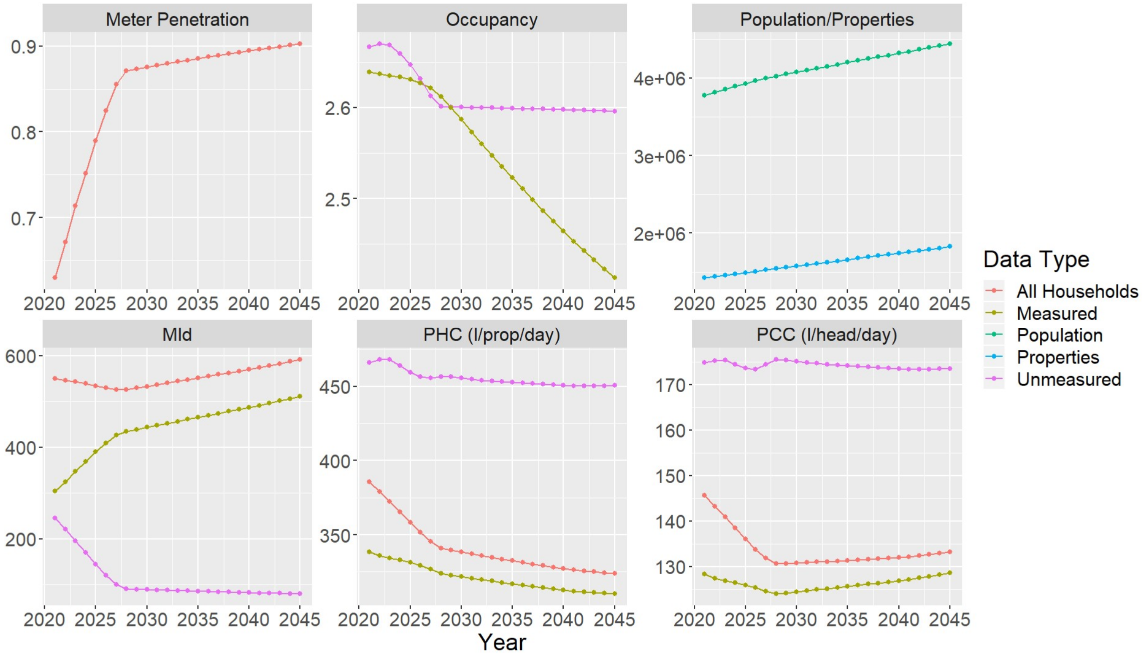


Figure 11: Company level outputs for PCC, PHC, occupancy and Ml/d

3.3.30 Our meter penetration (the percentage of properties that are metered) increases from 59.2% in 2020, to over 90% in 2045. Throughout this period, population and number of properties are steadily increasing, with total occupancy reducing. The falling occupancy rate is driving the increase in PCC seen after 2028.

3.3.31 We used the results of our MLR model to calibrate a micro-component model. This model provides an indication of the breakdown of household demand by different uses (or micro-components): WC flushing, shower use, bath use, dishwasher use, washing machine use). Technical Report 2.2 provides further detail.

Non-household forecast

3.3.32 We developed forecasts for non-household water demand along with those for household customers. Further detailed explanation on the methodology used is available in Technical Report 2.4.

3.3.33 Historic consumption data going back at least ten years was used to generate the non-household demand forecast using a regression model. Various sources of data were used to produce the forecast:

- Billing extracts containing annual water consumption data for each measured non-household customer for the period 2001-02 to 2015-16 for the Central region and 2006-07 to 2015-16 for the Southeast and East regions.

- Population data.

- Standard Industrial Classification (SIC) code for each non-household customer.

- Economic data

3.3.34 The resulting non-household consumption forecast shows a downwards trend at a Company level from half way through the period, as illustrated in Figure 12.

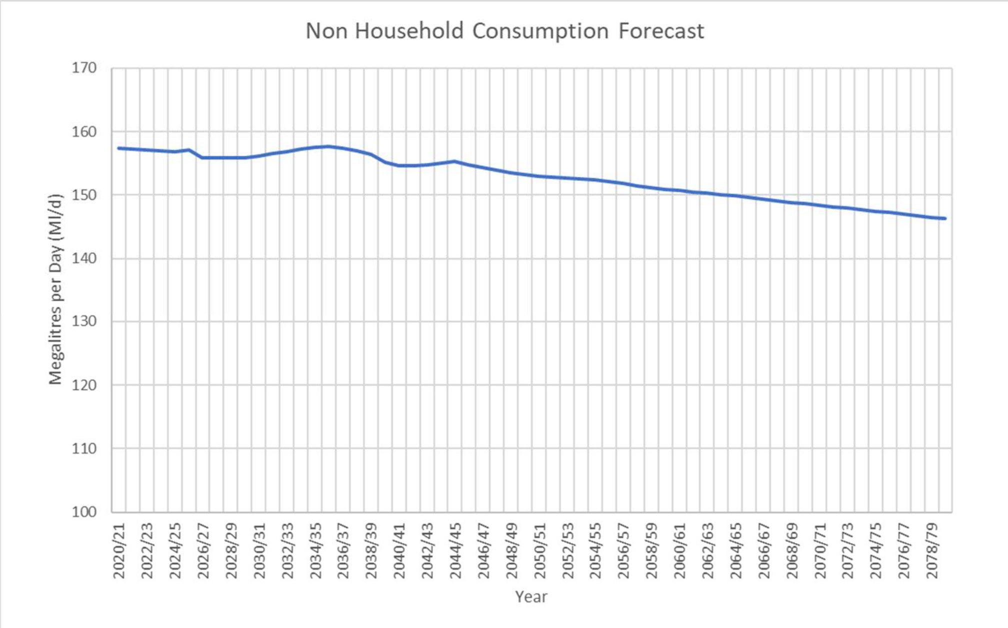


Figure 12: Non-household consumption forecast

3.3.35 There are a number of developments in our supply area that are likely to impact on future non-household demand including:

- **Heathrow Airport** – this consumes approximately 5 Ml/d, split between WRZ4 and WRZ6; there is likely to be a substantial increase in this when the new third runway is constructed, currently planned to start in 2020.

- **Dungeness Power Station** in the Southeast region is scheduled to be decommissioned by 2028. The current consumption is 1.5 Ml/d. There is unlikely to be a replacement, with the generation capacity instead met through the planned nuclear reactor at Hinkley Point.

- **Luton Airport** in WRZ3 has an average consumption of approximately 0.45 Ml/d. There is a current expansion plan to increase passenger numbers by 50% by the year 2020.

- **Oxford to Cambridge corridor (CaMKOx)** could result in an increase in population above that which is included in forecasts for this rdWRMP.

- **High Speed Rail** – the construction of a new high speed rail line into London is likely to require a 6 Ml/d water resource during construction.

- **Crossrail** – running from Ealing Broadway to Maidenhead through the centre of the Central region. This would most likely have a similar impact to the current Crossrail project.

- **Western Rail Link to Heathrow** - a new rail link is proposed from Slough to Heathrow linking the airport to the Great Western main line.

3.3.36 Of these, the direct demand associated with airport expansion and Dungeness Power station have been included in our base forecasts. The High Speed Rail demand is not included as this will be supplied through specific sources that will be developed by the project. The CaMKOx corridor risks have been quantified, but excluded from our baseline assessment as they are too uncertain at this stage. There are no known direct demands from Crossrail or the Western Rail Link at this stage.

3.3.37 These infrastructure projects will also provide local employment and help to drive an increase in population. The forecasts used in calculating household demand already show levels of growth that are consistent with these and other projects taking place, and therefore the impacts of these (or alternative similar developments) are arguably already taken into account within the forecasts.

Leakage forecast

3.3.38 Our baseline and forecast leakage is calculated using the latest 'convergence method' specified by Owfat and the EA. We have assessed the impact of applying the new method to forecast leakage for 2016/17, and concluded that this only resulted in a 2% increase in our base year leakage. The subsequent reporting year (2017/18) showed that the overall difference was negligible once the new methodology had been fully established. The difference between our latest forecasts of leakage and those from 2014 are therefore negligible and mainly relate to changes in the prioritisation of different WRZs and DMAs from our AMP6 (2015-2020) leakage strategy. This is explained in the leakage strategy Technical Report 4.8.

3.3.39 We forecast leakage by assuming that we meet our target to reduce leakage by 14% by the end of AMP6. The forecast value for the last year of AMP6 (2019/20) is then kept constant to 2080. By doing that, we assume that, as a baseline, we will maintain the same level of leakage in the future.

Overall demand (DI) forecast

3.3.40 Adopting a bottom-up approach, the property and population, household and non-household forecasts are combined in the Hub model to produce a total demand forecast, known as Distribution Input (DI) per water resource zone, region and for the whole company.

3.3.41 The model has been developed to be consistent with the terminology and calculations in the Water Resources Planning (WRP) Tables for Normal Year Annual Average (NYAA), Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP). It shows how each component of the demand forecast contributes to DI every year of the planning period, shown in Figure 13.

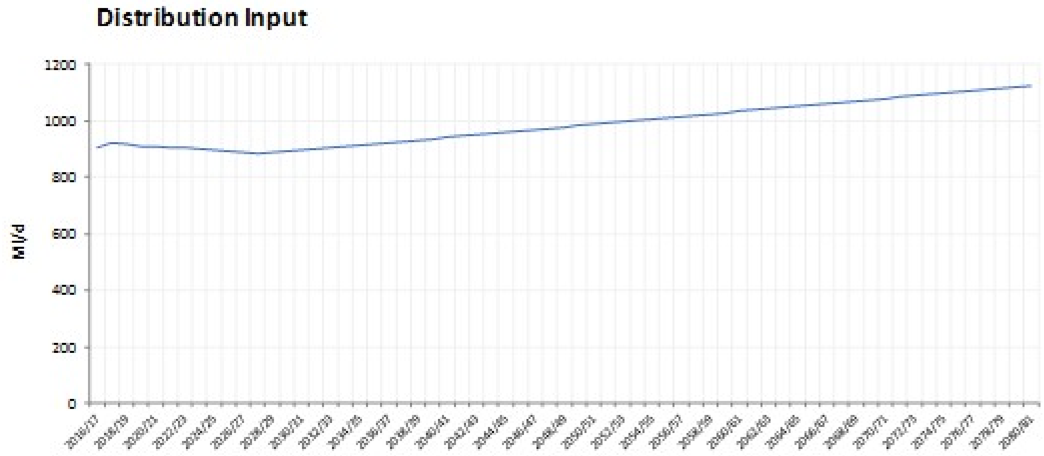


Figure 13: Forecast of Distribution Input (DI) from the base year 2016/17 until 2080/81

3.3.42 The final results show a general upward trend in DI. This is the result of combining the trends derived from each of the constituent forecasts (household, non-household, property and population). The increase in distribution input, notably in the long-term, is largely driven by a sustained increase in the property and population forecasts: a 27% population increase at company level and 30% increase in the property forecast results in a 55 Ml/day increase in household consumption for Normal Year Annual Average (NYAA) by 2044/45.

3.3.43 The upward trend in population and household consumption is counterbalanced in the first ten years of the planning period (2020 to 2030) by a reduction in consumption arising from meter installations under the Water Saving Programme (WSP). Meter penetration increases from 59% in 2020, to over 90% in 2045 company-wide. This is the single most important factor influencing household consumption forecast in the near term.

Climate change impact on demand

3.3.44 The Multi Criteria model makes the required adjustments for climate change based on the latest UKWIR guidance[7]. Table 3 provides a summary of the uplift applied for climate change impacts on household demand throughout the forecast.

Table 3: Summary of the uplift applied for climate change impacts on household demand

		Unit	2015/16	2020/21	2025/26	2030/31	2035/36	2040/41	2045/46	2050/51	2055/56
CC Forecast	WRZ1	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ2	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ3	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ4	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ5	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ6	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ7	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	WRZ8	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	Central Region	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%
	Company	%	0.00%	0.18%	0.36%	0.53%	0.71%	0.89%	1.07%	1.25%	1.43%

[7] UKWIR 13/CL/04/12 Impact of Climate Change on water demand.

3.4 Baseline supply forecast

Introduction

3.4.1 Our supply forecast represents the amount of water we can reliably supply to customers during our chosen baseline drought severity. For our rdWRMP this is the 1 in 200 year drought, meaning that we want to be able to maintain supply in the event of a drought that occurs on average once every 200 years.

3.4.2 We also calculate the amount of water we can supply during specific parts of the drought, known as 'critical periods' which are likely to be during the summer, when the customer demand for water is significantly higher than during other parts of the year.

3.4.3 Our water available for use is deployable output (DO), the amount of water that we can abstract (see paragraphs 3.4.5 to 3.4.13), to which we add the net amount of water we receive from transfers (i.e. the amount of imported water less the amount of exported water) (see paragraphs 3.4.14 to 3.4.21). We then subtract the following:

- Sustainability reductions – reductions we need to make to our abstractions for environmental reasons (paragraphs 3.4.22 to 3.4.31).

- Climate change allowance – reduction in water available as a result of climate change (paragraphs 3.4.32 to 3.4.35).

- Outage – temporary loss of deployable output for failure process or other reasons (paragraphs 3.4.36 to 3.4.41)

- Treatment loss – water lost during the treatment process (paragraphs 3.4.42 to 3.4.46).

3.4.4 The calculation of our supply forecast is presented in detail in Technical Report 1.1: Deployable output and climate change impact assessment, Technical Report 1.1.1 WRMP-DMP links and the DO Addendum Report.

Deployable Output

3.4.5 Deployable output (DO) is the amount of water that can be abstracted from a range of conditions but notably under dry year conditions and delivered into supply. The reliable supply over the course of a year is known as average DO (ADO) and the reliable supply during the summer is known as peak DO (PDO).

3.4.6 There are a number of constraints on supply which are incorporated into the calculation of DO such as the licence, or hydrogeological or physical constraints (such as the pump depth in a borehole, or a dewatering an adit[8], or the capacity of the treatment works) and water quality issues (see further paragraphs 3.4.47 to 3.4.59 below).

[8] An adit is a horizontal tunnel extending typically several hundred metres away from the vertical abstraction borehole. This is to enlarge the capture zone and hence the yield of the borehole.

3.4.7 Our rdWRMP uses average and peak DO figures for a 1:200 year return period drought as a baseline, which is beyond the worst historic drought experienced in the 20th century. The methodology we used to assess DO is a common method used widely in the water industry for hindcasting groundwater levels and linking them to source deployable outputs. In summary:

- we identified the worst historic drought based on hindcast groundwater levels for a number of observation boreholes (OBHs);
- we calculated the DO for the worst historic drought; and
- we used this to calculate DO for the 1 in 200 year drought; we also calculated the DO for a 1 in 500 year drought for comparison purposes.

3.4.8 The worst historic drought differs for each WRZ in terms of duration or severity but all occurred in the decades of the 1930s and 1940s and had return periods of between 1:60 to 1:80 years. We undertook further sensitivity testing that confirmed that the worst historic droughts in the 1930s and 1940s were indeed the worst in the area. This conclusion is consistent with work presented by the British Geological Survey and the Met Office, and is also consistent with Anglian Water's assessment.

3.4.9 We calculated the 1:200 year DO figures using hindcasting. We made some adjustments to the average DO and peak DO values for some sources to reflect the latest information on our sources. This information was not available at the time of developing the DO figures for the dWRMP19 and has been derived through ongoing studies, pumping tests or recent changes in the operational patterns of some sources. This resulted in an overall increase in available DO during the 1 in 200-year event.

3.4.10 A comparison of the DO assessment for our last plan in WRMP14, our draft WRMP and our rdWRMP is shown in Table 4.

Table 4: Comparison of DO methodology between fWRMP14, dWRMP19 and rdWRMP19

	fWRMP14	dWRMP19	rdWRMP19
DO assessment methodology	Basic assessment DO assessed using historic water level data against output data (UKWIR 1995, 2000).	Enhance assessment for drought vulnerable sources (c.65 sites) and DO re-assessed per source by developing source models and assessed in WRZ models.	As per dWRMP19, plus DO adjustment on a few sources to reflect latest operational understanding during drought conditions (overall increase).
Worst historic drought period	Assessments based on drought conditions in the 1990s, 2006 and 2012.	Assessments based on the worst historic drought in the hindcast record (1930s and 1940s) through an automated DO curve shifting approach.	Same methodology as dWRMP19 but with assessments based on a 1 in 200 year drought which goes beyond the worst historic droughts of the 20th century.

Levels of service (LoS) and return periods	Qualitative link between DO, drought return period and LoS.	It follows the existing LoS with explicit links between DO drought return periods and LoS. A range of DOs for different return periods (derived from WRSE stochastic climate data) and impact of drought conditions was tested in our EBSD model with or without demand restrictions and drought permits/orders (linking to Drought Plan).	Following EBSD testing and consultation responses, a 1 in 200 drought return period has been adopted as the baseline for the rdWRMP19, with no drought permits and orders post March 2024.

3.4.11 The 'worst historic', 'severe' and 'extreme' drought DOs are provided in Table 5 for the company area.

Table 5: Summary of region deployable outputs

Region	Plan	Worst historic ADO (Ml/d)	1 in 200 year ADO (Ml/d)	1 in 500 year ADO (Ml/d)	Worst historic PDO (Ml/d)	1 in 200 year PDO (Ml/d)	1 in 500 year PDO (Ml/d)
Central	fWRMP14	1,002	n/a	n/a	1,155	n/a	n/a
	dWRMP19	920	882	874	1,089	1,069	1,048
	rdWRMP19	N/A	897	888	N/A	1,079	1,058
Southeast	fWRMP14	52	n/a	n/a	61	n/a	n/a
	dWRMP19	51	46	46	58	55	51
	rdWRMP19	N/A	46	46	N/A	55	51
East	fWRMP14	38	n/a	n/a	53	n/a	n/a
	dWRMP19	38	38	38	53	53	53
	rdWRMP19	N/A	38	38	N/A	53	53
Company Total	***fWRMP14***	***1,093***	***n/a***	***n/a***	***1,269***	***n/a***	***n/a***
	dWRMP19	***1,009****	***968***	***958***	***1,201****	***1,177***	***1,153***
	rdWRMP19	***N/A***	***981***	***972***	***N/A***	***1,187***	***1,162***

**Note – the difference between fWRMP14 and dWRMP19 includes the AMP6 sustainability reductions and the move to best practice hindcasting techniques*

3.4.12 The worst historic DO values have reduced relative to WRMP14, largely owing to the sustainability reductions and shift to a more severe worst historic drought. Changes between our draft WRMP and rdWRMP are based on better understanding of our sources. The EA has been consulted on the revised DO figures and at the time of publication it is understood that they endorse these changes for use in the rdWRMP.

3.4.13 WRZs 4, 6 and 8 are assessed as not being sensitive to drought. In the case of WRZs 4 and 6, the DO is dominated by abstraction from the River Thames and the adjacent river gravels. We can abstract up to the licensed volumes and rates with no low-flow constraints. In WRZ8 the outputs of Ardleigh reservoir and the groundwater sources in the confined aquifer are also assessed to be not sensitive to drought.

Existing bulk transfers

3.4.14 We have a number of existing arrangements with neighbouring companies for bulk water imports. We also have arrangements to export water in bulk to neighbouring companies.

3.4.15 The national-level map in Figure 14 shows the location of Affinity Water in a wider geographic context where our company boundaries are shared with seven water companies[9].

Figure 14: Map of Water Companies in England and Wales

[9] We also share boundaries with and provide bulk supplies to new appointees. These are companies appointed by Ofwat to provide water and/or sewerage services for a specific geographic area, within an existing water company's water supply area. The scale of our bulk exports to new appointees is small and we have therefore not provided information about these supplies in our rdWRMP.

3.4.16 Our Central region shares borders with Thames Water, Anglian Water, Cambridge Water (South Staffs Water), Essex & Suffolk Water (Northumbrian Water), Sutton & East Surrey Water and South East Water. Our Southeast region shares borders with Southern Water and South East Water while our East region shares a border with Anglian Water. In a region which is so densely populated, the levels of resilience provided by bulk supply agreements is critically important. Figure 15 shows the indicative locations of our existing transfers, which are numbered according to Table 6.

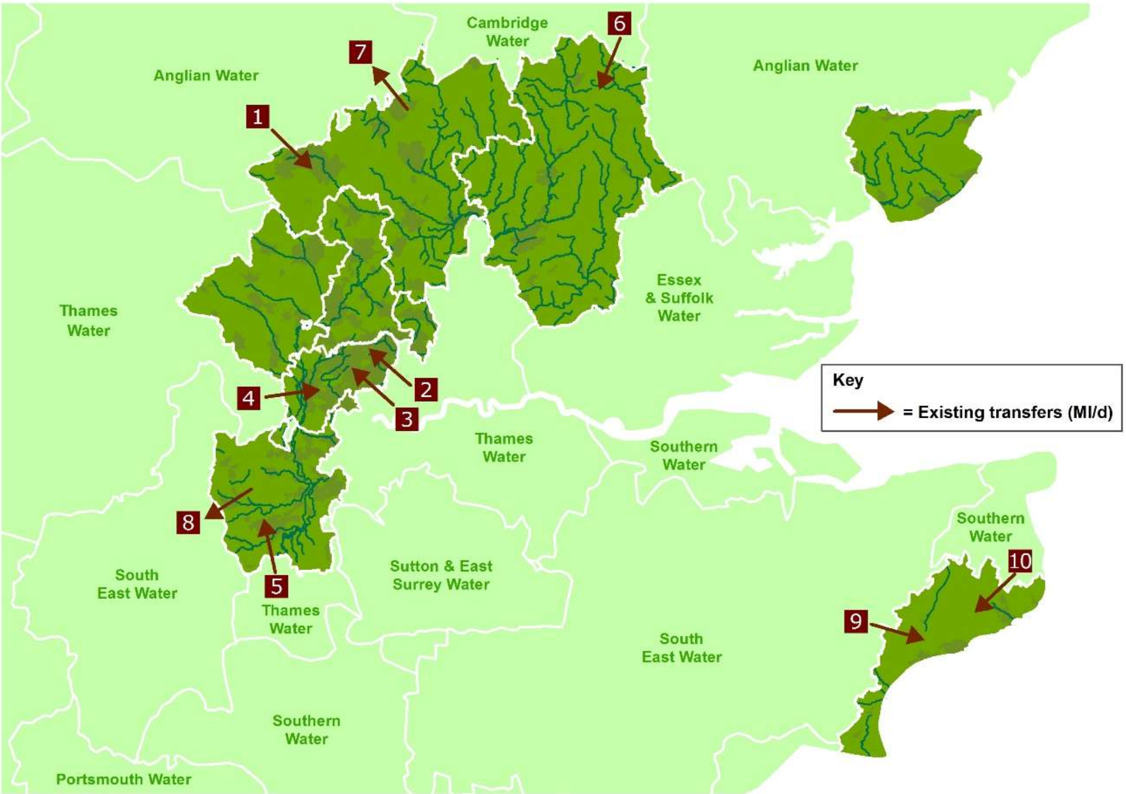


Figure 15: Location of existing import and export arrangements (numbers relate to transfer IDs in Table 6).

3.4.17 Table 6 provides a summary of the volumes for each of existing transfers. The volumes stated are the available capacity under the applicable agreement or arrangement, rather than utilisations which can vary depending on needs.

Table 6: List of existing bulk transfer capacities for our rdWRMP19

ID	Existing transfer	Providing Company	Receiving Company	Maximum capacity at average Ml/d	Maximum capacity at peak Ml/d
1	Existing	Anglian	Affinity Water WRZ3	91*	109.0
2	Existing	Thames	Affinity Water WRZ4	12	27.0
3	Existing	Thames	Affinity Water WRZ4	0.2	0.2
4	Existing	Thames	Affinity Water WRZ4	2.0	2.0
5	Existing	Thames	Affinity Water WRZ6	2.27	2.27
6	Existing	Cambridge	Affinity Water WRZ5	0.30	0.30
7	Existing	Affinity WRZ3	Anglian Water	0.14	0.14
8	Existing	Affinity WRZ6	South East Water	36.0	36.0
9	Existing	South East Water	Affinity Water WRZ7	2.0	2.0
10	Existing	Southern Water	Affinity Water WRZ7	0.0714	4.0

**We have capped the average capacity of this transfer to 50 Ml/d, until 2023/24 when we expect to have installed conditioning treatment at Sundon.*

3.4.18 We have a statutory arrangement with Anglian Water for a supply to our WRZ3. The maximum amount of water we are authorised to take under average conditions is 91 Ml/d. At present, we are unable to utilise all of this import for water quality reasons. We are planning to build a treatment plant during AMP7 to condition the water imported to ensure that the full 91 Ml/d peak capability can be transferred. Within our investment modelling we have therefore capped the average capacity of this transfer to 50Ml/d, until 2023/24 when we expect to complete the new treatment plant at Sundon.

3.4.19 We have two existing imports to our WRZ7 in our Southeast region; one from South East Water at Barham and one from Southern Water at Deal. These imports are both subject to agreements which end on the 31 of March 2020.

3.4.20 In our East region we operate a shared reservoir with Anglian Water under a statutory arrangement. We are entitled to take 50% of the output from the reservoir but have agreed with Anglian Water a share of 70%/30% (in favour of Anglian Water) until 2025. We will revert to a 50%/50% share from 2025.

3.4.21 We also retain a number of emergency inter-company connections that can provide additional resilience but which are not large enough to be considered bulk transfers. These are used to help meet customer demand in instances when our normal supplies are insufficient; for example, due to drought, high demand or outage.

Sustainability Reductions and Water Industry National Environment Programme

3.4.22 Our rdWRMP provides for reducing our abstractions from the environment by 36.31 Ml/day during AMP7. Table 7 sets out our sustainability changes and reductions agreed with the EA following publication of its Water Industry National Environment Programme ("WINEP"). Our rdWRMP plans to deliver all green and amber sustainability reductions included on WINEP and we have deducted these volumes from our DO in calculating our baseline supply.

Table 7: WINEP3 AMP7 (2020 to 2025) Sustainability Changes and Reductions for Central and East regions and presented at a Company level

Used in rdWRMP	Average Sustainability Change to licence Ml/d	Peak Sustainability Change to licence Ml/d	Average Sustainability Reduction to DO Ml/d	Peak Sustainability Reduction to DO Ml/d
Central (Green)	39.2	19	27.33	13.4
Central (Amber)	5.22	9.14	6.38	7.66
Central (Total)	**44.42**	**28.14**	**33.71**	**21.06**
East (Green)	0	0	0	0
East (Amber)	2.597	2.597	2.6	2.6
East (Total)	**2.597**	**2.597**	**2.60**	**2.60**
Total Company			**36.31**	**23.66**

3.4.23 The Water Industry National Environment Programme (NEP) is a list of environmental improvement schemes defined by the Environment Agency (EA). In addition to sustainability reductions, it includes other measures to support achievement of the water body environmental objectives under the WFD, such as morphological works.

3.4.24 Our rdWRMP includes the full programme of river morphology actions listed on WINEP3, in discussion with the EA. We are working with the EA to refine the location and projects to start work in AMP7 (2020-2025). We have also included biodiversity enhancement works on our landholdings, to meet our duties under the NERC Act and our catchment management planned work.

3.4.25 WINEP also provides for us to carry out investigations where it is suspected that abstraction may be impacting on achievement of environmental objectives. Where an investigation confirms an impact then an options appraisal is carried out to assess the most appropriate way forward. This is assessed against a cost benefit ratio context to understand the viability of the different options, e.g. river restoration and habitat enhancement, river support schemes or changing an abstraction licence.

3.4.26 The EA has identified 25 new investigations and options appraisals in WINEP all with "green" level of certainty.

Table 8: Investigations and options appraisals identified for AMP7 with a green level of certainty in WINEP3

Watercourse study	Type of investigation	Source(s) under investigation
Salary Brook	No deterioration investigation and options appraisal	ARDL
River Pant		HEMP
River Chelmer		HEMP and ARMI, THAX.
River Ash		THUN and HADH
River Rib		THUN, WADE, SACO, CHIP and STAD
Stansted Brook		STAN and NORS
Upper Stort		STAN
River Lee (Hertford to Fieldes Weir	Investigation and options appraisal	THUN and MUSL
Stort and Bourne Brook		CAUW, STAN and NORS.
Upper Bedford Ouse Chalk	No deterioration groundwater investigation and options appraisal	CRES, KINW, WATT, AST1, STEV, BALD, FULR and BOWR
North Essex Chalk		ARMI, THAX, HEMP, HIGH, LATT, SHEL, STOK, and EASB
Mid Chilterns Chalk		CHES, CHAR, BERR, BRIC, BUSY, NETH, BLAF, CHOR, MILE, WALL, NORO, SPRW, STOC, WESY, GERR, KENS and GREM
Upper Lee Chalk		DIGS, WHIH, SACO.
Cam and Ely Ouse Chalk		WEND, NEWP, DEBD, SPRF and UTTL
Mid Chilterns Chalk	Groundwater investigation and options appraisal	PICC, MUDL, HOLY, AMER, CHAL and MARL
Upper Lee Chalk		ALBE, CRES, KINW, WATT, AST1, STEV, PORT, THUN, HADH, CAUW, STAN, and NORS

3.4.27 In addition to the above, we are currently at risk of losing 2.9 Ml/d ADO at Friars Wash, which is the subject to an ongoing discussion with the EA. We have not included this in our baseline supply/demand balance, but have included it within the evaluation of future risks in our adaptive pathways analysis, as detailed in Section 5 of this Plan.

3.4.28 Our groundwater licence (8/36/17/G/0082) includes a provision to support flows in the River Brett when instructed to do so by the EA. This requires up to 25 litres per second (2.16Ml/d) to be discharged to the River Brett. As there is no flow trigger on the licence for the river support, this is not included within our DO assessment but can be accommodated within our existing supply surplus. The requirement for river support will be assessed as part of the Brett AMP7 NEP investigation and options appraisal. We have also made provision for a sustainability reduction of 2.6Ml/d from this group licence, as shown in Table 7 above.

3.4.29 As part of this process, we are adding to our already extensive monitoring programme. This will allow us to identify the benefits to river flows and ecology where reductions are made, as well as improve our understanding of the way in which river catchments and Chalk aquifers behave across a range of drought conditions.

3.4.30 Our evidence shared with the EA from the AMP6 NEP investigations indicates uncertainty around the environmental benefit of implementing some abstraction reductions included in WINEP3. We will continue to discuss reductions with the EA as more evidence becomes available to help ensure reductions are made in locations where environmental benefit will be realised.

3.4.31 More detail on these schemes can be found in Technical Report 1.4.1 AMP6 NEP Progress and Summary of WINEP PR19 Schemes.

Impacts of climate change on supply

3.4.32 The worst historic, severe and extreme drought DOs are representative of the reliable outputs that could have been achieved in the past (but with current levels of demand and abstraction). However, the DOs that might be available in a current or future drought could vary in response to the changing climate.

3.4.33 The impact of climate change on the worst historic DO is provided in Table 9 for 2020 and for the 2080s calculated using two methods: one is based on a revised equation within the regulator's Water Resources Planning Guideline (WRPG) for the dWRMP19 and the other based on the equations within the WRPG for WRMP14.

3.4.34 WRZs 4, 6 and 8 are assessed as being not sensitive to climate change (for the same reasons as given above with respect to drought sensitivity) and show no predicted change to DO as a result of climate change. Climate change is predicted to impact on WRZs 1, 2, 3, 5 and 7, with the greatest impact occurring in WRZ2. Further detail of our climate change assessment is provided within Technical Report 1:1 Deployable output and climate change impact assessment.

Table 9: Summary of climate change impacts on supply

Region	Median Impact on ADO (Ml/d) in 2020 (WRMP14 equations)	Median impact on ADO (Ml/d) in 2020 (dWRMP19 equation)	Median impact on ADO (Ml/d) 2079/80 (and 2045 in brackets)	Median impact on PDO (Ml/d) in 2020 (WRMP14 equations)	Median impact on PDO (Ml/d) in 2020 (dWRMP19 equation)	Median impact on PDO (Ml/d) 2079/80 (and 2045 in brackets)
Central	-9.42	-17	-41 (-26)	-6.2	-11	-27 (-17)
Southeast	0	0	0	0	0	1 (1)
East	0	0	0	0	0	0
Company Total	***-9.42***	***-17***	***-41 (-26)***	***-6.2***	***-11***	***-26 (-16)***

3.4.35 For this rdWRMP we have adopted a 'hybrid' approach of the two methods whereby we have adopted the long term 2080 impact and glidepath but included the increase that this has in comparison to WRMP14 incrementally over the 2020 to 2025 period. The resulting climate change impact for the central region for DYAA and DYCP can be seen in Figure 16 and Figure 17.

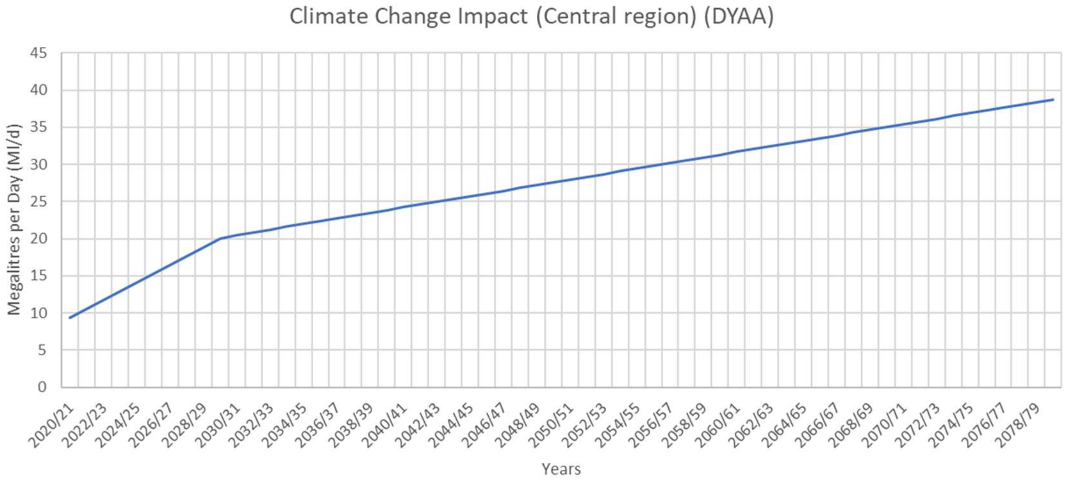


Figure 16: Climate change impact Central region (DYAA)

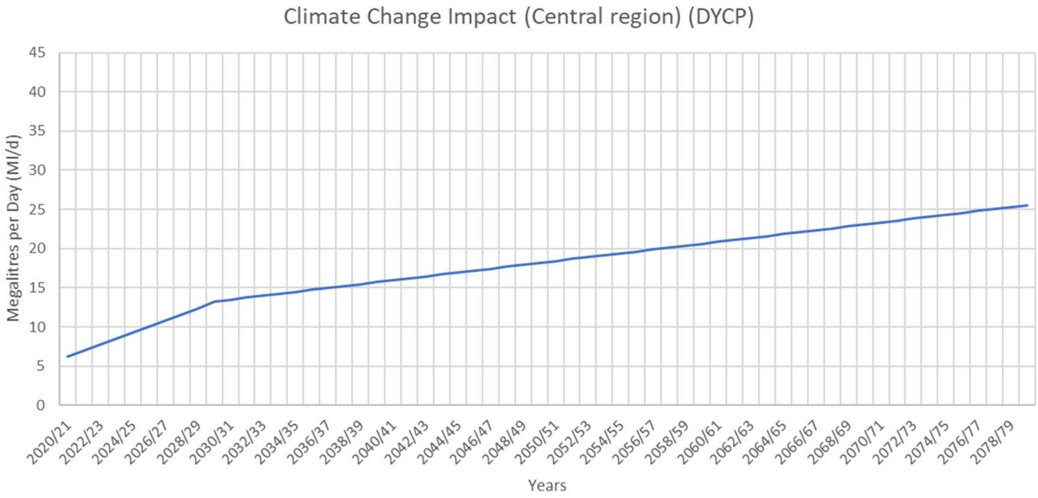


Figure 17: Climate Change impact Central region (DYCPP

Outage allowance

3.4.36 Outage is defined as a 'temporary loss of deployable output' within the UKWIR report 'Outage allowances for Water Resource Planning' (UKWIR, 1995). Outage events can be planned because of the need to carry out maintenance. Alternatively, they can be unplanned, caused by events such as pollution of a source, power failures or system failures.

3.4.37 The outage allowance was calculated following the methodology as set out in the 'Affinity Water Method Statement: Outage Assessment WRMP19' as well as the UKWIR (1995) methodology for assessing outage allowances within Water Resource Planning. Detailed information on this assessment can be found in Technical Report 3.1 – Outage.

3.4.38 An outage assessment was undertaken for seven of our eight WRZs (WRZs 1-7). WRZ8 was not assessed because guidance indicates this is not required where deployable output exceeds demand by a comfortable buffer, as it does in WRZ8.

3.4.39 The assessment made use of data about the duration and magnitude of outages obtained from our outage recording system (TRACE) for our Central region (WRZs 1-6) for the period 2012 to 2017 and from an operations log for our Southeast region (WRZ7).

3.4.40 We used this data in a Monte-Carlo computer model to obtain an outage allowance for each WRZ, which are shown in Table 10 alongside the PR14 and PR09 outage figures for direct comparison.

Table 10: Summary of outage allowance - all zones.

	WRMP09			WRMP14			WRMP19	
	Average	Peak		Average	Peak		Average	Peak
WRZ1	2.96	6.69		5.82	7.36		5.76	1.20
WRZ2	7.02	9.38		6.31	4.83		4.03	0.59
WRZ3	4.82	10.36		14.59	13.77		12.50	2.70
WRZ4	24.05	8.86		6.28	4.56		15.86	2.31
WRZ5	2.45	6.35		2.76	2.6		2.84	0.75
WRZ6	20.21	9.13		6.05	6.7		6.72	2.88
Central Region	61.51	50.77		41.81	39.82		47.69	10.43
WRZ7 Southeast	3.6	2.2		2.02	1.58		1.33	1.01
Company	65.11	52.97		43.83	41.40		49.02	11.43

3.4.41 During periods of average demand, the total outage in our Central and Southeast regions was found to be 49Ml/d, whilst at critical periods of demand, the total outage was found to be 11Ml/d. The critical period was defined as the peak week with a two-week buffer either side. The outage type contributing most to our outage is shutdowns associated with raw water quality at our large surface works. The only option for reducing this is the provision of either bankside storage or additional emergency supply routes at our key surface water site. We have included this in the investigations and potential design of our preferred strategic option, as described in Section 6.3 of this Plan.

Treatment works adjustment

3.4.42 Some water will be lost during the treatment process. We calculated an allowance for these by using information about typical losses at our treatment works.

3.4.43 At our surface water works and more complex groundwater treatment works, we meter the amount of water abstracted and the amount of water leaving the works, being the distribution input ("DI"). The difference between the two represents the quantity of water that is lost during treatment. These meters are calibrated to ensure accuracy (although even then they can have an error of 2-3%) and operate continuously.

3.4.44 We also meter at other points around our works; only the waste from small water quality monitors such as residual chlorine or turbidity instruments are unmetered. We have progressively reduced treatment works losses by adding secondary treatment in many cases with supernatant returning to the head of the works after abstraction metering, therefore total losses are small.

3.4.45 At other groundwater sites, where raw water quality is good such that it requires minimal treatment, we meter only at the point of abstraction. Waste at these sites has only two elements: pumping to waste at start-up or as a result of maintenance and continuous water quality monitoring instruments. Records are kept at each site for periods of pumping to waste and copied to our control room where adjustments to daily integrated flow reports are recorded.

3.4.46 Our treatment losses amount to 13.72 Ml/d at DYAA and 13.92 at DYCP. This represents less than 2% of Distribution Input, and is low as a result of the improvements that we have made in previous years. We carried out a full review of potential options as part of our unconstrained options report (see Section 8.2 of that report) and concluded that there were no more significant reductions that we could achieve whilst maintaining our commitments to water quality.

Water quality

3.4.47 Water quality considerations are an essential part of water resources planning. They may:

- put at risk, from diffuse or point pollution of raw water, the amount of water available to us to treat and supply
- constrain how we transfer water within our water supply area.

3.4.48 As part of our planning process we have reviewed the implications that risks to water quality might have on our rdWRMP. That evaluation includes risks to our current sources and consideration of the water quality implications of new supply options.

3.4.49 Historically we have seen a significant effect from diffuse and point source pollution on our sources. We have been proactive in monitoring and investigating pollution threats. Our Drinking Water Safety Plan risk assessments have identified that there are a number of ongoing risks to our sources, including from pesticides, lead, nitrates and discolouration.

3.4.50 We have adopted a twin track approach to managing and mitigating these risks. This comprises:

- Catchment management (including investigating and quantifying risks using catchment surveys, water quality monitoring, nitrate source apportionment modelling and groundwater level and abstraction data)

- Optimisation of existing treatment assets and, where appropriate, the provision of new treatment assets.

3.4.51 Our Catchment Management programme for water quality was established in 2010 to help deliver our commitment given in water quality undertakings provided to the Secretary of State in respect of metaldehyde. Since then, our programme has evolved significantly and is now aligned to the WFD National Environment Programme (water quality).

3.4.52 In 2013, we stopped abstracting from a groundwater source due to increasing nitrate concentrations. There is a significant risk of further loss of groundwater supplies between now and 2040 as a result of increasing nitrate concentrations. Our catchment management investigations conclude that it could take decades to see the benefits of catchment management activities in respect of nitrates.

3.4.53 Our surface water treatment works have no bankside storage (raw water reservoirs) to enable us to manage the risk of temporary river pollution events. To mitigate this risk, we plan to:

- enhance water quality monitoring in the catchment and at the treatment works
- apply advanced modelling techniques to enable us to predict and forecast scenarios
- optimise existing treatment assets and, where appropriate, provide new treatment assets.

3.4.54 Even with our 'twin track' approach of catchment management and investment in treatment processes, there is still a risk that we will have to reduce or discontinue abstraction at some of our sources due to trends in pollution risk. We have fully accounted for these residual risks within our assessment of Target Headroom using industry standard techniques, as described in section 3.5.

3.4.55 The only significant residual water quality risk that we have not included within our Target Headroom calculation relates to the bromate contamination plume that caused us to stop using our Hatfield source for water supply in 2000.

3.4.56 Currently, we are using this source in a mitigation capacity where we abstract and pump the polluted water to waste to prevent the bromate from polluting our Essendon source. In the medium term, the existing arrangement will not be adequate once the contamination within the Chalk matrix reaches Hatfield and puts at risk other sources. We expect the EA to use its powers under Part IIA of the Environment Act 1990 to mitigate this risk as far as is reasonably practicable.

3.4.57 We are constrained by water quality considerations in how we transfer water across our supply area. For example, we can only use imported water from Grafham to supply local areas in the north of the Central region of our supply area (or to other locations only for limited periods of time). This has the effect of limiting our maximum import from Grafham WTW to 50 Ml/day average and prevents us from supplying the treated water from Grafham WTW widely within our supply area. The construction of the planned conditioning treatment at Sundon would remove the current constraint.

3.4.58 The DWI has produced guidance that explains that the duty in section 68(1)(b) of the WIA 1991 may impact on transfers of water within a company's supply area and for exports and imports across company boundaries.

3.4.59 The DWI Guidance explains that the standard of no deterioration (referred to in Section 68(1)(b)) should be measured by reference to compliance with the standards of wholesomeness (paragraph 4.3.6). Paragraph 4.3.7 specifically states:

“*Proposals to transfer water that increase the risk of non-compliance, or of consumer complaints about the aesthetic character of the water supply, such as by taste and/or odour, discolouration, nitrates, pesticides or bacteriological challenge, will not be permitted until steps to mitigate those risks are in place.*”

3.5 Risk and uncertainty – target headroom

3.5.1 WRMPs are based on the best available and most appropriate data and methods, but due to the long-term planning nature it is inevitable there will be a degree of uncertainty in the forecasts.

3.5.2 We address this uncertainty in our rdWRMP in two ways which are provided for in the current Water Resources Planning Guideline:

- by calculating a volume of water (or buffer) that is subtracted from our supply-demand balance to cater for supply-side and demand-side uncertainties – target headroom
- through our decision-making process to arrive at an adaptive plan.

3.5.3 We have used target headroom to allow for risks and uncertainties associated with calculation of our baseline and our adaptive planning to address risks and uncertainties associated with future policy considerations. We have ensured there is no double-counting such that each risk and uncertainty is only taken into account through one of target headroom or adaptive decision-making. We explain target headroom in the rest of this section. The way in which our adaptive planning takes account of future uncertainty is explained in Chapter 5.

3.5.4 Target headroom is determined by applying a risk profile to total headroom uncertainty. The planning risk allowance reflects a range of uncertainty. For the different forecast time horizons in our Plan we include a different proportion of the full uncertainty range as a planning risk allowance. The proportion of the potential uncertainty range that we include reduces over time in accordance with standard water industry practice. Until 2024/25 we have included most of the full range of uncertainty in our Target Headroom allowance (statistically this is equivalent to the ‘95th percentile’). We have then taken less of the full uncertainty range, decreasing our allowance to the 75th percentile in 2044/45 and the 60th percentile in 2079/80 (to set this in context, the 50th percentile of the range is equal to our expected central estimate - i.e. effectively no Target Headroom allowance). The headroom results have then been interpolated between the 2019/20 and 2079/80 values to permit a smooth target headroom profile to be derived.

3.5.5 Baseline dry year (DYAA) target headroom varies from 94.05 Ml/d (or 9.95% of the company 1 in 200 DO) in 2020/21, the base year to 62.43 Ml/d (or 6.60% of DO) in 2079/80, the final year of the plan. Baseline critical period (DYCP) target headroom varies from 148.58 Ml/d (or 12.91% of DO) in 2020/21, the base year to 95.12 Ml/d (or 8.27% of DO) in 2079/80.

3.5.6 We acknowledge that it is unusual that target headroom is higher at the start of the planning period than the end. This is because we have included the risk associated with the water saving programme and the associated delivery risk within our demand forecast.

3.5.7 There are some changes to target headroom compared to that calculated for WRMP14. Dry year baseline target headroom as a percent of total DO:

- is similar to WRMP14 for WRZ1, WRZ2, WRZ3 and WRZ6
- has decreased for WRZ7
- has increased for WRZ8 for the first years but broadly similar from 2029/30
- has almost approximately doubled for WRZ4 and WRZ5.

3.5.8 The picture is more complex when comparing critical period target headroom to WRMP14 as a percent of DO, where it has:

- increased notably in WRZ3, WRZ4 and WRZ5
- has increased in WRZ3
- is broadly similar in WRZ2 and WRZ8
- has decreased in WRZ1, WRZ6 and WRZ7.

3.5.9 The most significant change in baseline target headroom as a percent of DO was in WRZs 4 and 5, where it has approximately doubled. This is related principally to increase in demand forecast uncertainty including uncertainty in savings expected from WSP, increase in uncertainties of source yields and an updated method to calculate climate change uncertainties.

3.5.10 It should be noted that, although the base year Target Headroom allowance is, overall, higher than WRMP14, the allowance towards the end of the statutory planning period (2040) for the Dry Year Annual Average (DYAA), which is the key driver for strategic investment, is almost identical to the value that we used in WRMP14.

3.5.11 Technical Report 3.2 contains supporting evidence and sets out clearly the assumptions behind the ambitious levels of demand management savings contained in our rdWRMP and the impact of climate change on headroom.

3.6 Baseline supply demand balance

3.6.1 We calculated our baseline supply-demand balance as:

Water available for use (or supply)

Minus **Water demand** (Distribution Input, DI)

Minus **Target headroom**

3.6.2 Water Available for Use, or WAFU, is simply the water that is available for supply within each WRZ and is equal to the Deployable Output, minus outage, minus treatment losses plus or minus the net imports and exports from the WRZ.

3.6.3 We calculated a baseline supply-demand balance for each WRZ and combined them to produce a baseline supply-demand balance for each of our supply regions. They are summarised in Table 11, which shows we are facing a significant supply-demand deficit in our Central Region from 2020 onwards, a small deficit in our Southeast Region and a small surplus in our East Region.

3.6.4 It should be noted that the 'deficit' in the Central region that is highlighted in 2020 is reflective of our desired change to drought resilience moving from the worst historic drought to 1 in 200 year drought. We cover this 'deficit' in the first few years of our Plan through the use of drought permits and orders (emergency abstractions during drought events), but stop reliance on those interventions as early as we practically can, at the latest by December 2024. Section 6.10 provides further information on our drought levels of service before and after implementation of our rdWRMP.

Table 11: Supply-Demand balance for 2020, 2045 and 2080 for all regions at DYAA and DYCP

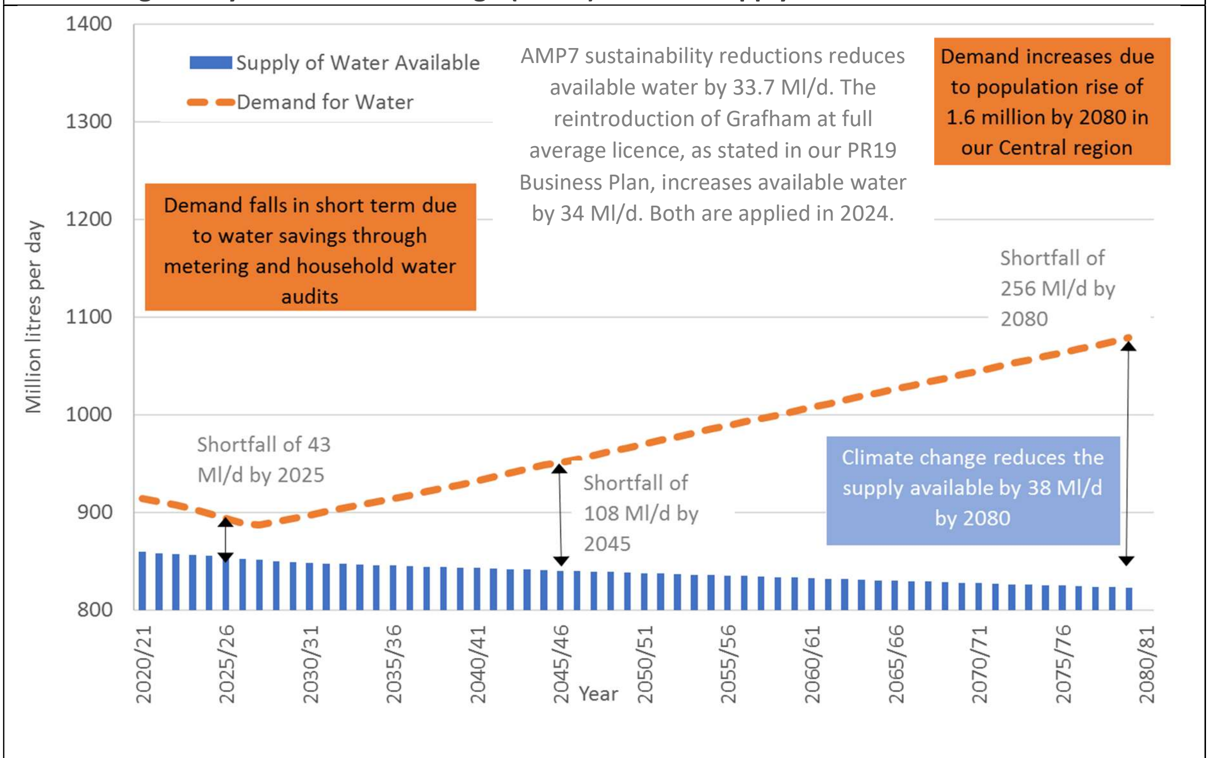
Region		Supply-Demand Balance (Ml/d)		
		2020	2045	2080
Central	DYAA	-54.5	-107.9	-255.7
	DYCP	-26.8	-100.7	-279.5
Southeast	DYAA	1.3	-0.1	-4.3
	DYCP	-0.65	-3.8	-11.1
East	DYAA	7.2	3.2	0.2
	DYCP	13.9	9.8	6.2

3.6.5 We present our supply-demand balances for each region in more detail (paragraphs 3.6.6 to 3.6.11 below) and then at a more detailed WRZ level below (paragraphs 3.6.12 to 3.6.14 below). We conclude by explaining why our baseline position appears to have worsened since our WRMP14.

Central region

3.6.6 Figure 18 shows the baseline supply / demand balances at Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP) for our Central region. The water available for supply is reduced by 33.7 Ml/day by 2024/5 as a result of sustainability reductions; this is off-set by use of our full statutory entitlement of Grafham Water from 2024/5 onwards following installation of conditioning treatment at Sundon. The water available for us then falls through the planning period due to the impact of climate change.

Central region Dry Year Annual Average (DYAA) baseline supply demand balance



Central region Dry Year Critical Period (DYCP) baseline supply demand balance

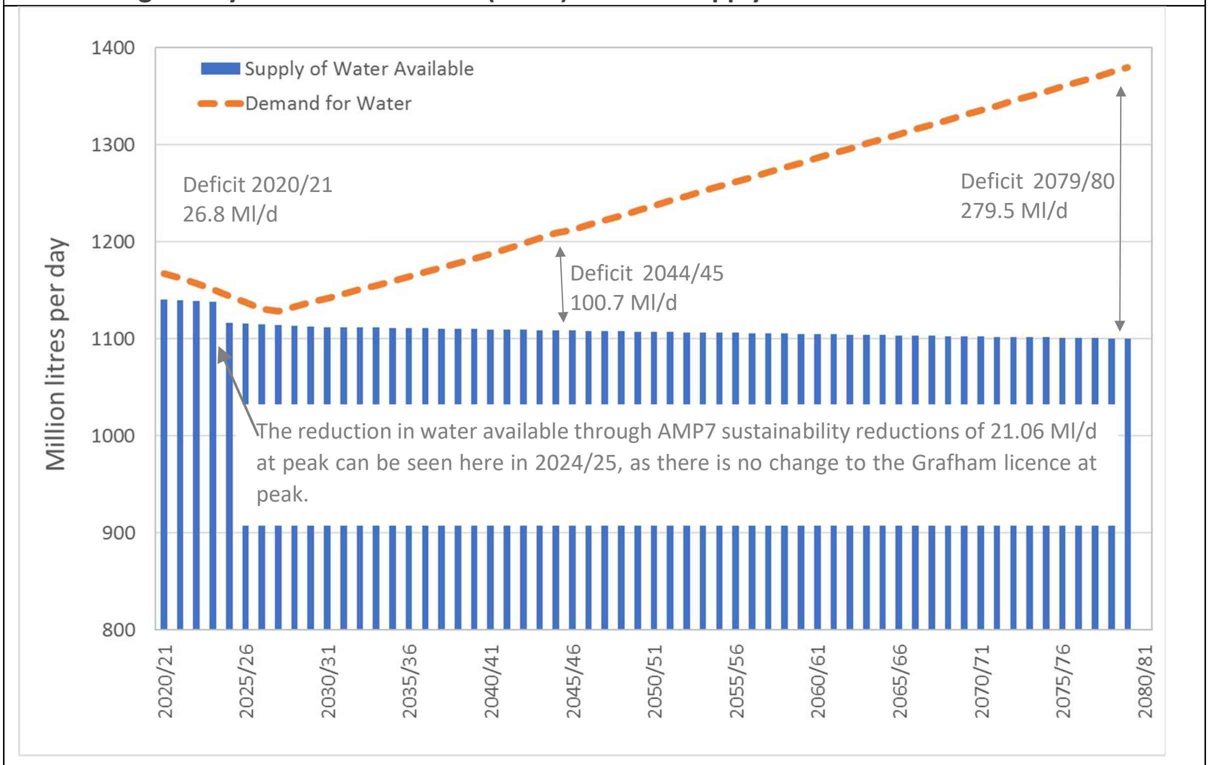


Figure 18: Central region baseline supply / demand balance at DYAA and DYCP

3.6.7 Demand initially falls under average and peak conditions as a result of our WSP. It rises from 2027/28 due to population growth, estimated to be 12% by 2025, 27% by 2045 and 50% by 2080, equivalent to 1.6 million more people living in our Central Region.

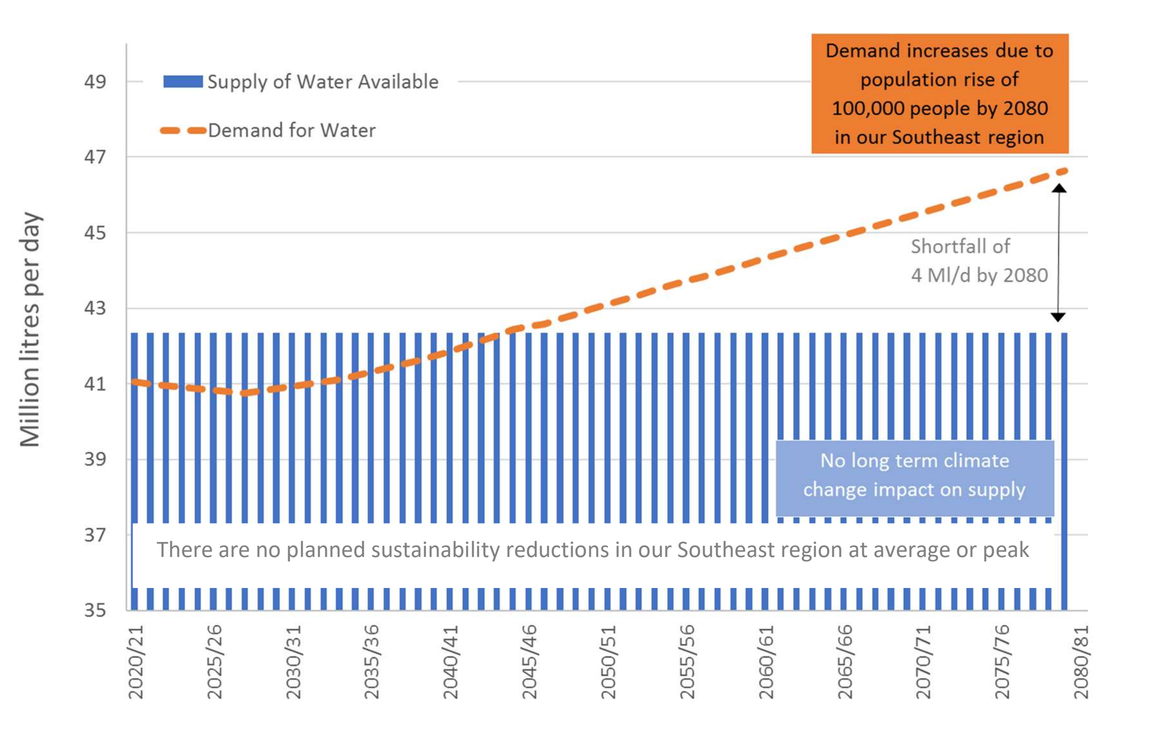
3.6.8 The baseline supply-demand balance shows that by 2045 there is a shortfall of water of 100.7 Ml/d under peak conditions and 107.9 Ml/d under average conditions. This shortfall increases by 2080 to 279.5 Ml/d at peak and 255.7 Ml/d under average conditions.

Southeast region

3.6.9 Figure 19 shows the baseline supply-demand balances at Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP) for our Southeast Region.

3.6.10 There is no significant change in the amount of water available for use between 2020 and 2080. Demand increases from about 2026 onwards due to population growth in the region of 13% by 2025, 32% by 2045 and 64% by 2080, equivalent to over 100,000 more people living in our Southeast Region. This growth in demand results in the small surplus of 1.3 Ml/ under average conditions in 2020 moving to a small deficit of 0.1 Ml/day under average conditions in 2045 to a larger deficit of 4.3 Ml/day under average conditions in 2080.

Southeast region Dry Year Annual Average (DYAA) baseline supply demand balance



Southeast region Dry Year Critical Period (DYCP) baseline supply demand balance

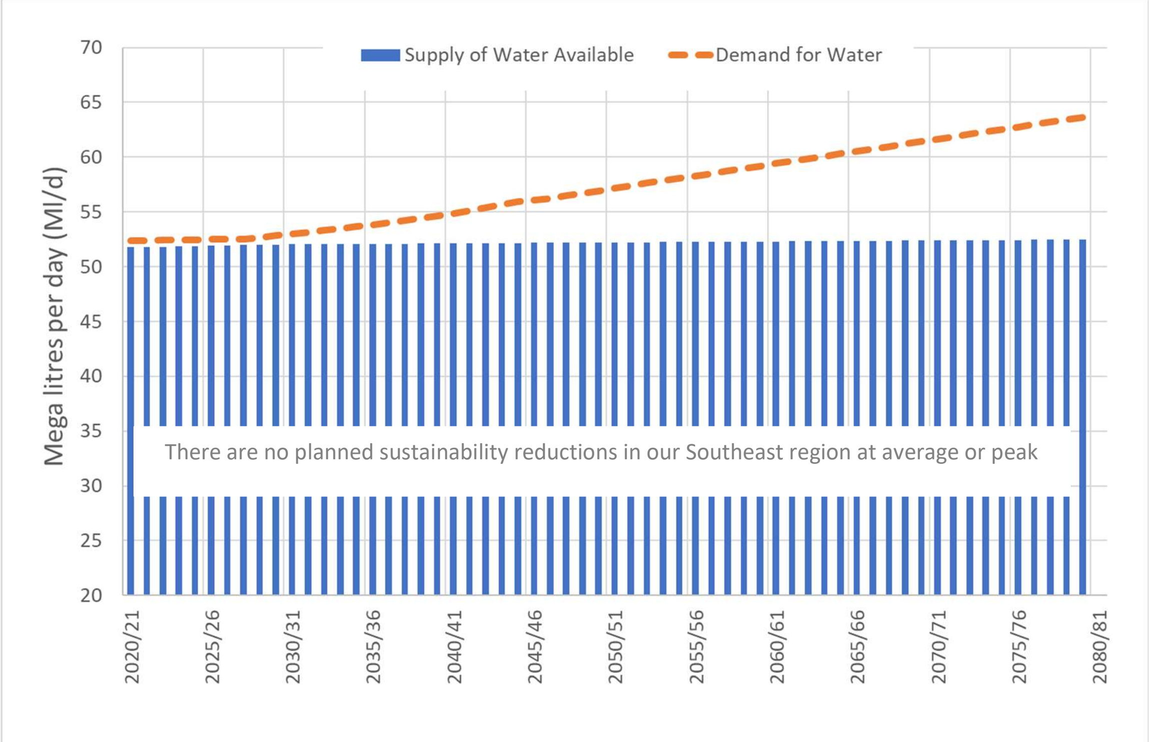
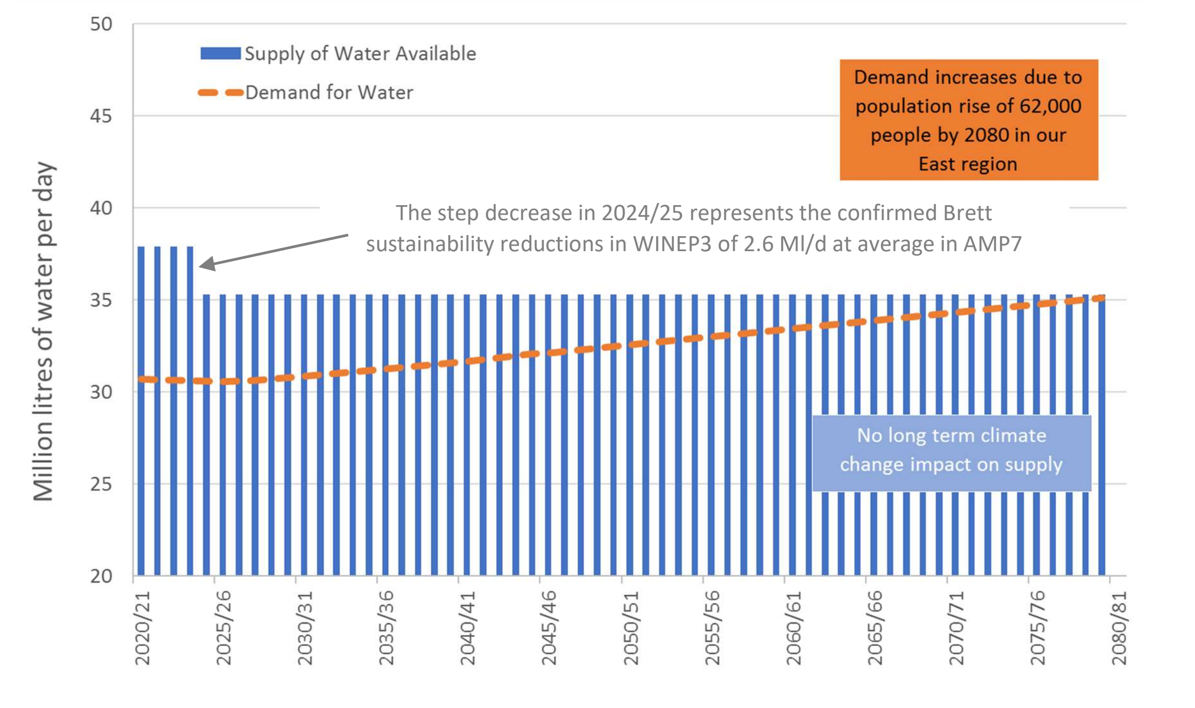


Figure 19: Southeast region baseline supply / demand balance at DYAA and DYCP

East region

3.6.11 Figure 20 shows the baseline supply-demand balances at Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP) for our East region. Our East region is in surplus under both average and peak conditions from 2020 to 2080. The water available for use drops in 2024/25 in response to a sustainability reduction; it also reflects reversion to a 50:50 share with Anglian Water for our jointly owned Ardleigh Reservoir from 2024/25 from the current 70:30 share. We note that we tend to require a small surplus within our East region due to operational constraints on transfers within the WRZ, as we can encounter operational issues in the area served by Ardleigh reservoir if the zone as a whole only just meets a supply-demand balance.

East region Dry Year Annual Average (DYAA) baseline supply demand balance



East region Dry Year Critical Period (DYCP) baseline supply demand balance

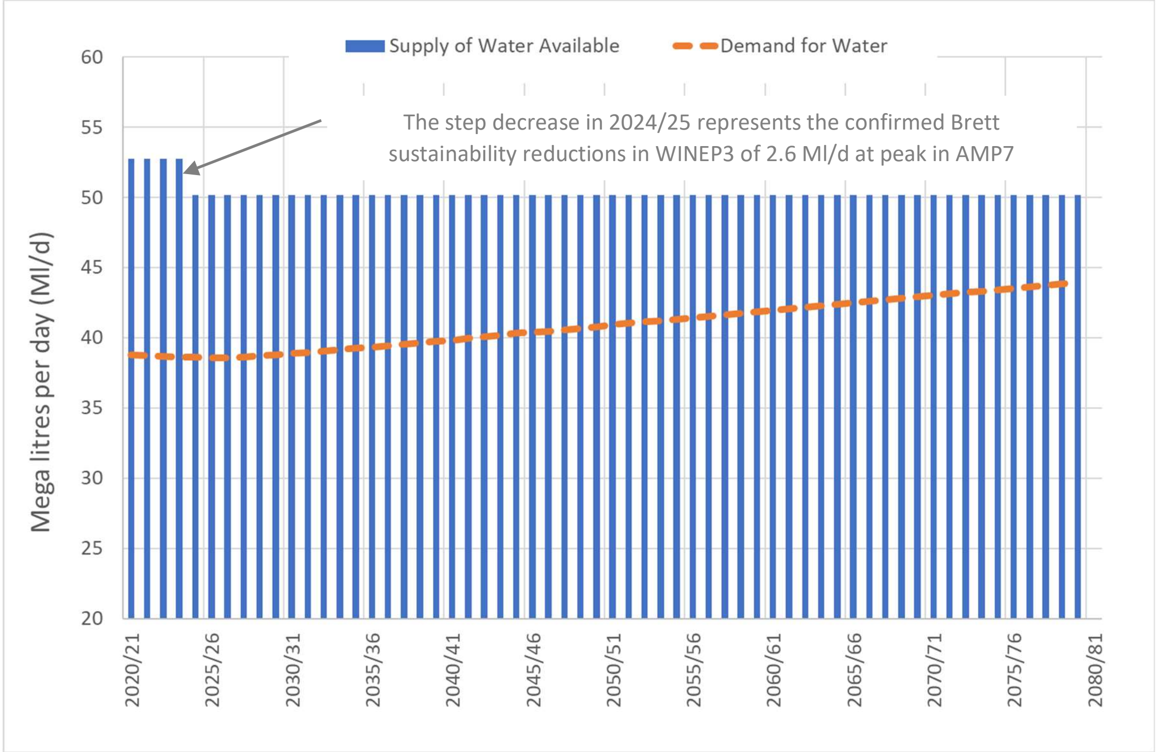


Figure 20: East region baseline supply / demand balance at DYAA and DYCP

Baseline supply-demand water balance by WRZ

3.6.12 Table 12 and Table 13 present the supply-demand balance by WRZ for the beginning, mid and end of our planning horizon. The information is displayed in a map format in Figure 21.

Table 12: Baseline zonal supply-demand balance for DYAA

DYAA	2020/21	2044/45	2079/80
WRZ1	-0.53	-3.38	-2.29
WRZ2	-17.14	-40.27	-59.22
WRZ3	-9.76	-20.47	-66.92
WRZ4	-17.36	-21.44	-67.02
WRZ5	-28.80	-38.00	-52.20
WRZ6	19.06	15.68	-8.03
WRZ7 – Southeast region	1.30	-0.09	-4.28
WRZ8 - East region	7.19	3.22	0.18
WRZ1 to 6 - Central region	*-54.53*	*-107.88*	*-255.68*

Table 13: Baseline zonal supply-demand balance for DYCP

DYCP	2020/21	2044/45	2079/80
WRZ1	14.48	9.77	9.41
WRZ2	6.51	-0.03	-16.98
WRZ3	31.59	-13.79	-68.14
WRZ4	-73.61	-77.51	-137.53
WRZ5	-37.83	-49.19	-67.91
WRZ6	32.05	30.04	1.60
WRZ7 -Southeast region	-0.65	-3.75	-11.18
WRZ8 - East region	13.96	9.82	6.20
WRZ1 to 6 - Central region	-26.81	-100.70	-279.55

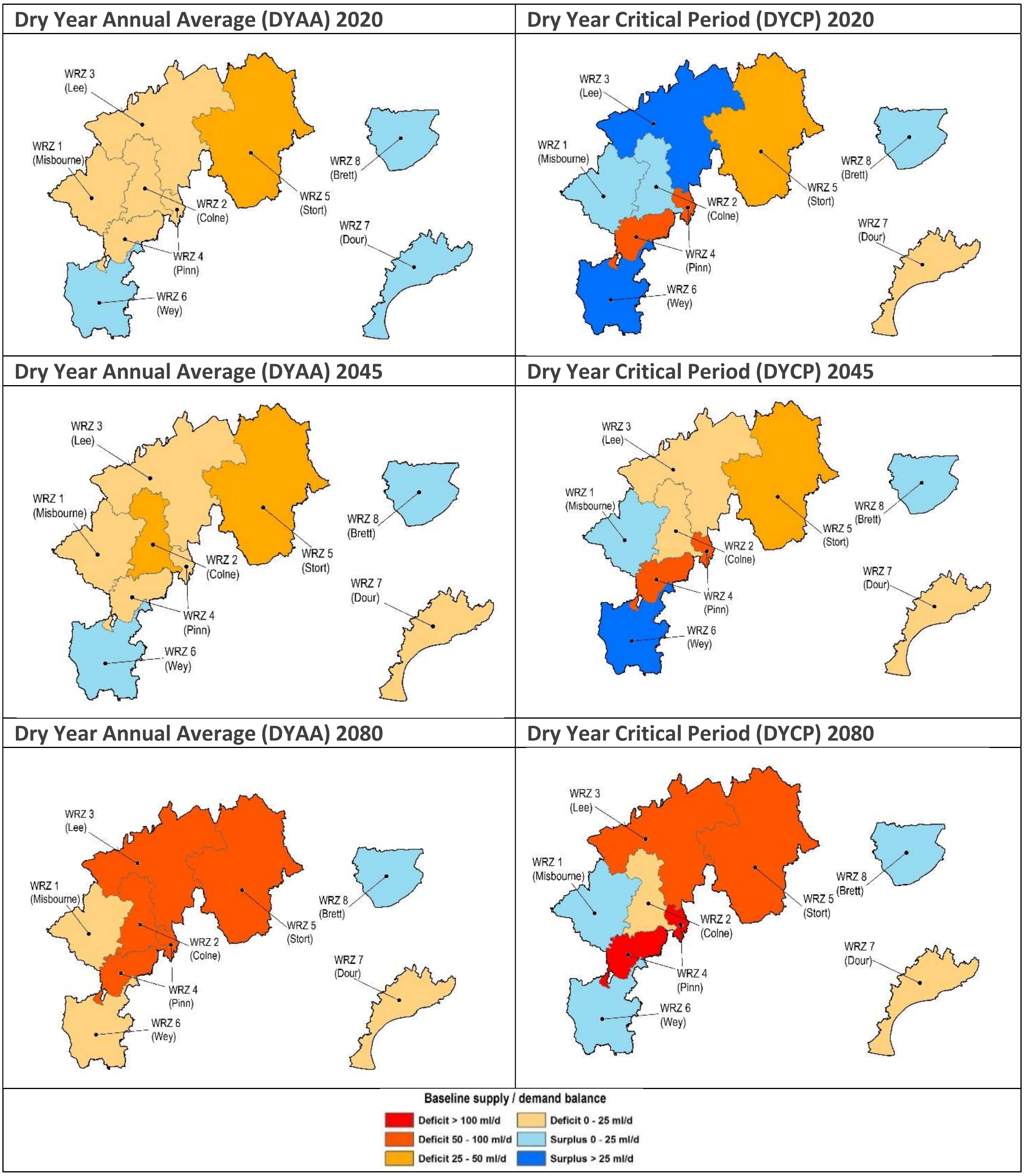


Figure 21: Baseline Supply-Demand balance by WRZ for 2020, 2045 and 2080

3.6.13 These show the baseline supply-demand balance by WRZ under average and peak conditions for 2020, 2045 and 2080. Under average conditions at the beginning of the planning period in 2020 there is a surplus of water in the Wey community (WRZ6) to the south of the Central region and a deficit across the other WRZs in the Central region increasing in severity in a north-easterly direction.

3.6.14 In 2045 there is a similar pattern but with a more severe shortfall of water. By 2080 all WRZs in the Central region are in deficit with the largest shortfall of water existing in the north-western areas. This shows a clear need to increase the connectivity between WRZs in our Central region in a broad south-westerly to north-easterly direction. We propose to carry out a programme of work to provide additional connectivity to move water from the south-west (WRZ6), an area of surplus, to feed the WRZs further north in deficit. This is known as Supply 2040 and is described in Section 6.3.

Changes since WRMP14

3.6.15 Since WRMP14 there has been a significant change in baseline. The key reasons for this are:

- A change in methodology to assess DO, which has tended to result in lower assessments of DO.
- Incorporation of additional sustainability reductions.
- Increase in severity of baseline drought to a 1 in 200-year design drought from the worst historic drought, which was used for WRMP14.
- Reduction in use of import from Anglian Water at average conditions to a maximum of 50 Ml/day until 2023/24 due to water quality constraints; this was previously included at full statutory entitlement of 91 Ml/day even though we could not make use of this volume operationally.
- Higher demand at 2020 because population and PCC is higher in the 2016/17 base than was forecast in the WRMP14.

4 Appraisal of future options

4.1 Introduction

4.1.1 Our baseline supply-demand balance shows that without action being taken there would not be enough water to meet our forecast demand. Our next step is to work out what options we have available to us to increase our supply of water and to reduce our demand for water. This process is known as options appraisal.

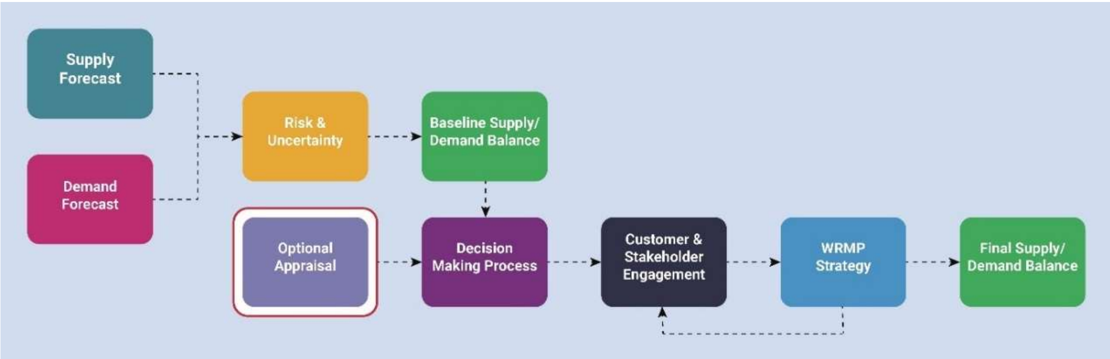


Figure 22: WRMP Process

4.1.2 Our options appraisal follows the industry standard approach as set out in UKWIR (2002) as updated in the Decision-Making Process: Guidance (2016) referred to in the WRMP Guidelines. It has three stages:

- Stage 1 Unconstrained options – we compile a list of all possible options for increasing our supply or reducing demand for water, which are technically feasible (see Section 4.2 below and Technical Report 4.1).
- Stage 2 Options screening – we subject all of the unconstrained options to a screening process to create a shorter list of "feasible options" (see Section 4.3 and Technical Reports 4.2 and 4.3).
- Stage 3 Feasible options development – we develop the feasible options in more detail, assessing the cost to construct and operate them, assessing their environmental and social costs and further evaluating them (see Section 4.4 and Technical Reports 4.4 to 4.7 and 4.9).

4.1.3 Our list of feasible supply options include six strategic supply options, which are options capable of delivering a minimum of 50 Ml/day additional water but which require significant investment to bring them forward. We describe these in section 4.6.

4.1.4 Stages 2 and 3 above have been informed by the work carried out in preparing our SEA, our HRA and our WFD Assessment. At the options screening stage, we screened out any options having an unacceptable environmental impact. These included options where there was no further water in the catchment or where the option may have a significant impact on a designated site. Information from the SEA assessment was then used as one of the three key factors taken into account at the secondary screening stage. Further detail of how this has been done is provided in section 4.5 and we set out the results of our SEA, HRA and WFD Assessment in section 6.8.

4.2 Unconstrained options – Stage 1

Unconstrained supply option types

4.2.1 Our list of unconstrained options for increasing our supply include the following option types:

- **Surface water** – increasing the amount of water we take from surface water sources and include reservoirs and river augmentation schemes, where the flow in a watercourse is supported (for example by a release of water from a reservoir) enabling more water to be abstracted.

- **Groundwater** - constructing new boreholes, improving the performance of existing boreholes and drought options, temporarily increasing abstraction during times of drought.

- **Transfers and trading** – transfers within a WRZ, transfers between our WRZs and transfers from our neighbouring water companies, known as bulk supplies.

- **Treatment** – improving the treatment of water (e.g. new treatment processes or reducing the losses of water during the treatment process) so that more of the water abstracted can be used for public water supply (e.g. New treatment works and process losses).

- **Effluent reuse** – making use of waste water from sewage treatment works.

- **Third party options** – transfers from third parties or trading of abstraction licences. An abstraction licence is granted by the EA and fixes the amount of water that the holder may abstract from the environment. The holder of an abstraction licence can choose to transfer all or part of its licence to another person subject to satisfying the EA that this will not adversely affect the environment.

- **Outage** – reducing the amount of time that an existing source is unavailable.

- **Catchment management** – addressing issues with the quality of the raw water we abstract allowing us to use that water.

- **Desalination** – treating seawater to make it suitable for drinking.

4.2.2 We also considered options to provide additional resilience to our operations or networks. Within our unconstrained options review these types of options are often to replace or twin an existing asset, e.g. a new treatment works, or a new mains connection. These options do not increase the water supplied but they ensure that we can make best use of the water we have available and increase resilience of our network.

Unconstrained demand option types

4.2.3 The demand option types are as follows:

- **Leakage** – reducing the amount of water lost from our network.
- **Metering** – improving our measurement of water used to enable customers to better understand and control their usage and allow us to identify leaks more easily.
- **Reuse** – small scale re-use of grey water, which is water from baths, showers and washing.
- **Water efficiency** – reducing the amount of water that customers use.
- **Tariff** – adjusting the price customers pay for water to provide an incentive to reduce use.

4.2.4 The number of unconstrained options of each type is set out in Table 14 and the full list is available in Technical Report 4.1 and Technical Report 4.2.

Table 14: Unconstrained option numbers by option type

	Unconstrained Options	
	Option Types	**Number of Options**
Supply	Surface Water	56
	Groundwater	111
	Conjunctive Use	0
	Transfers and trading	134
	Treatment	17
	Effluent Reuse	10
	Third Party	Included in transfers and groundwater options
	Outage	4
	Catchment Management	1
	Desalination	18
	Effluent Reuse	10
Demand	Leakage	11 (plus ALC)
	Metering	5
	Reuse	4
	Water Efficiency	7
	Tariff	1
	TOTAL	**389**

4.3 Options screening – Stage 2

Screening our supply options

4.3.1 We used a two-stage approach to screen our supply options:

- a high-level screening; and
- a more detailed secondary screening.

4.3.2 Our high-level screening was on the basis of a traffic light system, which allocated each option to one of three categories:
Green – no major issues or sensitivities identified for this option.

Amber – some issues or sensitivities identified, which may not be showstoppers but which could result in risks or complicated design and implementation strategies. For example, this could be an option located within an Area of Outstanding Natural Beauty (AONB).

Red – significant issues or sensitivities that affect the ability to implement this option. This included options in areas where there is no further water available within the catchment (under the EA Catchment Abstraction Management Strategies or CAMS) or where the option may have a significant detrimental impact on a designated site.

4.3.3 We took forward 104 green and amber options. Green options were included on the constrained options list on the basis of the traffic light screening. Amber options were subject to the secondary screening stage.

4.3.4 Our secondary screening consisted of a peer review of these options focused on the following factors to decide whether each option should be developed into a constrained option:

- **Technical feasibility** – the option yield, being the amount of additional water resulting from implementing an option, whether there are any major risks or uncertainties that impact on the viability of implementing an option (e.g. adverse site conditions or lack of land availability) and the quality of the source water.
- **Environmental considerations –** we assessed the environmental impact and risk of the option using the results of the SEA, HRA and WFD assessments.
- **Stakeholder acceptability -** whether the option is likely to be contentious or liable to objections based on previous experience and knowledge of the area.

Screening our demand options

4.3.5 Our unconstrained demand management options were also screened, using a qualitative screening methodology for the following criteria:

- Yield uncertainty – how certain we are that an option will help to reduce demand.
- Lead-in time – how long it will take to deliver an option.
- Flexibility – can the option be enlarged in the future, or combined with other schemes if required.

- Security of supply – how robust the scheme is; the likelihood of savings varying over time e.g. 'bounce back' from metering.
- Environmental impact – the extent to which the option impacts on the environment.
- Sustainability and promotability – the scheme's impact on energy use, carbon footprint. If the scheme is socially acceptable and customers approve.
- Suitability – will the option provide the right amount of savings at the right time – seasonality impact.
- Technical difficulty – how difficult an option is to deliver.

4.3.6 A score of 1 to 5 was allocated to each of these criteria with 5 being the worst score and 1 being the best. The maximum worst score available was 40. We took forward options that scored 24 or lower. The only exception to this was the inclusion of non-household schemes to tackle high consumption at airports.

Our feasible options list

4.3.7 The number of options considered for each type at the feasible option stage are presented in Table 15.

Table 15: Number of feasible options in each category

	Feasible Options		
	Option Types	Number of Feasible Options	Number of Options 'Screened-out'
Supply	Surface Water	8	47
	Groundwater	29	81
	Transfers and trading	55	75
	Treatment	6	11
	Effluent reuse	7	2
	Third Party	Included as part of groundwater and transfer options	
	Outage	0	4
	Catchment Management	0	1
	Desalination	14	4
	Effluent Reuse	7	2
Demand	Leakage	11 (plus ALC)	0
	Metering	5	0
	Reuse	4	0
	Water Efficiency	7	0
	Tariff	1	0
	TOTAL	**147**	**225**

N.B: The total of feasible options and options screened out is seven less than the total unconstrained options in Table 14. This is due to the merging of two groundwater, one effluent reuse, one surface water and two transfer schemes and there is one trading scheme which is yet to be screened.

4.4 Developing our feasible options – Stage 3

Developing our supply side options

4.4.1 For each of our feasible supply options (including third party options) we developed an “option dossier" containing the following information:

- A description of the option and any links or dependencies to other options.
- A profile of the yield (based on the capacity of the solution) or water saved over 80 years.
- An estimate of the time needed to investigate and implement the option, including the earliest start date.
- An assessment of the risks and uncertainty associated with the option yield and deliverability.
- A profile of the option costs over 80 years, for the cost of construction (capex) and the cost of operating (opex).
- Any other factors or constraints specific to the option.

Our options dossiers are presented in Technical Report 4.6. Information on the environmental and social impacts of the options is found in our SEA, HRA and WFD Assessment reports.

4.4.2 We scored how well the options performed against the following criteria to provide a “multi-criteria analysis” for each option:

- Option deliverability – this assessed how easy an option is to deliver on a scale of 1-5, considering risk around obtaining planning permission, construction, technology and other implementation risks.
- Option yield uncertainty / Cost uncertainty – this assessed how much uncertainty there is regarding how much water will be made available and how certain the costs information is on a scale of 1-5.
- Environmental Impacts – this assessed the environment impact of an option based on our SEA work on a scale of -5 (being negative impact) to +5 (positive impact).

The “multi-criteria analysis” scoring for each option is presented in Technical Report 4.9.

Developing our feasible demand options

4.4.3 We ensured that we had equivalent information available for our demand management options and these are presented in Technical Report 4.7.

Impact of climate change on options

4.4.4 Our assessed yields for each option took into account the effect of climate change. This is reflected in the assessment of yield uncertainty. We therefore incorporated this into our calculation of target headroom allowance associated with new options. Typically the full range of uncertainty (i.e. maximum potential climate change risk) was between 5% and 10%, depending on scheme type. The effective impact on yield then depends on the Target Headroom risk profile used for each WRZ. Further information about the impact of climate change on potential yields of our supply options can be found in Technical Report 4.6.

4.4.5 The impact of climate change on potential savings from implementation of demand management options has been assessed as negligible.

4.5 Strategic supply options

4.5.1 Our list of feasible supply options includes six "strategic supply options", capable of providing significant additional water resource in the mid-term. These strategic supply options require significant investment, take time to develop and need us to work collaboratively with other water companies and third parties.

4.5.2 Our strategic supply options are illustrated in Figure 23 and are summarised in Table 16.

Table 16: Summary of potential strategic schemes for the Central region

Scheme	Development partner	Description and Options Developed
South East Strategic Reservoir	Thames Water	This scheme is a relatively simple winter storage and release, where we would reserve the volume required to provide our required yield. We developed costs and updated metrics for three options which are: a. Treating 50Ml/d of water at Iver b. Treating 50Ml/d of water at Harefield c. Treating 100Ml/d at Iver
Severn-Thames Transfer	Thames Water	We worked with Thames Water on the feasibility of the option to transfer water from the River Severn to the River Thames. As a result, we developed the following three possible options: a. Treating 50Ml/d of water at Iver b. Treating 50Ml/d of water at Harefield c. Treating 100Ml/d at Iver
South Lincolnshire Reservoir	Anglian Water	We have discussed a number of strategic options with Anglian Water. The feasible option is for Anglian Water to build a new reservoir in South Lincolnshire, which would allow us to increase our take from Grafham. Anglian Water would then provide us with a bulk supply. We have considered two schemes (both of these represent a share of the water that might be made available): a. A 100Ml/d scheme (share of a 150Ml/d total yield). Under this option Anglian Water would transfer water from the River Trent to the River Witham to augment yield. b. A 50 Ml/d scheme (share of a 75Ml/ total yield). Under this option there would be no transfer from the River Trent.

Scheme	Development partner	Description and Options Developed
Minworth Effluent Transfer	Severn Trent Water	This feasible option is to take treated waste water from Minworth WWTW, which is operated by Severn Trent Water, and transfer it via pipeline to our supply area and then treat it close to our existing Sundon Treatment Works. We have considered two options. a. A 100Ml/d scheme b. A 50 Ml/d scheme
Grand Union Canal Transfer	Canal & River Trust	We have worked with the CRT to update the costs at different levels of yield for a scheme to transfer water from Minworth WWTW and use the canal system to convey the water. The Canal & River Trust have provided updated information for two options. a. A 100Ml/d scheme b. A 50 Ml/d scheme (this option requires significantly less engineering of the canal system itself to allow the transfer of water).

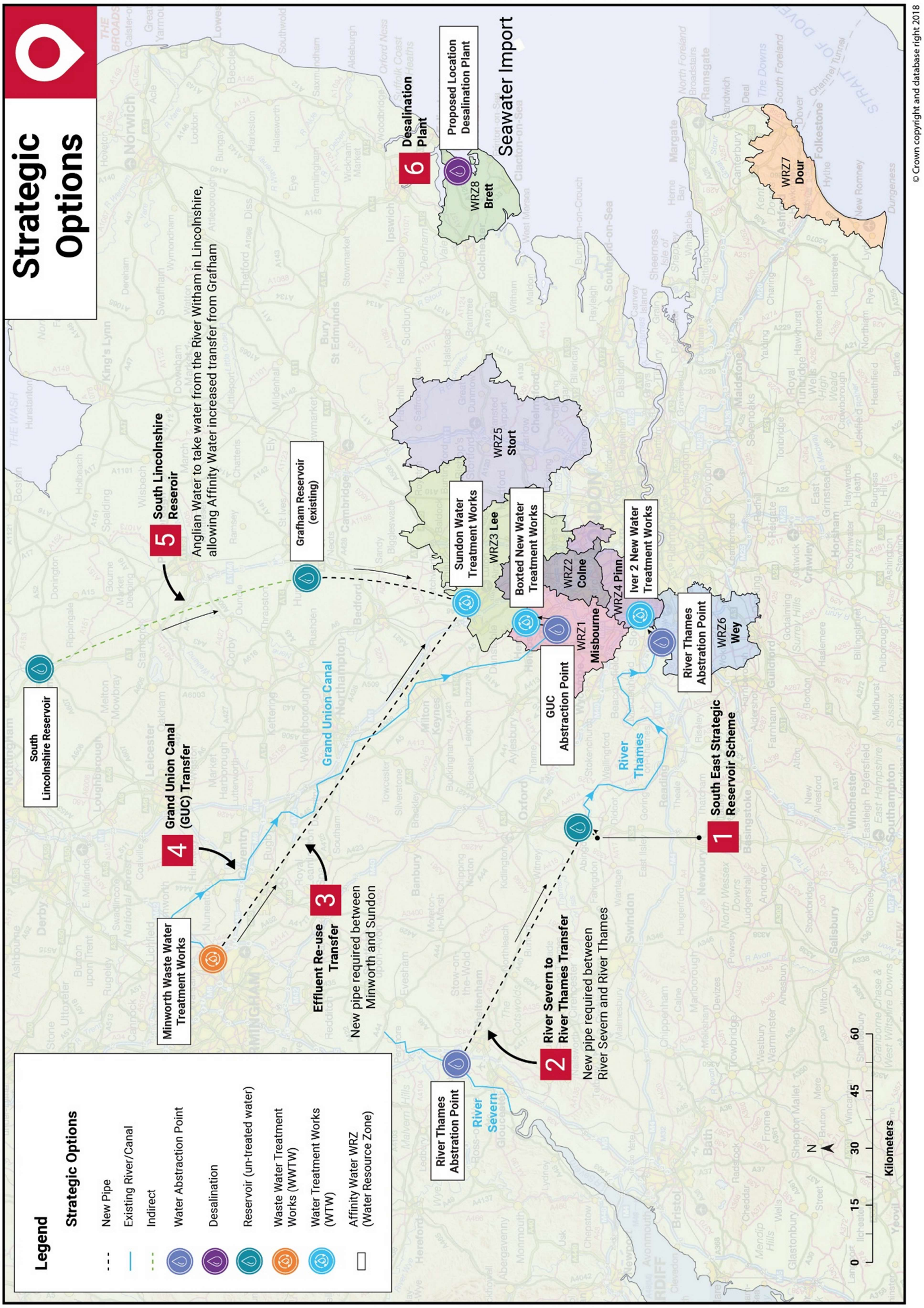


Figure 23: Summary of our Strategic Supply Side Options

4.6 Assessing the environmental impact of options

4.6.1 We have used our SEA, HRA and WFD assessments to inform our appraisal of our options.

Strategic Environmental Assessment of options

4.6.2 The SEA informed decision-making at two key stages of our appraisal of supply options:

- **Screening of unconstrained supply options –** information from our SEA formed part of our detailed secondary screening assessment of unconstrained options, informing our decision to either reject or progress options to the next stage.

- **Development of feasible supply options –** a detailed assessment of environmental impacts for each feasible supply option was made in carrying out our SEA

4.6.3 Development of our feasible supply options included scoring each option against each of twelve SEA scores to determine if any positive or negative effects existed prior to mitigation being proposed or indeed implemented. This was used as a basis for scoring the environmental impact of an option as part of our "multi-criteria analysis".

4.6.4 The SEA also considered demand options and concluded that environmental impacts of the demand options are similar for each option and are generally positive because they reduce water use and loss. Any negative impacts were found to be minimal.

4.6.5 Further information about our SEA can be found in Section 6.8 below and Technical Reports 4.10 and 4.11.

Habitats Risk Assessment (HRA)

4.6.6 We carried out an HRA on each of our feasible options. Our HRA concluded that options relating to SESR would be likely to have a significant effect on the South West London Waterbodies SPA and we carried out an appropriate assessment of these along and in combination with schemes in Thames Water's plan. Our appropriate assessment concluded that with appropriate mitigation these would not have an adverse effect on the integrity of the site. Further information about how we carried out the HRA can be found in Section 6.8 below and Technical Report 4.12.

Water Framework Directive Assessment

4.6.7 Our Water Framework Directive (WFD) assessment considered each of our feasible options. It identified potential issues with three groundwater options: Runley Wood and Kings Walden Lower Greensand boreholes and GSK Slough boreholes. These were identified as potentially posing a WFD compliance risk if abstractions start to affect the northwards flow of groundwater. It will only be possible to assess this through a pumping test and monitoring of the impact of pumping on groundwater flows. We would carry out these tests prior to implementation of any these options. We would only abstract a volume of water that was demonstrated not to risk deterioration of WFD status or achievement of good status.

4.6.8 We would also implement these options incrementally. Runley Wood and Kings Walden are abstractions that are located in close proximity to each other. We can implement Runley Wood first and monitor impacts over a longer period of time to provide further confidence in our assessment before increasing our abstraction by implementing Kings Walden. GSK Slough comprises two sub-options that can be implemented on an incremental basis in the same way. In this way, we will ensure that we only abstract a volume of water that it is demonstrated does not cause a risk of deterioration or failure to achieve good status.

4.6.9 The WFD assessment also identified a potential issue in relation to the Brent Reservoir. There is uncertainty around how much yield could be obtained without affecting the benefits from the river support that is currently effectively provided by the reservoir. We will carry out further assessment of this impact and will ensure that we only abstract a volume of water from the reservoir that is demonstrated not to cause deterioration or to risk not achieving good status.

4.6.10 Further information about our overall WFD assessment is provided in Section 6.8 below and Technical Report 4.13.

5 Formulating our Plan

5.1 Introduction

5.1.1 We have identified all the feasible options available to us to increase our supply of water and to decrease demand for water. We now have to decide on the best mix of these options to arrive at our "Best Value Plan" taking into account:

- government policy
- customers' preferences
- costs and benefits (both monetary and non-monetary)
- impact on the environment
- long-term best value.

We do this using the decision-making process described in this Chapter and in more detail in Technical Report 4.9.

5.1.2 Our decision-making process makes use of three inputs: our baseline supply-demand balance presented in Chapter 3, the results of our customer and stakeholder engagement presented in Chapter 2 and our options appraisal presented in Chapter 4.

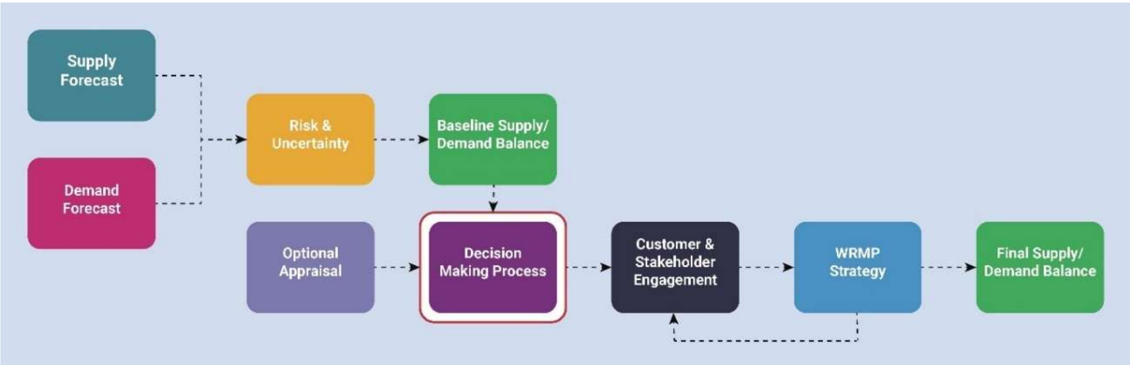


Figure 24: WRMP Process

5.1.3 There were two key stages in our decision-making process:

- We identified the best approach to selecting our preferred mix of options by carrying out "problem characterisation" - see section 5.2 below and Technical Report 1.7;
- We developed a decision-making approach that reflects the conclusion of our "problem characterisation" – see sections 5.3 below, for our Central region, and section 5.4 for our East and Southeast regions and Technical Report 4.9.

5.1.4 We describe the results of our decision-making process in section 5.5 for our Central region and in section 5.6 for our East and Southeast region. The final stage in developing our plan is to test it to make sure it caters for risks that may arise that have not already been accounted for in our baseline supply and demand balance or in our decision-making process – see section 5.7 below. We have taken into account our SEA, HRA and WFD assessments in our decision-making and Section 5.8 provides a summary of how we have done this.

5.1.5 We designed our decision making to be tailored to our specific circumstances while meeting the requirements of the EA's Water Resources Planning Guideline: Interim Update July 2018 and the UKWIR Decision Making Guidance. We have compiled a checklist of how our decision-making process meets the key requirements from this guidance (section 5.9).

5.2 Selection of the modelling process – Problem Characterisation

5.2.1 Problem Characterisation is the industry standard method used for identifying the best approach to decision making based on how big the gap is between supply and demand (the "deficit") and how difficult it will be to address the deficit in the baseline supply-demand and the scale of the deficit. Problem characterisation is set out in full in Technical Report 1.7.

5.2.2 The final assessment matrix from this process is replicated below.

Table 17: Problem Characterisation for rdWRMP

Problem Characterisation		Strategic needs score ("How big is the problem")			
		0-1 (None)	2 -3 (Small)	4 -5 (Medium)	6 (Large)
Complexity factors score ("How difficult is it to solve")	Low <7		East Southeast		
	Medium 7-11				
	High (11+)				Central

Problem Characterisation – Central region

5.2.3 The Problem Characterisation for the Central region falls in the "High" complexity factor score and "Large" Strategic Needs score. The UKWIR Decision Making Methods guidance document indicates that this means a company should consider whether it would be useful to apply an "Extended" or "Complex" approach to decision-making. We decided we needed to adopt an "Extended" or "Complex" approach.

5.2.4 The UKWIR Decision Making Methods guidance indicates that where companies decide to make use of an "Extended or "Complex" approach they need to decide between an "aggregated" or "system simulated" approach depending on the nature of their supply system.

5.2.5 A "system simulated" approach would involve complex modelling of the supply system and tends to suit supply systems that rely on raw water storage. In contrast, an "aggregated" approach considers the supply-demand balance of water using total deployable output and total demand during each year in the planning period.

5.2.6 We concluded that our supply system suited an "aggregated" approach because our supply system does not have raw water storage, and available supply can be well represented by deployable output.

5.2.7 UKWIR Decision Making Methods guidance sets out a number of “aggregated” approaches. We selected the “Adaptive Pathways Planning” decision-making approach for our Central region. This type of plan “adapts” as new information becomes available. We chose this approach because it is specifically designed to respond to uncertainties over future risks in a structured way. In our case we know we have uncertainties regarding the size of demand reductions that can be delivered by our long-term demand management options and also supply-side risks. We explain our approach to decision-making in the Central region in more detail in sections 5.3-5.6 below.

Problem Characterisation – East and Southeast regions

5.2.8 Problem characterisation for our East and Southeast regions concluded that a “Current” approach to decision-making is appropriate and this is explained in further detail in section 5.4 below.

5.3 Our decision-making process for our Central region

Overview of decision-making process

5.3.1 An overview of the decision-making process that we used for our Central region (covering stages 6 to 8 of the UKWIR guidance) is provided in Figure 25 below.

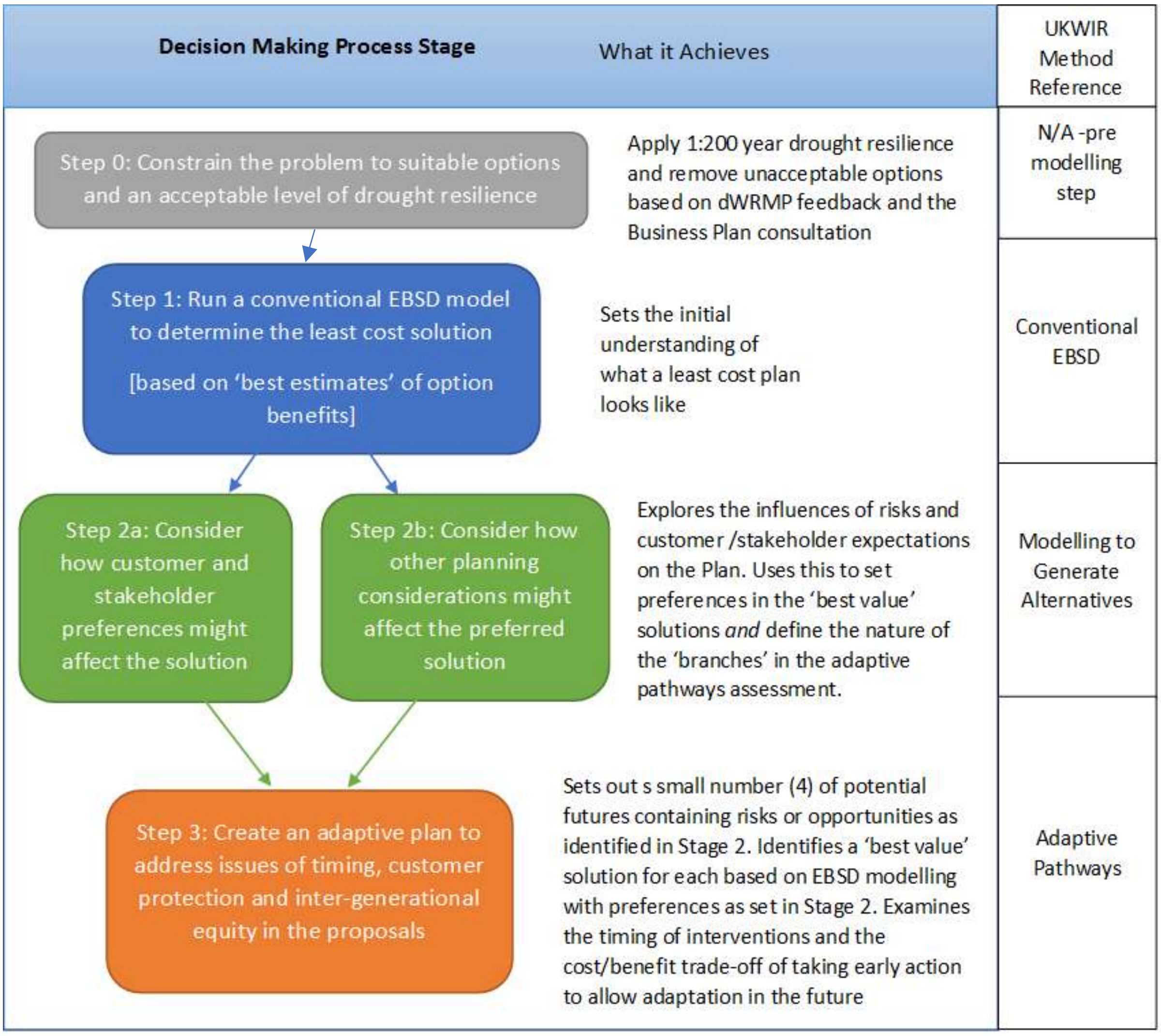


Figure 25: Summary of the decision-making process

5.3.2 Our approach involved four steps:

- **Step 0** – we removed certain feasible options on the basis of stakeholder feedback (see paragraph 5.3.3).

- **Step 1** – we ran a conventional Economic Balancing Supply and Demand ("EBSD") model, which selected a mix of options that would balance supply and demand at the least cost (see paragraphs 5.3.4 – 5.3.6).

- **Step 2a and 2b** – we took account of customer and stakeholder preferences (customer and stakeholder analysis or "CSA") and of our multi-criteria analysis ("MCA") of options described in paragraph 4.4.2 above (see paragraphs 5.3.7-5.3.9).

- **Step 3** – we developed an adaptive plan by developing "four futures" informed by our CSA and MCA. We then re-ran our EBSD model to identify the least-cost mix of options for each of our four futures. This allowed us to develop adaptive pathways to bring forward different options in response to the future that is realised (see paragraphs 5.3.10-5.3.13).

Central region - Step 0: Defining the problem constraints

5.3.3 We included the following constraints to all of our decision-making modelling analyses on the basis of stakeholder feedback:

- Groundwater options involving new Chalk groundwater abstraction were not allowed for selection under any stage or scenario.
- Because we are seeking to improve our drought resilience and stop having to rely on Drought Orders and Permits for droughts that are less severe than a 1 in 200 year event, the models were not able to use Drought Orders and Permits to balance supply and demand from 2024 onwards.

Step 1: Derivation of the least cost plan

5.3.4 We used the EBSD model to generate the plan that comprises a mix of options that is least cost. The inputs to the EBSD model include information from our baseline supply-demand balance and options for closing the gap between supply and demand. These options include existing transfers from other water companies and our constrained options derived from our options appraisal process. As we explained at paragraph 3.4.18, we are not currently able to make full use of our transfer from Grafham, and within our EBSD model we therefore capped the average capacity of this transfer to 50Ml/d, until 2023/24 when we expect to complete the new treatment plant.

5.3.5 This selected all of the smaller, more cost-effective supply side options that we have available to us, along with most of the main demand management options before the first strategic option needs to be developed. The key exception to this was the smart metering programme, which was found not to be cost effective in comparison to the strategic options. Under this least cost plan the first strategic option was the South East Strategic Reservoir scheme in 2035.

Step 2a: Taking into account customer and stakeholder preferences

5.3.6 In Step 2a we analysed feedback from customers and stakeholders provided in consultations on our draft WRMP and Business Plan and further customer pre-consultation during preparation of this rdWRMP.

5.3.7 This Customer and Stakeholder Analysis ("CSA") drew the following key conclusions, which were used in two ways:

- to modify the selection of schemes in the subsequent Step 3 analysis; and
- to develop the adaptive pathways futures for that analysis:

Table 18 sets out each of our findings from CSA and how we have responded to these findings in developing our rdWRMP.

Table 18: The influence of customer and stakeholder feedback on our decision-making process in the Central region

Key findings	Data sources and evidence	Modelling implications for the 'best value' adaptive pathways in Step 3.
Preference for data information to improve awareness, support demand management and leakage reduction	Customer consultation on the dWRMP and the customer engagement on the Business Plan, supported by rdWRMP pre-consultation customer focus groups.	Rollout of a smart metering programme with an associated fixed network to allow behavioural changes and supply pipe leakage reductions were mandated in all Step 3 investment programmes.
Lack of support for variable tariff options.	rdWRMP pre-consultation customer focus groups, plus the rising block tariff trial carried out prior to PR19.	We considered including tariff options, which had been screen out at the options appraisal stage. Given lack of policy and customer support we did not include these.
Preference for strategic schemes that use existing infrastructure	rdWRMP pre-consultation customer focus groups.	We have two options that make use of existing infrastructure: the Grand Union Canal Transfer that was described in section 4 above and the Brent Reservoir, which is a reservoir owned by the Canal & River Trust. We have included enabling actions to further develop [both of these options] – see sections 5.5.12 to 5.5.18 below. Brent Reservoir has a yield risk and we have included this risk in our adaptive planning rather than reducing the yield – see section 5.5.
Support for strategic reservoirs	rdWRMP pre-consultation customer focus groups.	General support for these options, but no change as strategic reservoirs already performed well on an economic basis.
Requirement to include 'stretching' ambitions of demand management and leakage as part of the analysis. Include consideration of greywater re-use.	Stakeholder consultation (Defra, Ofwat, NIC). Customer focus groups (N.B. whilst customers support the concept, they are not in favour of subsidising devices in new homes)	The delivery of very low leakage and PCC targets (50% leakage and 110l/h/d PCC @ 2050) was included as an adaptive pathways branch in the analysis – see section 5.5. The option of delivering low PCCs through highly water efficient new homes was included as an option in all analyses, but additional costs from this clearly identified – see section 5.5.
Requirement to consider how we would manage the risk of lower levels of benefits from our demand management and leakage initiatives.	Stakeholder feedback on the draft WRMP and stakeholder pre-consultation	This risk was included as a core part of our adaptive pathways analysis for the Central region – see section 5.5.

Key findings	Data sources and evidence	Modelling implications for the 'best value' adaptive pathways in Step 3.
Requirement to consider further reductions in abstraction on Chalk rivers.	Stakeholder consultation	The potential need to meet a greater level of challenge was included in one of the adaptive pathways branches.

Step 2b - Multi-Criteria Analysis ("MCA")

5.3.8 In Step 2b we considered our MCA that we carried out as part of our options appraisal (see paragraph 4.4.2) above. It highlighted the following key risks that were used in developing the adaptive pathways for the Step 3 adaptive pathways analysis:

- The ranges of forecast benefits of our two long-term, largest demand management options (concerted action on water efficiency and smart metering fixed networks) represented a key risk to the deliverability and timing of our Plan.
- The large risks associated with the yield on some of the smaller supply-side schemes.
- There was an uncertainty regarding the potential yields that might be realised from the Runley Wood, Kings Walden and Brent reservoir options without compromising achievement of WFD objectives.

Step 3 – Developing our four futures and adaptive pathways

5.3.9 We developed "four futures" that could occur and need to be solved if we are going to be able to plan our supplies resiliently over the next 60 years using our CSA and MCA. We carried out EBSD modelling for each future to determine the 'best value' plan for that future. This identified some options that are needed under all our futures.

5.3.10 We then examined when key investments and decisions ("tipping points") need to be made to ensure that we can respond in a timely way under each future. This allowed us to develop our adaptive pathways.

5.3.11 We then determined what actions we need to take in AMP7 (2020-2025) to ensure we are able to balance supply and demand under any of our four futures. These are our "enabling actions".

5.3.12 As some of this investment could turn out not to be necessary under one or more of our four futures, we have carried out a review of long-term cost effectiveness. We carried out a "least regrets" analysis. This involved comparing our adaptive plan, including enabling actions against a "wait and see" approach that did not include the relevant enabling actions. It has allowed us to establish whether or not the longer-term benefits of the enabling actions outweigh the shorter-term costs, on an economic, probability weighted basis.

5.4 Our decision-making process for our East and Southeast regions

5.4.1 For the East (WRZ7) and Southeast (WRZ8) regions the initial EBSD modelling indicated that very little investment beyond the core demand management programme and a small number of low cost supply side schemes in the Southeast region was required, and that none of the required schemes had a high environmental or social impact. The decision-making modelling did not therefore need to progress beyond Step 2 of the framework in those two regions (i.e. no requirement for formal adaptive pathways analysis).

5.5 Results and key decisions – Central region

Our four futures

5.5.1 Based on the Step 2 findings we identified four potential futures for consideration in our Step 3 adaptive pathways analysis. The choice of four futures represents a pragmatic selection and was designed to allow us to test the full range of supply/demand uncertainty (around 100Ml/d) in a reasonably small number of discrete futures. The four futures are described below:

Future 1: Our 'Challenging' future. There are two key challenges that we are reasonably likely to face:

1. *Supply side challenges.* These are challenges affecting just over 18 Ml/day of the water that we have to supply. There are three elements:

   - Sustainability reductions - Our CSA identified that there may be a need to further reduce abstraction from Chalk catchments (this represents 7 Ml/day).

   - Yield risks - Our WFD assessment identified that we may not be able to realise the full yield of two of our groundwater options (Runley Wood and Kings Walden) and the Brent Reservoir option without compromising achievement of WFD objectives. In addition, our MCA of GSK Slough borehole indicated yield and water quality risks. We consider 50% of the yield of these options to be at risk (8.3 Ml/day)

   - Existing source at Friars Wash – our operation of this source is under review (2.9Ml/day).

2. *Demand side challenges.* There is a risk that longer term demand management measures will not provide the benefits we have included in our 'expected' future. We assessed that the probable risk from this is also in the order of 18Ml/d, which equates to PCC of 128 l/h/d.

   We have modelled this future as an either/or challenge (i.e. we have not incorporated supply and demand challenges into the pathway), with the supply side challenges representing a marginally higher risk. We accounted for the risk that these might be combined through our final plan target headroom allowance, as detailed in section 5.7.

Future 2: Our 'Expected' future. Under this future our longer-term demand management schemes perform as we expect. We achieve a PCC of 124 l/h/d and we reduce leakage by 39% from its 2015 level by 2045. These reductions are consistent with the 2018 National Infrastructure Commission "Preparing for a Drier Future" report. The leakage reduction is the maximum reduction we can deliver without either replacing our mains or finding unknown efficiencies beyond even the optimistic stretch targets we have allowed for in our modelling. There are no supply side challenges.

It also encompasses a range of different "mixed" futures combining elements of our "Challenging future" with elements of our "Optimistic" future. For example, we could achieve higher reductions in leakage in line with our "Optimistic future" (saving up to 20 Ml/d) but see the supply-side challenges of our "Challenging future" (reducing supply by 18 Ml/d).

Future 3: Our 'Optimistic' future. Under this future we do not experience any supply-side challenges, and we are able to outperform to the upper end of our ambition on long term demand management reducing PCC to 119 l/h/d by 2045 and leakage by 50% of its 2015 level by 2045.

Future 4: Our 'Aspirational' future. Under this future we do not experience any supply-side challenges, achieve the upper limit of ambition on leakage and we are able to go even further on demand management and reach our ultimate aim of 110l/h/d PCC.

5.5.2 Under the 'Challenging future' the scope of the sustainability reductions was calculated based on the current analysis of licence capacity that may be reduced because it typically has not been used historically and therefore may be removed under the WFD principle of 'no deterioration'. In this case that means licences may be cut to historic average values to prevent increased abstraction at those sources. This value is 11Ml/d across our supply area as a whole, 7Ml/d of which is calculated within the Central region.

Options selected under all our futures

5.5.3 The economic analysis showed that investment needs for all four futures are the same with the exception of:

- One of our longer-term management options, which is only selected under our "Aspirational" future; and
- The timing for delivery of the first and second strategic supply options, which is different for each of the futures.

5.5.4 All the futures required all the demand management options to be delivered except one. The key supply options that are required alongside our demand management options are:

- Increase in Anglian Water Grafham bulk supply up to its full 91Ml/d capacity (pre climate change impact), which requires construction of a storage reservoir and conditioning plant at Sundon.
- Development of Greensand borehole schemes at Kings Walden, Runley Wood and Slough borehole.
- Brent Reservoir – Brent Reservoir is owned by the Canal & River Trust.
- Development of inter-zonal transfers – this forms part of our "Supply 2040" programme described in Section 6.3.
- Strategic supply options to deliver additional water in the mid-term.

5.5.5 The EBSD modelling selected the SESR option as the preferred strategic option, with 100Ml/d of total resource being economically viable. It then selected the Grand Union Canal ("GUC") transfer as the next preferred option.

Tipping points for our four futures

5.5.6 The date when we need to deliver strategic supply options varies between the four futures in response to whether supply from other options is less than expected or demand is higher than expected:

- **Challenging future** – the first strategic option is required by Summer 2038 and the second strategic option by 2061.
- **Expected future** – the first strategic option is required by 2041/42 and the second strategic option is required by 2065.

- **Optimistic future** – the first strategic option is required by 2047/48 and the second strategic option is required by 2070.

- **Aspirational future** – the first strategic option is required by 2059/60 and the second strategic option is not required within the planning horizon (2080).

5.5.7 Both of our strategic options, SESR and GUC, require a 15-year lead time. The GUC option has a 9-year development period, but currently there is no supporting water quality data or environmental investigation data so we have allowed six years to gather this data pre-development. This means that in our "Challenging" future we need to begin development of our first strategic option in 2023 – this is our first tipping point. We need to assess at this first point whether we are facing a "Challenging", "Expected" or "Optimistic" Future (which could become an "Aspirational" Future).

5.5.8 We expect to know whether we need to deliver sustainability and whether we will be able to realise the full yield of our small supply-side schemes in 2025 – this is our second tipping point. This second tipping point is relevant in our "Expected" future. It tells us whether we are continuing in our "Expected" future or are facing a "Challenging" future.

5.5.9 Achieving our "Aspirational" future in an affordable way will require policy or legislative support that would allow us to achieve the maximum benefits from our long-term demand management strategy, and ensure that most (or all) new homes incorporate highly efficient water saving devices and some water re-use. Without this policy support the costs of investment for this future are significantly higher (£450m additional total expenditure up to 2050 compared with our 'optimistic future') because the lower PCC and leakage targets require expensive demand management and leakage options.

5.5.10 We will continue to aim to achieve the targets contained within this future as part of our long-term planning, but recognise that there is a significant risk that this cannot be economically achieved. We expect to know whether our "Aspirational" future can be affordably achieved by 2027 – this is our third tipping point. This third tipping point is relevant to our "Optimistic" future and tells us whether we are able to move to an "Aspirational" future.

5.5.11 A conceptual summary of the adaptive pathways and decision points generated through the above analysis is provided in Figure 26 overleaf.

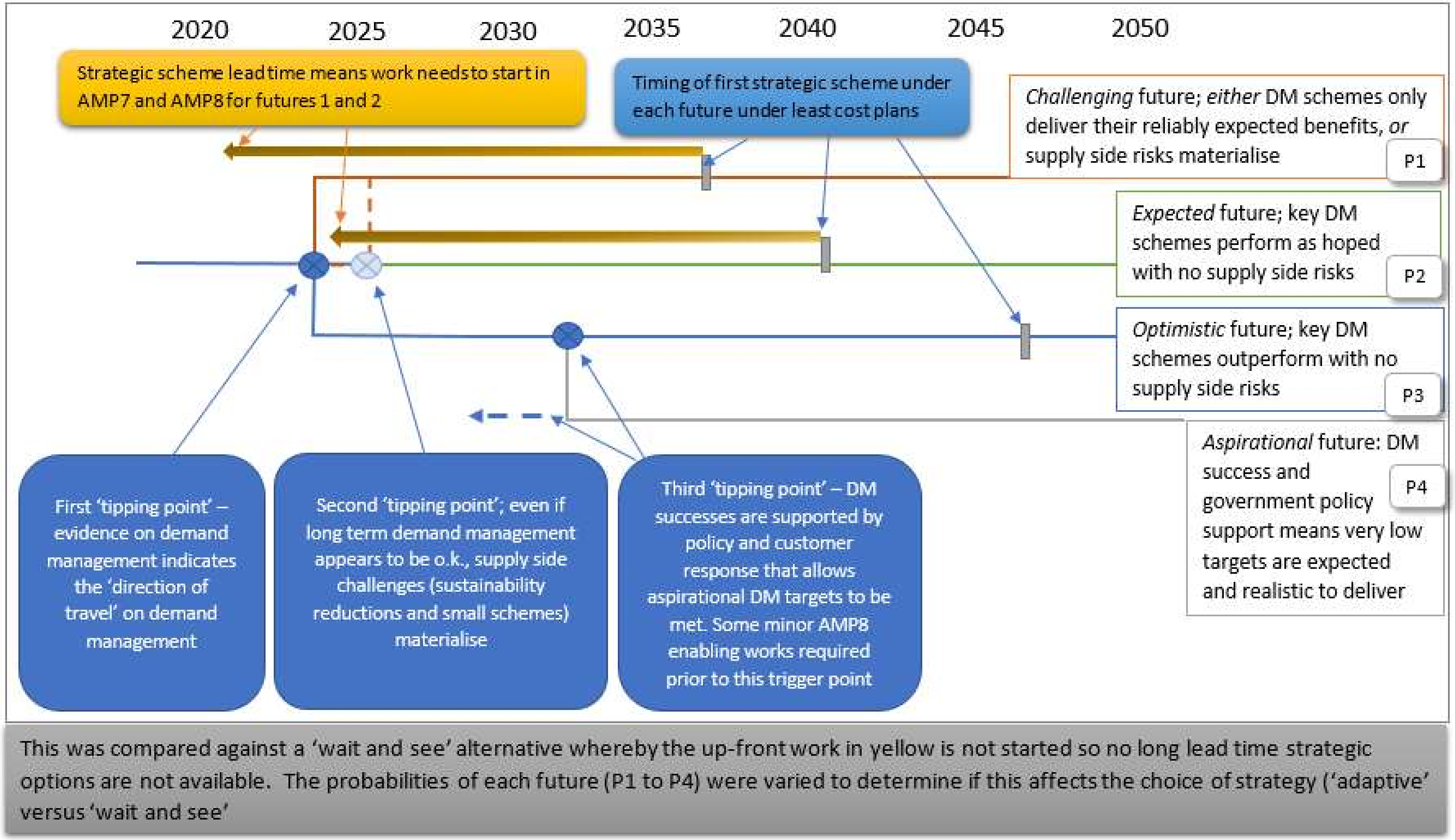


Figure 26: Conceptual summary of the adaptive pathways analysis

Enabling actions

5.5.12 We need to include in our rdWRMP enabling actions to be started in AMP7 in order to ensure that we are able to meet our 'Challenging' future should it arise.

5.5.13 Our analysis shows that for all four futures, the EBSD modelling selects the SESR option as the clearly preferred option for the first strategic supply scheme. We recognise, however, that there are a number of risks associated with this strategic option. These include the need for planning and regulatory approval, likely significant local objection and the possibility that Thames Water will at some point decide not to develop the scheme. In the latter case, the scheme would not be viable for us to take forward alone.

5.5.14 We therefore reviewed our other potential strategic schemes to determine how we could best adapt if we are unable to deliver SESR. Table 19 summarises this analysis.

5.5.15 In the event that SESR is not possible, the EBSD selects the GUC transfer as the second preferred strategic option. We have therefore included enabling activities within our adaptive plan to ensure that this second strategic option remains a viable alternative. We will also continue discussions with Anglian Water regarding the South Lincolnshire scheme.

Table 19: Evaluation of preferences and enabling needs for other strategic schemes

Scheme	Preferences	General Enabling Requirements in AMP7
Grand Union Canal Transfer	Second preference for strategic scheme after the SESR, it is chosen as second strategic option in most model runs. It will tend to have an upper economically effective limit in terms of size (between 50Ml/d and 75Ml/d capacity), so a further option may be required within the 60 year planning horizon if SESR is not available. Although scheme development is only 9 years, considerable water quality and environmental investigation, monitoring, modelling and analysis will be required to try and reduce the delivery risks, scope and costs of treatment prior to that 9 year period.	Include enabling activities to deliver in time for "Challenging" future.
South Lincolnshire Reservoir	Although this scheme is currently relatively expensive, it does provide potential support in the longer term after the GUC scheme.	Work with Anglian Water to determine if there are any options for reducing the overall costs of the scheme.

Scheme	Preferences	General Enabling Requirements in AMP7
Minworth effluent re-use	Not preferred. Although the larger scheme did appear as a potentially economic second scheme under some of the analysis runs, we consider that there is a greater potential for cost engineering on the GUC transfer, and customers significantly preferred the GUC transfer in comparison. We would only pursue this option if costs or delivery risks on the GUC transfer or South Lincolnshire reservoir escalated beyond our current expectations.	No enabling actions.
Severn Thames Transfer	Not preferred. The main issue with this scheme for us is that we do not have the raw water storage that is needed to manage variability in transfer availability. We would therefore need to utilise Thames Water's existing London reservoirs storage to develop the scheme by ourselves, which would be a highly complex arrangement given the different nature of our systems and timing of drought risk and would therefore increase the cost further. If the scheme was developed independently by Thames Water then we could consider the option of purchasing fixed volumes from Severn Trent or United Utilities to release to us.	No enabling actions.
Desalination	Excessively costly to develop and transfer across to the Central region and not preferred by customers, therefore not considered as potential option.	No enabling actions.

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5.5.16 We have included enabling actions in our rdWRMP to develop our preferred 'backup' scheme to the SESR, the GUC transfer, and our third preferred scheme, the South Lincolnshire Reservoir.

5.5.17 Importantly, the enabling activities for the GUC will ensure that our understanding of the scope, requirements and risks associated with this scheme will be at the same level as the SESR option when final decisions are made about the progression of development after the AMP7 2023 decision point.

5.5.18 Demand-side enabling activities relating to lobbying and industry wide collaboration are required in AMP7 to aim for the 'Aspirational' future, but these are contained within our 'concerted action on water efficiency' initiative, which is selected within all futures. The "Aspirational" future does not therefore require any future specific enabling activities until AMP8, when the 'water efficient new homes' initiative would need to be commercially designed for implementation in AMP9.

Review of long-term cost effectiveness

5.5.19 We wanted to make sure that our rdWRMP is best value for customers. It is a requirement of the WRMP Guidelines that we carry out a cost benefit analysis to consider whether the benefits of implementing the solution are greater than the costs.

5.5.20 We therefore carried out a "least regrets" economic analysis to compare two costs:

- the cost of the 'core' AMP7 enabling activities described above (initial development of the SESR and GUC schemes, with associated monitoring and investigation), which we estimate to be £27m – "the adaptive strategy"; and
- the cost of having to rapidly develop more expensive, but shorter lead-time strategic schemes and/or more expensive demand management options because we do not carry out the shorter term enabling activities – the "wait and see approach".

5.5.21 If our "Challenging" future arises then our adaptive approach means that we will have carried out the enabling activities that are required to deliver the required strategic option in time for the need. However, under our "Expected" or "Optimistic" Futures we will have modestly accelerated investment beyond the economic optimum. In our "Aspirational" Future, we would not need to start work on the strategic option until the mid-2040s, and there is a chance it would not be required at all.

5.5.22 This means that if we were to adopt a "wait and see" approach we might delay or avoid incurring the cost of the enabling activities, but there is a risk that we incur significantly greater cost if our "Challenging" or "Expected" futures are realised and we have to deliver more expensive options in short timescales.

5.5.23 We compared these two costs under a range of planning horizons and probability weightings for each future. This analysis showed that even under a shorter term (2050) planning horizon where we assume that the "Optimistic" or "Aspirational" Futures are three times as likely to occur as the "Challenging" or "Expected" futures, there is still almost a 3:1 benefit to cost ratio of pursuing an adaptive approach over the "wait and see" approach.

5.5.24 We are therefore confident that the enabling actions we have included within our adaptive plan represent an appropriate balance between long term resilience and value for customers.

Monitoring

5.5.25 An important part of an adaptive plan is the development of the associated monitoring framework, which allows us to make the relevant decisions on future actions. That framework needs to be geared towards the key 'tipping points' and associated decisions identified through the adaptive pathways analysis. We describe our monitoring framework in further detail in Section 6.4.

Conclusion

5.5.26 Overall this means that our rdWRMP includes both enabling actions for delivery of SESR and other strategic options in 2038 and also monitoring that allows us to determine whether we are able to defer construction of these strategic options. Our proposed investments, including enabling activities and monitoring framework, are described in Chapter 6.

5.6 Results and key decisions – East and Southeast regions.

5.6.1 For the East region, there is no significant investment need under the current WINEP and associated sustainability reductions. The existing resources provide a surplus of circa 7Ml/d to 2024/25, which increases to circa 9Ml/d once the Ardleigh agreement reverts back to a 50/50 share with Anglian Water, and the 2.6Ml/d sustainability reduction scheme comes into force.

5.6.2 There is a potential for a further 2Ml/d sustainability reduction in AMP7, and Anglian Water has indicated to us that it may need a temporary agreement for a small transfer, but only for a short time during the start of the period. We still therefore have sufficient headroom within AMP7 to allow us to share resources with Anglian Water and meet the potential sustainability reduction prior to the return to a 50:50 sharing agreement in 2025/26. There is therefore no requirement for significant investment within the WRZ.

5.6.3 There is a risk that up to 15 to 20 Ml/d of additional sustainability reductions could be applied to this WRZ (see Technical Report 1.4). The size of this risk means that we could only address this requirement through the construction of a desalination plant within the WRZ, as we could not deploy enough demand management to address this size of impact, nor do we have any other supply side options of sufficient size. We have not included this as an investment proposal within our WRMP Table information, but we have therefore considered the desalination plant as part of the SEA. If a smaller level of reduction is required then it may be possible to seek regional transfer solutions, which we could explore once the size of the challenge is known.

5.7 Testing the Plan

5.7.1 We have tested our rdWRMP in two ways:

- we have considered risks not included in the futures and the adaptive pathways, including the risk of experiencing combined supply and demand challenges; and
- we have carried out sensitivity testing.

Risks from combined 'challenging' futures

5.7.2 It is standard WRMP modelling practice to review the Target Headroom allowance in an iterative way once the final choice of demand-side and supply-side options has been identified. A Target Headroom allowance above and beyond the 'baseline' allowance described in section 3.5 is then added to reflect the uncertainties in the yields and benefits of the investment options themselves.

5.7.3 Our Adaptive Pathways already accounted for some of this risk in our 'Challenging' future, but it is acknowledged that this only allows for either supply-side or demand-side option benefit uncertainties. As described within Technical Report 4.9. we therefore calculated the level of Target Headroom risk that had not been covered in the use of the 'Challenging future', at 5Ml/d. To cover this risk, we have identified a small water trading option on the River Thames, which we are actively pursuing with the licence holder. The yield from this option is not yet agreed with the EA, but we are confident that it will be enough to cover the increase in final planning Target Headroom allowance.

Other risks not included in the Central region Adaptive Pathways Analysis

5.7.4 There are potential emerging challenges that we have not accounted for in either the adaptive pathways analysis or the Target Headroom allowance. These are associated with the proposed Cambridge - Milton Keynes - Oxford (CaMkOx) development corridor, the potential for high growth rates in London as contained in the draft Greater London Authority (GLA) development plans, and the possible need to move to an even higher level of resilience (e.g. 1 in 500 years) within future WRMPs. As these are only emerging challenges we have not identified any investment to address them and acknowledge that it would be unlikely that we could develop a strategic option in time to cover them if they do occur. Under that circumstance we may need to temporarily revert to Drought Orders and Permits to cover the very small chance of a drought occurring during the temporary deficit period that would occur within the planning period.

5.7.5 The level of reductions in abstraction that we have incorporated into our 'Challenging' future (7Ml/d associated with potential future sustainability challenge for the Central region, plus 2.9Ml/f for Friars Wash) is also relatively modest, and we acknowledge that final levels of abstraction reduction will not be known until the existing AMP6 and planned AMP7 schemes have been delivered and the associated monitoring is completed. We cannot therefore realistically quantify this risk at this stage, but are confident that the overall scope for reductions will be lower than the volumes of growth risk described for the GLA draft plan above. We have therefore used the GLA scenario to guide our understanding of how our future planning might cope with further sustainability reductions beyond those considered in our 'Challenging' future.

5.7.6 As noted in Section 3.4, there is also a risk from bromate contamination at our Essendon source. The magnitude of impact is relatively small (loss of 4Ml/d), and currently we consider that we have sufficient indication that the EA and polluter will take action to prevent the risk from materialising.

Sensitivity testing

5.7.7 The adaptive pathways analysis that we used in our Decision-Making Process is, in itself, a highly structured form of sensitivity testing, and therefore incorporates all of the sensitivities around demand management and the more likely supply-side risks that we might face.

5.7.8 Our sensitivity testing of our rdWRMP has therefore focused on three considerations that were not covered within the adaptive pathways analysis:

- Environmental impacts – we considered what happens if we exclude options with the most environmental impact in the absence of mitigation as part of the scheme design and construction.
- Drought resilience – we considered the implications of increasing drought resilience to a 1 in 500 year return period level.
- GLA growth – we considered the implications of the potential growth figures published by the Greater London Authority (GLA) in their draft development plan.

Environmental impacts

5.7.9 We assessed the sensitivity of our rdWRMP to environmental impacts by removing any options scoring -2 or -3 in the MCA analysis in the absence of mitigation measures (see paragraph 4.4.2) and re-running our "Expected Future" along with several other adaptive futures.

5.7.10 The high-level findings of our Expected Future are the same as the other adaptive futures as the same options are selected with the only variation being date selected. We found that most of our options scored "-2" or "-3" in the absence of migration.

5.7.11 Without mitigation, the choice of supply side options was therefore limited. Only the Minworth pipe transfer did not attract a score of '-2' under any of the SEA categories. The 100Ml/d version of that option was therefore selected alongside very high levels of leakage reduction and demand management. Under this run the total cost to 2050 was some £537m than our best value investment under our 'Expected' future, and some £1,176m by 2080.

Increased drought resilience

5.7.12 If a move to a 1 in 500 year level of drought resilience is incorporated from AMP8 onwards, then this would result in a fall in DO of 9.6Ml/d ADO, 17Ml/d PDO. The impact of this on the best value plan, is therefore limited, and would involve bringing forward our first strategic option by 2 years.

GLA growth

5.7.13 The GLA draft development plan growth assumptions are far more significant, as they involve an increase of 127,000 new properties by 2045 in comparison to the baseline forecast. That equals a demand increase in the order of 38Ml/d.

5.7.14 Within this analysis we ensured that there was no double counting of the population growth risk that was already incorporated into our Target Headroom allowance.

5.7.15 With the profile of this growth, we estimate that the GLA draft plan would require that we bring forward the need for our first strategic option to 2035 (or 2033 if our "Challenging" future supply side risks materialise. It would also require the development of an additional option beyond our preferred combination of the SESR and 50Ml/d GUC transfer within the 2080 time horizon. This option could be the South Lincolnshire Reservoir or the Severn-Thames transfer, if the issues identified in Table 19 above could be addressed.

5.7.16 As it may not be possible to accelerate the preferred strategic options to meet the accelerated timescale, we may need to re-introduce reliance on drought orders and permits for a short period of time if the GLA draft plan forecasts occur in combination with our "Challenging" future risks.

Implications and adjustments to the Plan

5.7.17 The run carried out to exclude options that require mitigation according to the SEA demonstrated that such an approach would be prohibitively expensive for customers. Our preferred approach is therefore to continue with the adaptive plan, and mitigate the risks through constraining yield on the two Greensand borehole plus the Brent reservoir schemes, and providing mitigation on the development of the SESR as appropriate. This is reflected in our “Challenging” future.

5.7.18 In relation to the GLA growth risk, we believe that the strategic options that we are planning to deliver will give us sufficient time to develop other strategic options should this growth occur.

5.8 Incorporating environmental considerations into our decision-making process

5.8.1 Our SEA, HRA and WFD Assessment were used to inform the decision-making process in three key ways:

- The SEA and WFD findings on feasible options were incorporated into Stage 2 of the decision-making process and resulted in the identified risks to yield for the Runley Wood, Kings Walden and Brent Reservoir options being included in our “Challenging” future. As described, in section 4.8, we will carry out further assessment of these options prior to implementation and will adopt an incremental approach to implementation. We will only implement these options to the extent that we can demonstrate that there is no risk of deterioration in status or risk that the option will prevent good status from being achieved. The “Challenging” future sets out what we will do if further assessment is unable to rule out WFD risks; our first strategic option will be implemented by 2038. – see section 5.5 above.

- We carried out an SEA, HRA and WFD of our best value programme of options for each of the adaptive pathways included in our rdWRMP for the Central region and of our best value plan for the East and Southeast regions – see section 6.8 below.

- We considered the economic cost implications of an alternative plan that did not require any mitigation activities (i.e. no scores of -2 or -3 on any of the SEA categories) was also tested, as presented within section 5.7 above.

5.9 Checking compliance with technical guidance

5.9.1 The Water Resources Planning Guidance (WRPG) issued by the Environment Agency (Water Resources Planning Guideline: Interim update, Environment Agency, July 2018) provides a general description on how water companies should develop a WRMP, but in terms of decision-making, makes specific reference to a report produced by UKWIR (WRMP 2019 Methods – Decision Making Process: Guidance, UKWIR, 2016). These two documents between them therefore describe the overall approach and specific tools which a water company should use.

5.9.2 Figure 27 summarises how we have complied with the relevant requirements of those two guidance documents, whilst at the same time creating a flexible plan that balances ambition with the need to maintain resilience for customers and principles of inter-generational equity.

WHAT THE GUIDANCE REQUIRES	HOW WE DID THIS
It is recommended that the 'conventional' Economics of Balancing Supply and Demand (EBSD) is used as at least a baseline reference for the chosen decision-making process	We included simple EBSD least cost modelling as our first step in our decision-making process
If you face a future with a wide range of uncertainties, other methods may provide better overall solutions. The UKWIR Decision Making Process Guidance provides the relevant framework and tools for this	We developed our process in line with the framework and used the methods outlined in that report
Your decision-making process should be clear and transparent… whichever decision-making method you choose, the final options set should be justified economically, socially and environmentally	Our final process relied fully on standard economic modelling (EBSD), within an adaptive pathways framework that was transparently informed by customer, stakeholder and non-monetary considerations
You should consider the ability of the solution to cover a range of possible futures and provide resilience	Our process was specifically developed to identify, solve and generate a plan that could cope with multiple uncertain futures
You should consider whether future changes may make the solution redundant … solutions that are not intended to resolve a deficit should still be cost beneficial	We used adaptive pathway modelling methods and monitoring that are designed to ensure there are no stranded assets. Where we identified up-front enabling actions we subjected these costs to *formal* 'least regrets' economic analysis

Figure 27: Summary of our compliance with the Planning Guidance

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6 Our best value Plan

6.1 Introduction

6.1.1 This section presents our best value Plan for each of our supply regions and the resulting final supply-demand balance as a result of implementing our Plan. The WRMP process is illustrated in Figure 28.

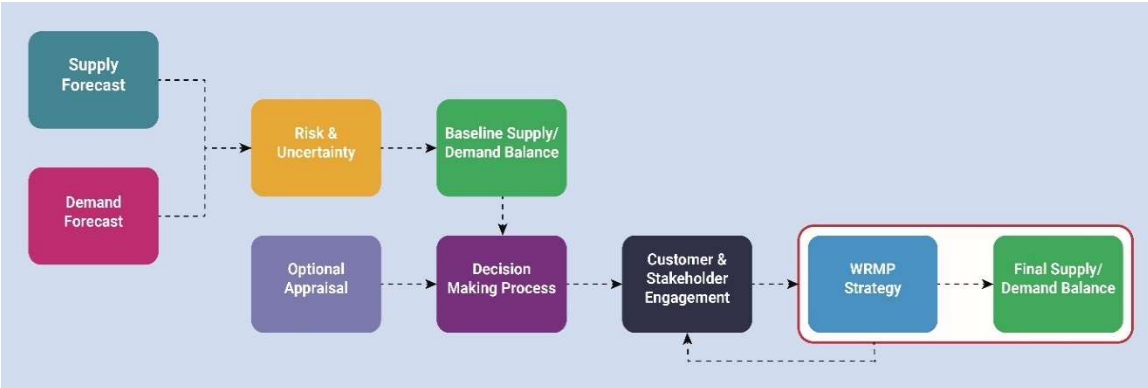


Figure 28: WRMP process

6.1.2 Our best value Plan for the Central region is an adaptive Plan delivering a "twin-track approach" that combines ambitious demand management activities with the appropriate and timely development of supply-side schemes in order to address the supply-demand deficit that we face. It comprises:

- Our demand management strategy (see Section 6.2).
- Our water supply strategy for the Central region based on our 'Expected' and 'Challenging' future (see Section 6.3).
- Our adaptive strategy setting out how we will implement our demand and supply strategies in our four different futures, identifying key decisions (or tipping points), setting out enabling actions and establishing a monitoring plan (see Section 6.4).

6.1.3 Our best value Plan for our Southeast region is more straightforward and comprises:

- Our demand management strategy (see Section 6.2).
- Supply options (see Section 6.5).

6.1.4 Our best value Plan for our East region is also more straightforward and comprises:

- Our demand management strategy (see Section 6.2).
- Supply options (see Section 6.6).

6.1.5 We have carried out SEA, HRA and a WFD Assessment of our rdWRMP and we summarise these in section 6.7. We provide a summary of the costs of our rdWRMP in section 6.8. Finally, we present our final forecasts of supply and demand showing how our rdWRMP affects our supply-demand balance in section 6.9 and show our levels of service for drought that we will achieve in section 6.10. We explain how our rdWRMP aligns with the WRMPs of our neighbouring companies in section 6.11.

6.2 Our demand management strategy

6.2.1 Our demand management strategy is the same across all our regions and is therefore described for the Company as a whole within this section. The WRMP tables that are produced alongside this Plan are based on our "Optimistic" future. This section describes the activities contained within our demand management strategy and sets out how they will evolve over time. It sets out strategies for:

- reducing PCC of household customers;
- reducing non-household demand; and
- reducing leakage.

Reducing Household Consumption (PCC)

6.2.2 We will reduce PCC to 129 l/h/d by 2024/5 through continuation of our existing Water Saving Programme and employing new demand management options. We have 'front-end loaded' our demand management strategy towards AMP7. This rate of reduction in demand is not sustainable in the longer term, as much of the saving is associated with the WSP, which will be largely complete by 2024/25. However, we have included options around household water efficiency audits and fast logging of customers in AMP7, which we intend to use to gain valuable insight into the behaviour of customers. By 'front-end loading' our initiatives we therefore hope to maximise the benefits from the longer-term strategies that are contained in our Plan.

6.2.3 The components and timing of the elements that make up our demand management strategy are presented below.

Water Saving Programme ("WSP")

6.2.4 We will extend our existing WSP (comprising meter installation and charging by reference to volume, customer supply pipe leakage reduction and water efficiency activities) in our Central region. We anticipate 80% meter penetration by 2025 and 90% meter penetration by 2045.

6.2.5 The savings from the metering element of our core WSP are currently estimated to deliver an 18% reduction in demand for each customer that is metered, along with further savings on demand as a result of our associated communication during their customer journey. These savings are towards the upper end of ranges typically quoted by water companies, but are supported by our initial evaluation of the programme to date.

6.2.6 We expect our PCC to reduce to around 136 l/h/d by 2025 through our WSP alone. These anticipated reductions are reflected in our baseline demand forecast – see section 3.2. Our WSP is an inherent part of our strategy, but was not modelled or separately costed.

New demand management options

6.2.7 We have a range of schemes that are designed to provide further demand reduction. These include community-based efficiency activities and some targeted household water audits. We summarise the most significant of these in Table 20.

Table 20: Our most significant demand management options

Demand Management Scheme	Description	Timing
Fast logging	Interacts with the WSP meters to provide us with time-variant information about individual customer use. We then use this information to contact customers with high usage (including possible internal leaks or plumbing losses). This is replaced by smart metering over time.	AMP7
Concerted action on water efficiency	Household water audits to provide short-term savings and to learn about customer use and how we might affect this in the long-term.	AMP7
	Full delivery of our concerted action on water efficiency, replacing household water audits with influencing type initiatives.	AMP 8 and beyond
Smart metering	Replacement of metering stock with smart metering and associated "fixed network" information management systems.	AMP8 and beyond

6.2.8 Our strategy is to roll out smart meters as part of our 'business as usual' meter replacement programme (i.e. we install the smart meter when the existing meter requires replacement anyway), which means we only incur the small additional cost of the meter technology compared with our ongoing business activities. At the same time, we progressively roll out the IT and 'fixed' recording network, which is where the larger expense would come from. The associated data management infrastructure is essential as this would allow us to pro-actively inform customers of high use, and provide us with information about potential supply pipe leaks or leaks within customers' properties to support our leakage reduction programme.

6.2.9 The smart metering programme would act to replace the 'fast logging' contained within our AMP7 programme, and over time we would anticipate that we will improve on the behavioural savings achieved in fast logging by providing customers with more timely, relevant information on their usage.

6.2.10 Savings from smart metering are based on the assumption that we can achieve between 2% and 3% behavioural change (as estimated for the smart metering initiative in the energy sector) and an average 75% reduction in supply pipe leakage from properties that we are able to identify as having significant leaks through the smart meter data.

6.2.11 The "Concerted Action on Water Efficiency Project" incorporates some 'conventional' household water audits but in the longer term it seeks to replace that type of activity with influencing type initiatives that are largely outside of our direct control, but that could potentially significantly reduce demand in the longer term. Potential activities include:

- Supporting and influencing suppliers to generate further reductions to WC flush volumes for new WC cistern purchases and installations (possibly as low as 4 litres per flush).
- Encouraging further innovation, market transformation and point of sale control for other water using devices in the home; such as automatic dishwashers, washing machines, low water use showers, recycling showers and low flow taps.
- Encouraging wide spread behaviour change of water-using habits and practice.
- Adoption of voluntary building controls to deliver water efficient new homes.
- Supporting water-efficient or water-neutral developments through liaison with local planning authorities and developers.

6.2.12 The challenge in delivering these types of water savings is that a wide range of stakeholders need to be engaged who can craft, own and run an integrated programme of education, multidisciplinary research, outreach and delivery. This means that government departments (e.g. Defra, CLG), regulators (EA and Ofwat), Water Regulations Advisory Scheme (WRAS), local authorities, consumer groups, researchers and developers, entrepreneurs, educators, schools, the supply and delivery chains and customers all need to be engaged, in an integrated and coordinated manner. This will not happen on its own, and therefore the thrust of the option is for us to take a community lead, and to manage action plans, goals and deliverables for stakeholders. This could be coordinated with neighbouring water companies and NGOs.

6.2.13 We have estimated the level of demand savings that could be delivered by concerted action on water efficiency on two bases:

- The level of savings achieved if we gain the co-ordinated support and policy backing (including water using product codes where relevant) and there is full and positive engagement from customers. We estimate this to be 64 Ml by 2045, equivalent to 16 l/h/d; and
- The level of savings without such policy support considering only the more reliable elements of the strategy (white goods labelling, behavioural change initiatives involving media campaigns and educational institution support). We estimate this to be 32 Ml by 2045, equivalent to 8 l/h/d.

6.2.14 Table 21 presents the expected savings in the amount of water used for different purposes ("micro-components") to the end of AMP7 as a result of our WSP and other new demand options and longer-term as a result of the Concerted Action Project. This does not take account of behavioural change as a result of smart metering. It is consistent with our estimate above in predicting a long-term expected reduction from concerted action of 8l/h/d.

Table 21: Comparative Estimate of Expectations from our 'Concerted Action on Water Efficiency' Programme.

Micro-component	Detailed reductions anticipated to End AMP7 – completion of WSP and new demand options other than concerted action		Long term *expected* reductions anticipated from concerted action	
	Percentage reduction from baseline	Resulting effect (l/h/d)	Percentage reduction	Resulting effect (l/h/d)
Bathing /showering	5%	-2.4	3%	-1.3
Flushing toilets	20%	-6.0	10%	-3.0
Cooking and drinking	7%	-1.2	0%	0.0
Washing hands	4%	-0.6	0%	0.0
Washing dishes	22%	-3.0	11%	-1.5
Washing clothes	20%	-2.4	10%	-1.2
Gardening	13%	-1.2	7%	-0.6
Other household use	13%	-0.6	0%	0.0
Totals (l/h/d)		**-17.4**		**-7.6**

6.2.15 We have identified a final option for reducing demand, which relates to the installation of highly efficient white goods and fittings and the opportunities for greywater recycling in new homes. Fitting within new homes is the most efficient way that we can implement such a scheme, and our analysis indicates that we could theoretically achieve very low levels of average PCC in new homes using this approach. These very low consumption levels in new homes should allow us to reach our aspirational target of 110l/h/d (or 106l/h/d if the influence of occupancy rate driven inflation is discounted) across the housing stock in our supply area. However, implementing this approach, which requires widespread uptake of measures amongst developers, without policy support would be expensive for customers, an additional £450m cost to 2050.

6.2.16 Our aspirational target is therefore to leverage the influencing activities contained within the 'concerted action' investment to seek policy support around mandatory labelling and retailing of white goods and fittings, which may allow us to increase the benefits of the 'concerted action' programme towards its maximum potential (reducing PCC down to 115l/h/d). With this policy support we can then seek to work with developers to affordably deliver our water efficient new homes programme on a scale that is sufficient to reduce PCC down to our 110l/h/d aspirational target.

Our PCC forecast

6.2.17 A summary of our planned delivery and ambition for demand management, based on the above considerations, is provided in Figure 29 below. When estimating the savings from savings from longer term demand management it is important to note that PCCs in tend to increase as a result of falling occupancy rates - see Section 3.3. In the longer term that means all of our demand management initiatives have to act against this underlying inflation in PCC. We estimate that by 2045 the average PCC will be around 4l/h/d higher than it would be if occupancy rates remained stable from the 2025 position.

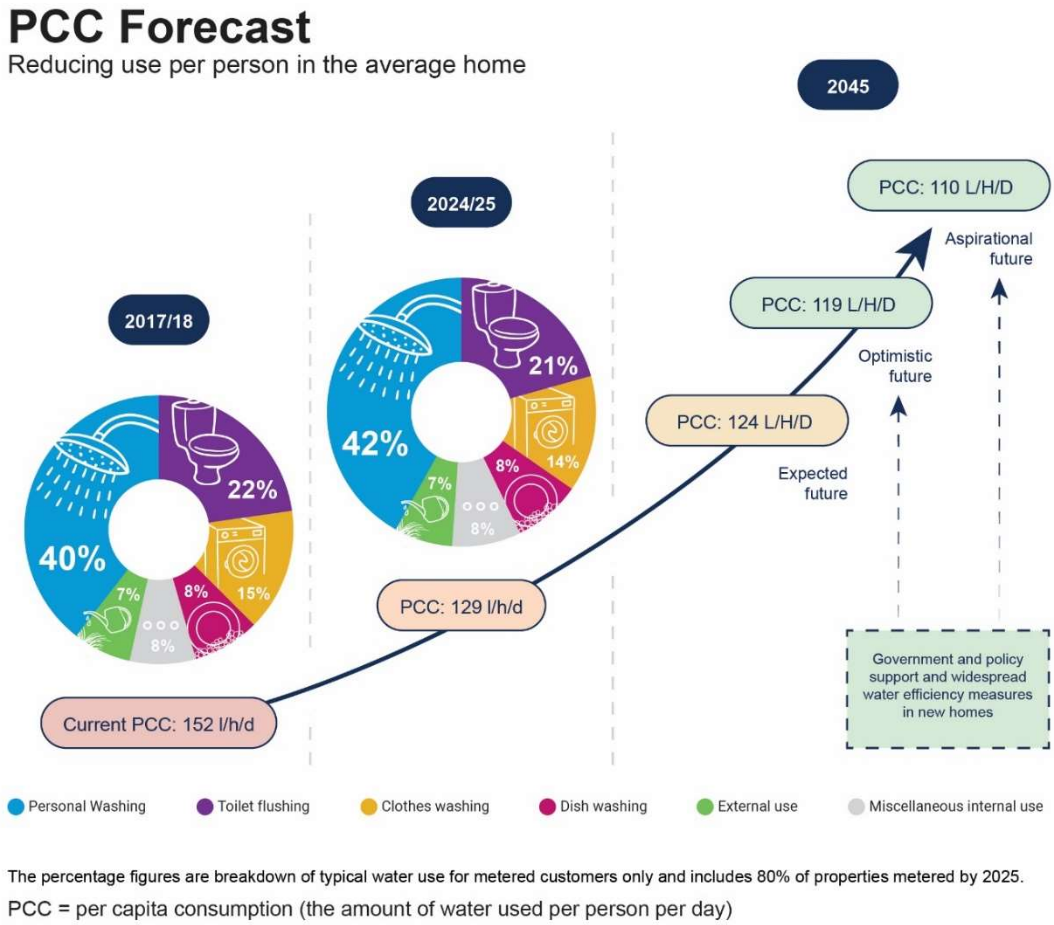


Figure 29: Summary of our demand management strategy impacts

Non-household demand management strategy

6.2.18 In the medium term, as well as the household initiatives described above we will be seeking to reduce demand in the non-household properties that are served by the water retailers in our wholesale supply area. Currently, our plans are to meter the remaining non-household properties within our region where it is practical to do so, and, working with retailers, we will look to extend our water audit offering to those customers that have high usage that is not associated with industrial processes. These plans are supported by potential schemes to install rainwater and greywater schemes at larger premises, again working with retailers in our supply area.

6.2.19 During AMP7 we will also start to explore the potential for working with the non-household water retailers in our region to seek water savings with their customers. We are looking at mechanisms whereby water retailers can propose savings and seek incentive payments from us to offset any loss of profit resulting from the reduction in the amount of water they sell. Currently this is a concept only and savings are likely to be modest in the overall context of our total demand, but we consider that it is important to explore this potential as part of our AMP7 activities. We consider that this process has the potential to generate non-household savings more cost effectively than proposals that require us to deliver the scheme, as it will seek to harness market innovation in the water retail sector. If possible, we will therefore use this process to replace the proposals described above within future WRMPs.

Leakage reduction strategy

6.2.20 We will reduce leakage by 18.5% during AMP7 (a total of 30% from our 2015 starting position). We will meet this target through a combination of pressure reduction schemes, supply pipe leakage savings achieved through metering and 'fast logging' of those customer meters, and a change in approach and policy to our Active Leakage Control (ALC) activities. ALC activities are those aimed at finding and repairing leaks as quickly as possible.

6.2.21 The change in ALC activities represents our largest leakage innovation in AMP7. We have already purchased over 20,000 noise loggers, which we will use in a new, technology-led approach based on targeted District Meter Area sweeps on our mains distribution network. Through this we intend to achieve a 30% efficiency in our current ALC detection and repair costs.

6.2.22 Achieving leakage reduction beyond this 30% will need to be supported by our Smart Metering programme, which we will use to further reduce customer side leakage, and additional stretch efficiency in our ALC. With these measures, we consider that it should be economic to reduce leakage by a further 9% (i.e. 39% overall) before leakage reduction becomes un-economic in comparison to our strategic supply-side options.

6.2.23 Achieving our ambition of an overall 50% reduction in leakage will require that we bring overall leakage to a level that is very close to our current 'background' level (i.e. the level that we cannot move below, even with extremely high levels of expenditure on ALC). Conventional approaches to leakage reduction to achieve this target would not be cost-effective. We therefore need to find a different way of achieving this final 11% reduction through a combination of maximising the benefits of smart metering (i.e. using the data to improve the accuracy and effectiveness of supply pipe leakage detection) and further increasing the efficiency of ALC through as yet undeveloped technologies (e.g. the 'internet of things').

6.2.24 Details of our planned leakage reduction strategy are contained in supporting technical report 4.8.

6.3 Our water supply strategy for the Central region

Key features

6.3.1 Our water supply strategy is designed to meet our 'Challenging' and 'Expected' futures. We explain how our strategy will adapt in response to our different futures in our Adaptive Strategy in section 6.4.

6.3.2 In order to ensure we have a resilient supply system, our strategy includes investment in improving our ability to move water around our network to where it is needed as well as new sources. It therefore consists of four components, as shown in Figure 30 below.

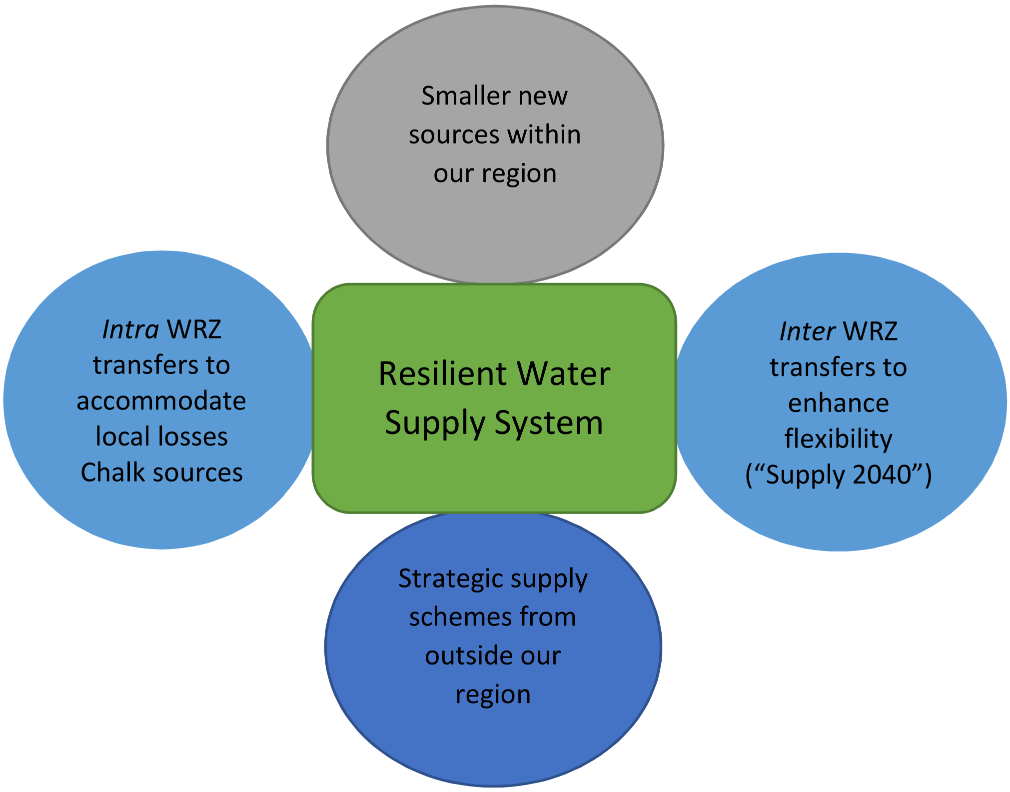


Figure 30: Components of our supply strategy for the Central region

**note – whilst the intra WRZ transfers are reflected where necessary in our 'supply 2040' bulk transfer strategy, the schemes themselves have been developed separately as they are below the scale where we would consider them within a WRMP.*

Providing additional water resources – new smaller sources and strategic supply schemes

6.3.3 A summary of the timing and location of the new water sources (both within our supply regions and from outside of our supply regions) is provided in Figure 31.

6.3.4 Our first major supply-side option relates to the expansion of the Grafham bulk supply, allowing us to use it up to the full statutory entitlement of 91Ml/d[10] (an increase of 30Ml/d over the baseline). This is fixed at the earliest possible delivery date (2024/25) to meet our near-term challenges, principally sustainability reductions and a move to an enhanced level of drought resilience.

6.3.5 We are currently prevented from using our full statutory entitlement because the chemical properties of water from Grafham differ to those of groundwater. Treated water from Grafham Reservoir reacts with galvanised iron pipes in our supply area leading to discolouration. In addition, the presence of chloramine, which customers are not used to, creates a risk of taste and odour that is unacceptable to customers. These issues mean that we are only currently able to use water from Grafham in the north of our Central region for a very limited period of time and to specific areas. We will install conditioning treatment at

[10] pre climate change impact

Sundon Reservoir to address these water quality issues, enabling us to supply water from Grafham WTW throughout our Central region at any time.

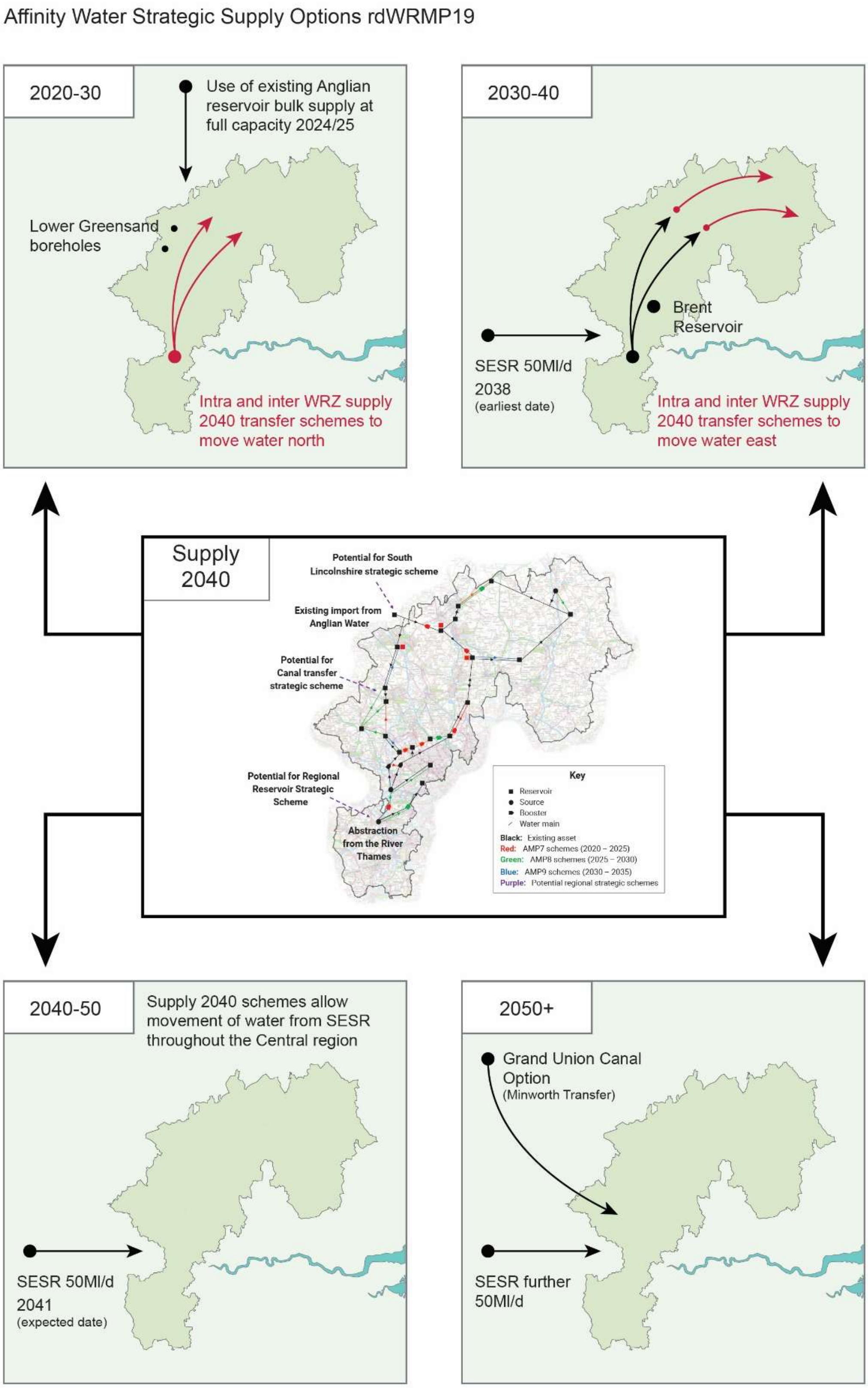


Figure 31: Summary of the timing and indicative location of the new water sources (within region and external transfers)

6.3.6 Our next preferred strategic development is the South East Strategic Reservoir (SESR), which we propose to develop jointly with Thames Water. We will contribute sufficient investment to reserve 100Ml/d out of the full 283Ml/d yield of the scheme. We will develop the reservoir itself by 2038 in our 'Challenging' Future. If we see our 'Expected' Future we will review whether to continue with development of the reservoir by 2038 or to develop it over a slightly longer time-scale to be ready for 2041/2. However, it may not be practical or cost-effective to delay development. We will carry out this review in consultation with Thames Water.

6.3.7 We will develop the transfer and treatment elements of the SESR scheme in two 50Ml/d stages. In the first stage we will develop an abstraction on the River Thames and transfer the new supply to a new treatment works located near our existing Iver works (WRZ4). In the second stage we will extend the transfer through to Harefield and a second 50Ml/d works in that location (WRZ1).

6.3.8 In addition to the SESR strategic scheme, we have identified a potential need for the Grand Union Canal Transfer. Currently this scheme is around 50% more expensive than the SESR on an equivalent basis, which is why we have identified it as a second stage of strategic development or 'backup' scheme to the SESR. Because this is our next preferred option we will continue to investigate the scheme as part of our adaptive plan. Part of that investigation process will include improving our understanding of the water quality and environmental constraints to determine if it is possible to reduce the scope and hence costs of the scheme. If we can reduce the scope and costs then we will review the timing of the scheme in comparison to the SESR as part of our adaptive strategy (see section 6.4).

6.3.9 The smaller options, consisting of three developments of the Lower Greensand and the development of the Brent reservoir, which is an existing asset owned by the Canal & River Trust, are proposed for development in the period prior to the SESR. They provide us with both flexibility in supply and represent an economically cost-effective part of our supply-demand management strategy.

6.3.10 In addition to these committed supply-side developments, we have identified a further potential option, which relates to a licence trade on the River Thames. The viability of this has not yet been confirmed with regulators, and hence the yield is not certain, but could result in up to 7Ml/d of additional supply. As discussed in Section 5.5, we have assigned this option to offset the combinations of development uncertainties (equal to the increase in Target Headroom from baseline to Final Plan) that we have not effectively accounted for within our adaptive pathways analysis.

Maintaining and improving operational flexibility – Supply 2040

6.3.11 For our rdWRMP we have developed a long-term strategy that allows us to improve connectivity in our Central region and unlock the constraints within our current network. This will enable us to move water within our Central region by 2040; this strategy is known as "Supply 2040". It includes a portfolio of new strategic internal transfers to move water more freely from further north and east in our Central region, and allows us to move the forecast surplus in WRZ6 to other WRZs. An outline summary of the development is provided in Figure 32 below.

6.3.12 In the short term (AMP7) Supply 2040 is needed to enable the successful transfer of 17Ml/d water from Wey in the far south of the Central region to Pinn (the only Community to border with Wey) and then north to Colne, Lee and Stort. It also ensures that we retain a constant level of operational risk once the increase in the Sundon transfer has been introduced into the network.

6.3.13 As noted previously, many of our proposed demand management schemes represent new approaches, so there is limited data on which to base our benefit realisation assumptions. This is even more evident when savings are considered at a WRZ, rather than regional level. That means that the benefits and hence surpluses and deficits that are generated within our WRZs could vary from our forecasts. To mitigate against this, our Supply 2040 programme improves the connectivity in our Central region to ensure we protect headroom associated with our existing water resources, as represented by the AMP8 schemes.

6.3.14 In the medium and long term (AMP9+), the Supply 2040 programme includes a series of options to manage the supply-demand balance through preparing the network in anticipation of our first strategic development.

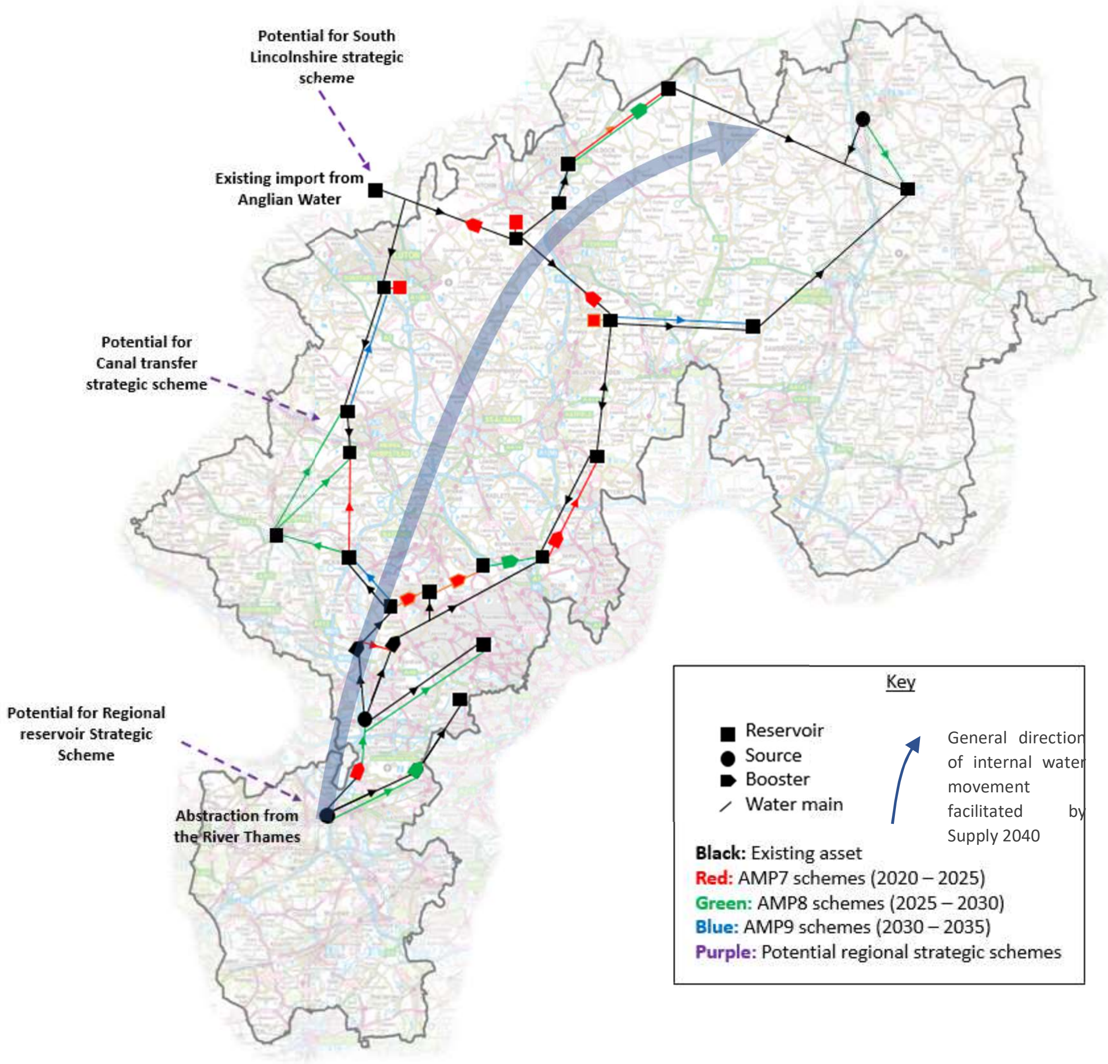


Figure 32: Our Supply 2040 scheme

Climate change risks to our proposals

6.3.15 We formally analysed the risk from climate change on the options that are contained within our best value plan, as shown in section 4.4. However, as the majority of our supply schemes are either internal transfers, abstractions from the Lower Greensand (which is resilient to drought and climate change) or sourced from effluent discharges (the GUC scheme), the risks are extremely small, accounting for less than 1Ml/d of the overall uncertainty.

6.3.16 Two options are potentially vulnerable to climate change, the SESR and the Brent Reservoir. Modelling carried out by Thames Water and provided in its WRMP demonstrates that the SESR is not vulnerable to climate change. For the Brent Reservoir we have some concerns, but these are more generally incorporated within our overall yield uncertainty for the scheme (25% uncertainty on yield) and will work towards resolving this uncertainty as we develop the option.

Water quality considerations

6.3.17 Our first strategic development is the conditioning of the bulk water supply from our Grafham import and associated new treated water storage, which will allow us to maximise the use of the transfer. This scheme introduces surface water into areas that have been historically served by Chalk groundwater. The conditioning treatment therefore ensures that the difference in the nature of the water that it introduces into parts of our supply system will not create any deterioration in water quality.

6.3.18 The supply schemes associated with the Brent reservoir, Greensand boreholes and the abstraction and distribution of the SESR water all require conventional treatment that we are familiar with. We will review the extent of supply of these sources within our network as part of the detailed design of the schemes and, if required, incorporate conditioning plant within the treatment processes. For the SESR scheme this will be relying on water from the River Thames, so we will need to make sure that we have source protection measures and emergency storage or alternative supply arrangements in the case of pollution incidents in the river. Again, these will be reviewed as part of the detailed design for the scheme.

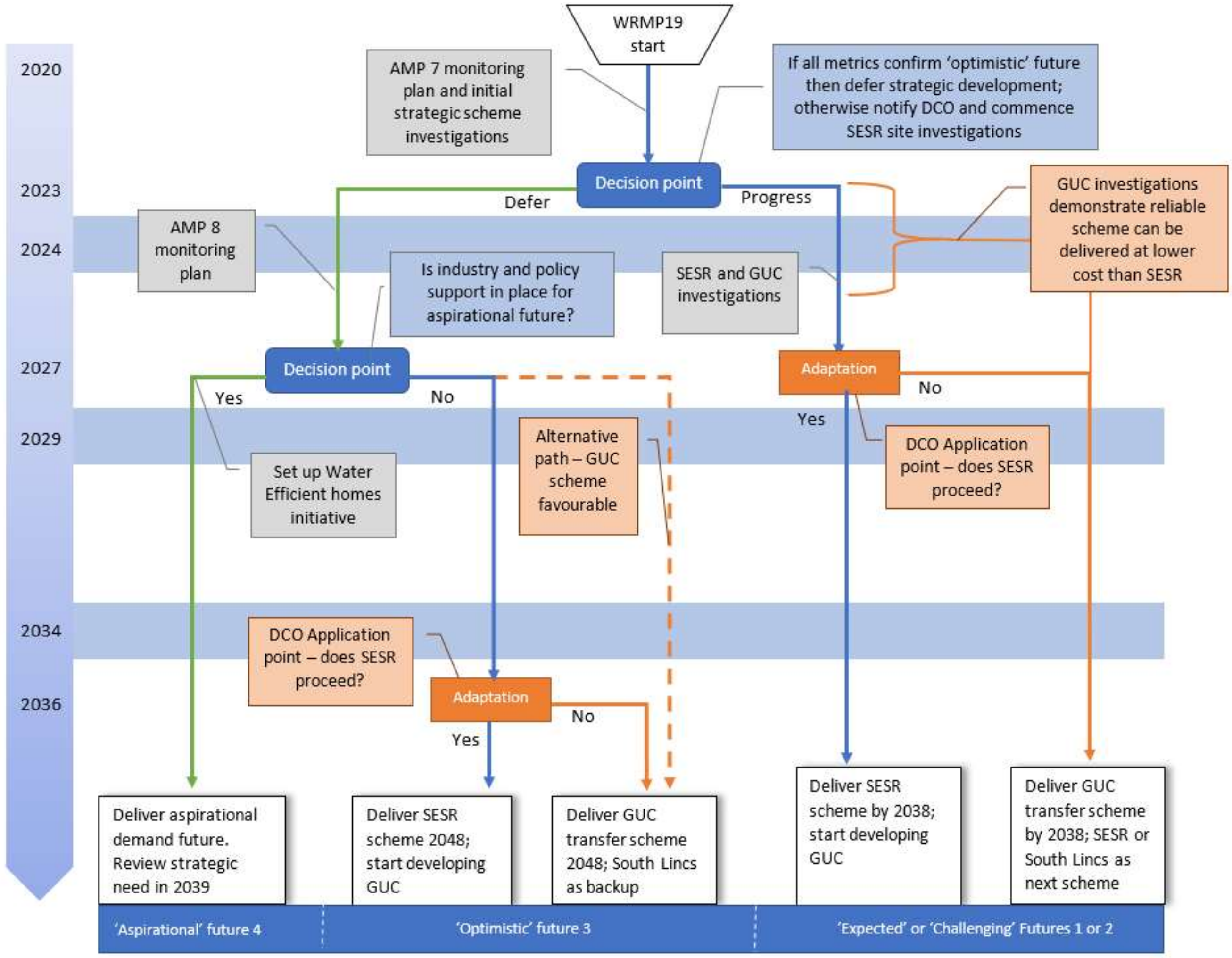
6.3.19 As part of the design for the transfer and treatment of water we will look for opportunities to improve our resilience against pollution events and the current rate of water quality shutdowns associated with our large surface water works, which may help us to reduce outage allowances. The nature of the SESR schemes means that we will be able to explore such options jointly with Thames Water, through connections and emergency supplies from their existing London storage reservoirs.

6.3.20 As noted previously, we do not currently have water quality data for the GUC, and we have not yet modelled the impact of introducing the treated effluent from Minworth on that water quality. Our current scheme costings for the GUC transfer therefore allow for a very high level of treatment, and we will work with our water quality regulator to ensure there is no risk to customers from any of the 'value engineering' of the scheme that we identify as investigations proceed during AMP7.

6.4 Our adaptive strategy for the Central region

6.4.1 The key objectives of our adaptive plan are to allow us to make decisions in a timely manner. This includes the potential deferring of investment on strategic supply options to reduce costs to customers, but *only* if we are able to satisfactorily demonstrate that this will not create a risk to our ability to supply water to customers. The adaptive plan is summarised graphically in

6.4.2 Figure *33* below, which shows the different adaptive pathways in our strategy.



	Enabling / monitoring	Investigation / monitoring prior to delivery of a strategic scheme.
	Decision (or Tipping Points)	A decision is needed to start or defer investment in an option.
	Other adaptations	A decision that is needed within a given future.
	Investment End Point	The point at which a strategic investment is needed.

Figure 33: Our Adaptive Plan

All four futures – 2020 to 2023

6.4.3 During the period 2020-2023, we will implement our demand management strategy and our supply strategy. We will also carry out enabling actions and commence our monitoring plan during the period 2020-2023.

6.4.4 Our enabling actions are set out in Table 22.

Table 22: Summary of our AMP7 enabling actions 2020-2023

AMP7 enabling action	Activities and timing
SESR reservoir pre-development	A requirement to check and model conjunctive capability of water resource needs, confirm reservoir sizing and flood risk, design details of transfer, operational management and emergency measures.
GUC water quality monitoring and initial investigations	Two years monitoring at points along the canal (monthly), plus reporting and collation and evaluation of Minworth plus River Thame data.
GUC combined water quality and flow/resource modelling	Includes canal water quality modelling plus associated Aquator runs. We will continue to work together with Canal & River Trust
GUC initial environmental investigations and feasibility review	Discuss with EA and review detailed environmental risks for the Berkhamsted and extended Iver options, including implications of abstraction further downstream. Collate options for value engineering of the scheme into a feasibility study report.
Water quality, environment, yield and design investigations for Brent Reservoir	Up front studies into environment, water quality, yield and treatment design. This includes preliminary on-site environmental and water quality investigations.
Additional water trading capability and retail innovation	Additional review and development of water trading options beyond those identified for WRMP19, plus initial development of water efficiency innovations such as the retailers' incentives.

6.4.5 Our monitoring plan will allow us to assess objectively which of our four futures is being realised and should ensure that we invest in a strategic supply option at the right time. We will ensure that we use industry standard models and studies and that we provide evidence-based assessments.

6.4.6 Our monitoring plan will include three categories of monitoring activities as set out in Table 23.

Table 23: Our proposed AMP7 monitoring framework.

Assessment category	Monitoring activity	Metrics being reviewed	Purpose and relationship with AMP7 decision points
Category 1: Technical assessments to provide an evidence base of benefits realised through demand management options and yields of supply options.	Borehole development investigations	Yield and likely licence capacity of the Greensand borehole schemes.	Confirm if 'Challenging' supply future can be excluded.
	Brent reservoir investigations	Expected Deployable Output of the Brent reservoir scheme.	Confirm if 'Challenging' supply future can be excluded.
	WSP outturn benefits	Water saved by the current metering and water saving programme on household demand.	Provide supporting information to determine whether the 'Optimistic' demand future is likely.
	WSP data analysis	Confirm size of supply pipe leakage and overall scope for reduction	Identify whether leakage reduction could follow the 'Aspirational' future.
	Fast logging metering results	Impact of 'smart' information on customer behaviour, plumbing and supply pipe losses	Identify whether the full smart metering rollout can achieve the 'Optimistic' demand future in the long term.
	Development plan data provided by Local Authorities or national government	Impacts of new development plans on housing and population forecasts	Confirm growth projections remain within Target Headroom allowances
	Leakage control costs and efficiencies	Analysis of leakage costs based on updates of cost data and outturn cost curves	Confirm if efficiency targets are in line with assumptions
Category 2: Evaluation of policy direction and developments in technology relating to demand management and supply	Liaison with industry and policy makers as part of the 'concerted action' programme	Scope of white good labelling and media activities to reduce demand.	Identify whether the 'optimistic' demand future is likely.
		Scope for governmental policy support or construction industry wide potential for water efficiency targets on new developments*	Initial identification of whether the 'aspirational' demand future could be achievable.
	New policy leakage data and cross industry review	Scope for efficiency in active leakage control beyond that currently available	Initial identification of whether the 'aspirational' demand future could be achievable.

Assessment category	Monitoring activity	Metrics being reviewed	Purpose and relationship with AMP7 decision points
		through leakage technology	
	Liaison with Environment Agency and river groups	Likelihood and magnitude of potential further abstraction sustainability reductions in the Central region	Confirm if 'challenging' supply future can be excluded.
Category 3: Strategic Investigations	Enabling actions	Outcome of the pre-2023 investigations and studies and associated regional modelling checks	Confirm whether or not the SESR remains the preferred economic choice for our first strategic development

**In the short term this will include the government publications relating to per capita consumption targets, and the Water UK study into pathways for water efficiency. In the longer term we will seek to add to this through campaign findings and study reviews that we will develop with partner organisations (Government, local authorities and NGOs such as WaterWise) as part of our 'concerted action on water efficiency' initiative.*

6.4.7 We propose to report on our progress against the delivery of these monitoring outputs through our annual submissions to the Environment Agency and Ofwat, and will maintain regular consultation with the Environment Agency as appropriate between submissions. We will also publish our monitoring plan results on an annual basis.

Decision point - 2023

6.4.8 In Spring 2023, our adaptive pathway splits into two: our "Expected" and "Challenging" futures are on one adaptive pathway and our "Optimistic" and "Aspirational" futures are on the others.

6.4.9 At this point, we will review the monitoring metrics to determine whether:

- The supply risks associated with the "Challenging" supply future are likely to occur.
- Demand management initiatives beyond AMP7 should at least be able to meet the "Optimistic" assumptions contained within this Plan.
- Innovation in leakage control is likely to be sufficient to meet, or come close to, the 50% target without having to replace water mains.
- Forecast housing and population growth is within the envelope of the Target Headroom contained within this Plan.

6.4.10 On the basis of this information gained from the first three years of our monitoring plan and following consultation with regulators, stakeholders and customers, we will decide whether we can defer progressing a strategic supply option. We will do this only if we are confident that this does not represent a risk to customers.

Expected and Challenging futures – 2023 onwards

6.4.11 We will proceed with investigations on both the SESR and GUC schemes and enabling activities for other supply options as summarised in Table 24, and will continue to implement our demand management strategy and our supply strategy.

Table 24: Summary of our AMP7 enabling actions 2023-2025

AMP7 Enabling Action	Activities and Timing
SESR reservoir site investigations.	Post 2023 DCO notification; first two years of site investigations, with Affinity Water incurring 1/3 of the total expenditure (aligned with Thames Water)
GUC further engineering design and optioneering	Post 2023. As appropriate; initial outline design of abstraction or Minworth conditioning and transfer arrangements, water treatment, bankside storage etc. to outline design level. Produce initial ESIA scoping and assessment documentation.
Additional water trading capability and retail innovation	Additional review and development of water trading options beyond those identified for WRMP19, plus initial development of water efficiency innovations such as the retailers' incentives.

6.4.12 In 2025, we will be able to confirm whether we are seeing our "Expected" or "Challenging" Future. We will also have carried out sufficient investigations on the GUC transfer to allow us to confirm (or otherwise) that the SESR remains the preferred option. If SESR remains the preferred option we will we proceed with a Development Consent Order ("DCO") application to seek permission for SESR. If the GUC transfer becomes the preferred option we will pursue it instead. We will also pursue the GUC transfer if the DCO application for SESR is unsuccessful, or other outside factors mean that we are unable to proceed with the SESR.

6.4.13 If we are faced with our "Challenging" future we will need to deliver our preferred strategic supply option by 2038. If we are seeing our "Expected" future we will consider the cost-benefit position of continuing a programme for delivery in 2038 or adopting a programme for delivery in 2041/2. We will do this in consultation with our delivery partner.

Optimistic and Aspirational futures – 2023 to 2027

6.4.14 We will continue to implement our demand management strategy and elements of our supply strategy other than those relating to delivery of a strategic supply option, which is deferred under our "Optimistic" and "Aspirational" futures. We will put in place an AMP8 Monitoring Plan that will be designed to determine, by 2027, whether there is enough policy support and low enough risks on the supply side to allow us to achieve our "Aspirational" future.

Optimistic and Aspirational futures - decision point - 2027

6.4.15 In 2027, our adaptive pathway splits in two again: our 'Optimistic' Future is on one pathway and our Aspirational Future is on the other. We will make the decision on the basis of information gained as a result of implementing our AMP8 monitoring plan and following consultation with regulators, stakeholders and customers. We will decide whether there is enough policy support and low enough risks on the supply side to allow us to achieve our "Aspirational" future.

Optimistic future – 2027 onwards

6.4.16 If we see our "Optimistic" Future we will at this point proceed with investigations into the SESR and GUC transfer with delivery planned for 2048. This timescale is similar to Thames Water's WRMP19 Preferred Plan, so we anticipate that the option would still be available to us. If not then we will develop the GUC transfer as above.

Aspirational future – 2027 onwards

6.4.17 If we see our "Aspirational" future we will start with the 'water efficient new homes' initiative (or other initiatives that may become open to us as a result of the policy environment) and defer the decision on any supply side development until 2039.

6.5 Our water supply strategy for the Southeast region (WRZ7)

6.5.1 The majority of the deficit for the Southeast region can be managed through the demand management measures described previously, plus extension of our bulk supply arrangements with our neighbouring water companies. Some licence changes and infrastructure schemes are still required (removing constraints around our Dover source and strengthening the network around Broome), primarily to address needs during periods of peak demand. A summary of the supply side schemes and timings is provided in Table 25.

Table 25: Summary of supply side developments for the Southeast region (WRZ7).

Scheme Name	Date Required	Deployable Output (Peak, Ml/d)
AFF-EGW-WRZ7-0629: Lye Oak Variation	2021	0.14
AFF-EGW-WRZ7-0908: Tappington South Licence Variation	2044	0.7
AFF-RNC-WRZ7-0626: Broome Network Improvement	2066	2.27
AFF-RNC-WRZ7-0900: Dover Constraint Removal	2022	1.32
AFF-RTR-WRZ7-0301: Barham Import Increase (of 2Ml/d) to 4 Ml/d	2057	2
AFF-RTR-WRZ7-0639: Deal Continuation After 2020	2020	0.0714
AFF-RTR-WRZ7-0909: Barham Continuation (After 2019/20)	2020	2

6.5.2 In terms of water quality, none of the schemes that we have identified represent new sources so there are no obvious risks from our proposals.

6.6 Our water supply strategy for the East region (WRZ8)

6.6.1 Under our preferred plan we are able to maintain a surplus within the East region throughout the planning horizon based on our demand management activities alone.

6.6.2 As noted previously, there is a risk that we will face substantial (up to 15-20Ml/d) reductions in abstraction for our sources within the River Brett catchment in the relatively near term. If that does occur then we would need to construct a desalination plant on the East coast or if the timing and the volumetric reduction changes a shared alternative option. As well as the costs of constructing this plant we are aware that this would involve a fundamental change in the nature and quality of the source water for many customers. We will therefore need to ensure that the plant design incorporates the necessary water conditioning that would be required to prevent deterioration of our pipe network and water quality if this scheme is required.

6.6.3 If a smaller level of reduction occurs then we will explore the opportunity for a more regionally based transfer solution, but the suitability of this will depend upon the timing required by the Environment Agency.

6.6.4 We will continue to liaise with the Environment Agency over the potential scale of any abstraction reductions in the River Brett catchment throughout the AMP7 period. We will end the temporary arrangement whereby Anglian receive 70% of the yield of Ardleigh Reservoir and we receive 30% to its usual position of each party receiving a 50% share from 2024/5. We believe by doing this we are planning prudently in advance of future uncertain sustainability reductions in the region.

6.7 Environmental assessment of our Plan

Strategic Environmental Assessment

6.7.1 We have carried out an SEA of our rdWRMP and of reasonable alternatives against the objectives of our plan as set out at paragraph 1.4.5 (see Technical Reports 4.10, 4.10.1, 4.11 and 4.11.1).

6.7.2 We assessed nine programmes in total including each of our four futures. We rejected five of these alternative programmes and incorporated four into our adaptive plan, being our four futures. As described at paragraphs 5.7.7 to 5.7.9, one of the alternative programmes was an "environmental adaptive run", a programme that omitted options which the SEA has flagged as being without mitigation. This generated a plan dependent on meeting very high levels of leakage reduction and demand management and consequently a very high cost for customers and so was rejected. Our adaptive plan includes four reasonable alternatives, those relating to our four futures.

6.7.3 We concluded that while some options included within the rdWRMP could have an adverse impact on the environment there is sufficient time before they are implemented to allow further investigation and assessment to be carried out and where necessary to allow mitigation measures to be developed to avoid potential impacts.

Habitats Regulations Assessment

6.7.4 A Habitats Regulations Assessment under the Habitats and Species Regulations 2017 was carried out on the options included in the rdWRMP (Technical Report 4.12). The screening stage identified two options as likely to have a significant effect on the South West London Waterbodies SPA and Ramsar Site:

- SESR to Harefield transfer of 50 Ml/d of water; and
- SESR to Iver 2 transfer of 50 Ml/d of water.

Both of these options provide for a pipeline running adjacent to the South Water London Waterbodies SPA.

6.7.5 An appropriate assessment was carried out on these two options. This identified two impacts of potential concern. The first is the potential for construction disturbance on the bird interest features, which are sensitive to noise and visual disturbance during the period October to March inclusive. In line with the HRA recommendation, we will ensure that programming and construction process take into account the proximity of the South West London Waterbodies SPA. We will either avoid the winter period (October to March) entirely or will design our construction programme to ensure noise is maintained at an acceptable level.

6.7.6 The second impact of potential concern was the hydrological connectivity of the flooded gravel pits and the local water table, which depending on the depth and construction method used to install the pipeline, could result in the gravel pits being impacted. The HRA concluded that the likely depth of construction of the pipeline will avoid these impacts. We will, however, ensure that this is the case by carefully designing the pipeline, informed by site-specific geotechnical and hydrogeological investigations to ensure there is no requirement for de-watering impacting on groundwater levels.

6.7.7 We also considered the in-combination effects of these two options with three Thames Water schemes impacting on the South West London water body (Datchet Groundwater, Kempton WTW and South West London Pipelines) and concluded that there were no in-combination adverse effects taking into consideration the potential for mitigation measures.

6.7.8 We will carry out a further project-specific HRA at the detailed design stage and will liaise with Natural England regarding required mitigation measures. We have five other options available to us should, contrary to expectations, we be unable to identify appropriate mitigation measures for these two options. We therefore conclude that our rdWRMP can be delivered without adverse effect on the integrity of South West London Waterbodies SPA or Ramsar site.

6.7.9 We also considered the in-combination atmospheric pollution effects of our rdWRMP and Thames Water's WRMP on three European sites and the potential for hydrological changes to Oxford Meadows SAC and concluded there were no adverse effects on the integrity of these sites.

Water Framework Directive Assessment

6.7.10 We undertook a WFD Assessment of all our constrained supply side options to assess whether the option could result in deterioration of a water body status or prevent a water body from achieving its environmental objectives in the future.

6.7.11 We identified six options in the rdWRMP with potential for a risk of deterioration in status or of preventing a water body from achieving good status. Two options were identified that may provide a potential improvement to status or allow good status to be achieved.

Option	Potential Adverse Impact	Potential benefit
Groundwater abstraction at Kings Walden	Yes	
Groundwater abstraction at Runley Wood	Yes	
Canal & River Trust Slough borehole	Yes	
Brent Reservoir	Yes	Yes
Birds Green Reservoir	Yes	
Grand Union Canal transfer	Yes	Yes

6.7.12 In most cases, the potential risks can be mitigated by appropriate design and management of the options. For example, measures can be taken to minimise the risk of invasive species for surface water schemes at the point of abstraction and transfer.

6.7.13 The potential risks in relation to options to be implemented post 2030 (Birds Green Reservoir and the Grand Union Canal transfer) will be investigated further and mitigations identified. We have explained our approach to those options to be delivered or started before 2030 (Runley Wood, Kings Walden, Slough borehole and Brent Reservoir) in Sections 4.8 and 5.8. We will not implement any option unless and until it can be satisfactorily demonstrated that there is no risk of deterioration in WFD status and that there is no risk that an option will prevent achievement of good status. Our "Challenging" future responds to these risks. If we are unable to fully implement these options we will provide our first strategic option by 2038.

6.8 Cost of our Plan

Overview of costs

6.8.1 Table 26 shows our overall planned level of capital investment in our Best Value Plan over the medium-term planning horizon (2045) and longer term planning horizon (2080). The costs are presented in 2017/18 prices. The costs shown include capital investment, operational expenditure, capital maintenance, and environmental, social and carbon costs.

Table 26: Summary of revised draft best value Plan costs

Total Expenditure	25 year Total 2020-45 (£m)	60 year Total 2079/80 (£m)
Baseline WSP – Metering programme only	75.85	75.85
Baseline WSP Activities (excluding metering)	7.20	7.20
Leakage	184.72	480.81
Non-household	19.15	51.62
Smart Metering	203.99	810.94
Water efficiency	119.92	124.49
Demand Management schemes	**610.83**	**1,550.91**
Supply (ground & surface water)	164.90	1,322.00
Bulk transfers	0.00	2.24
Network improvements	3.71	68.89
Supply side schemes	**168.61**	**1,393.13**
Total for Supply and Demand	**779.44**	**2,944.04**

Cost breakdown

6.8.2 In this section we break down the costs for capital expenditure (capex), operating expenditure (opex) and environmental and social carbon costs, see Table 27. The costs for treatment and deliverability of sustainability reductions are not included within this breakdown as they represent local intra WRZ network changes and are not therefore part of the WRMP analysis.

Table 27: Breakdown of investment within our Plan

	25 Year Total (2020 to 2045)			60 Year Total (2020-2080)		
	Capex (£m)	Opex (£m)	Env, Social & Carbon (£m)	Capex (£m)	Opex (£m)	Env, Social & Carbon (£m)
Leakage	41.05	139.98	3.69	47.68	424.32	8.81
Non-household	6.25	12.82	0.08	20.76	30.77	0.09
Smart Metering	77.24	126.41	0.36	267.29	543.03	0.65
Water efficiency	0.12	119.66	0.14	0.28	124.15	0.05
Demand Management schemes	**124.66**	**398.88**	**4.27**	**336.02**	**1,122.27**	**9.6**
Supply (ground & surface water)	130.48	18.51	15.91	1,412.15	158.47	85.65
Bulk transfers	0	0	0	1.57	0.67	0
Network improvements	1.61	2.11	0	53.75	5.84	0.12
Supply side schemes	**132.09**	**20.62**	**15.91**	**1.467.47**	**164.98**	**85.77**
Total for Supply and Demand	**256.74**	**419.49**	**20.17**	**1,803.49**	**1,287.25**	**95.37**

6.8.3 The resulting carbon emissions that result from the planned investment are provided in Figure 34.

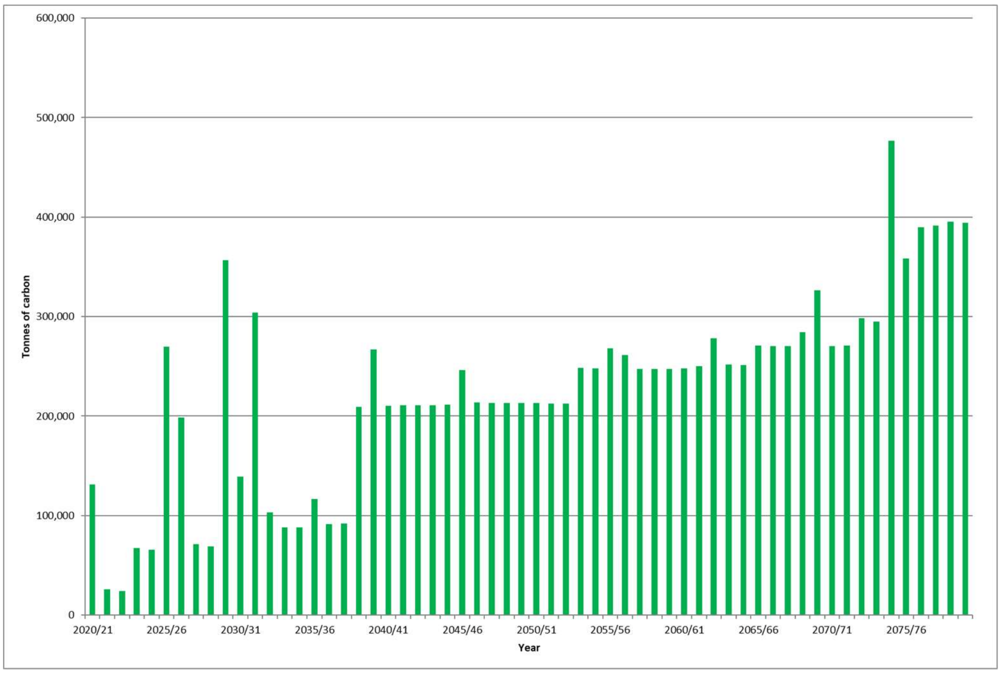


Figure 34: Summary of carbon emissions from our 'Best Value' Plan

6.9 Final supply / demand water balances

Central region

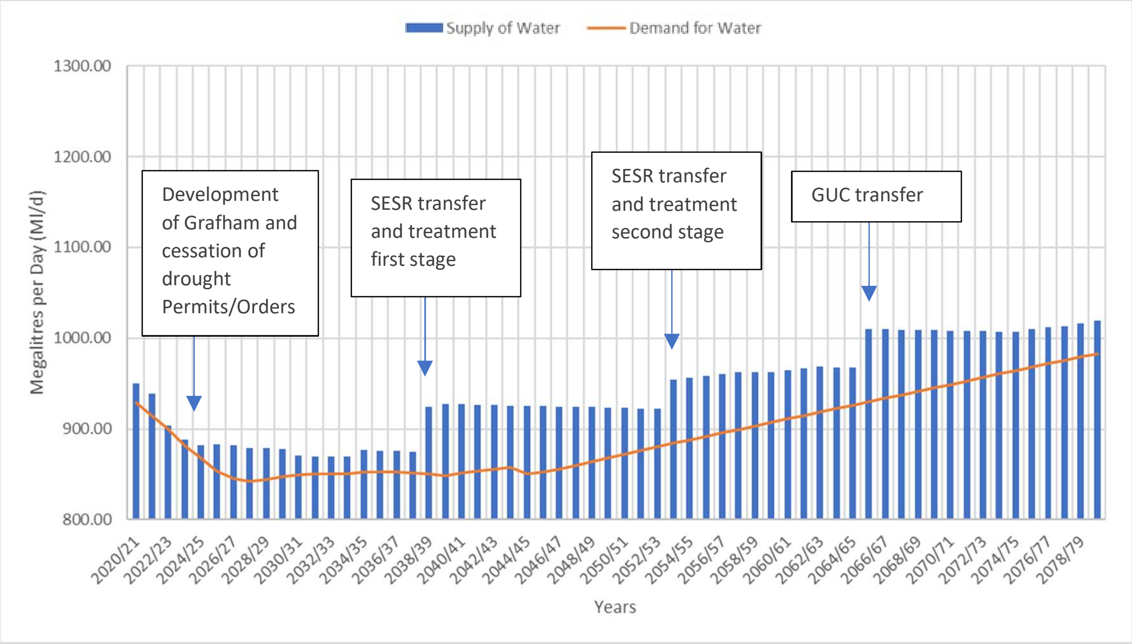


Figure 35: Central region final supply / demand water balance under average conditions (DYAA)

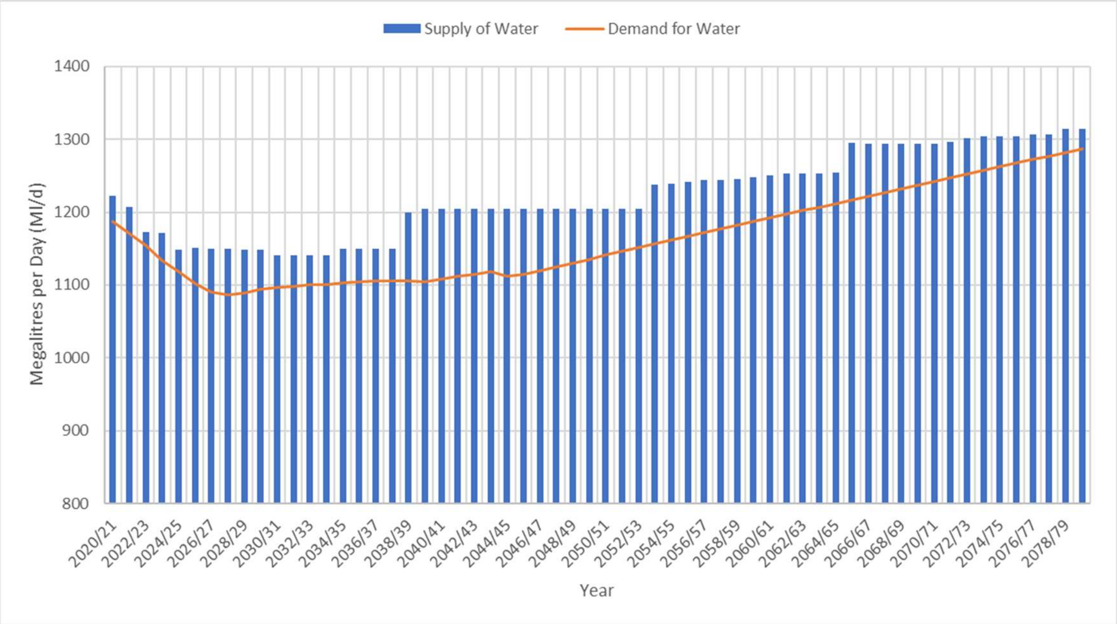


Figure 36: Central region final supply / demand water balance under peak conditions (DYCP)

6.9.1 The final plan supply demand balances for dry year annual average (DYAA) and dry year critical peak (DYCP) are shown in Figure 35 and Figure 36. They are reflective of the WRZ level balances presented in our WRP Tables. The 'Expected' future modelling run (Run 8) has been used to populate our supply-side option selection and utilisation, with the only exception to this being the first strategic option which reflects the 'Challenging' future. The effect of using the 'Challenging' future rather than 'Expected' future for this strategic option is that the option is selected three years earlier.

6.9.2 The demand management and leakage option selections are reflective of our 'Optimistic' future (run 13) which meets our Business Plan commitment of 129 l/p/d (PCC target) and 18.5% leakage reduction by the end of AMP7. This also shows a commitment to a long-term leakage reduction of 50% by the end of 2044/45.

6.9.3 As shown in Figure 35, there is a slight surplus available when strategic schemes are built. This is reflective of the risk management inherently contained in the adaptive strategy and demonstrates the resilience within our rdWRMP to future uncertainties.

Southeast region

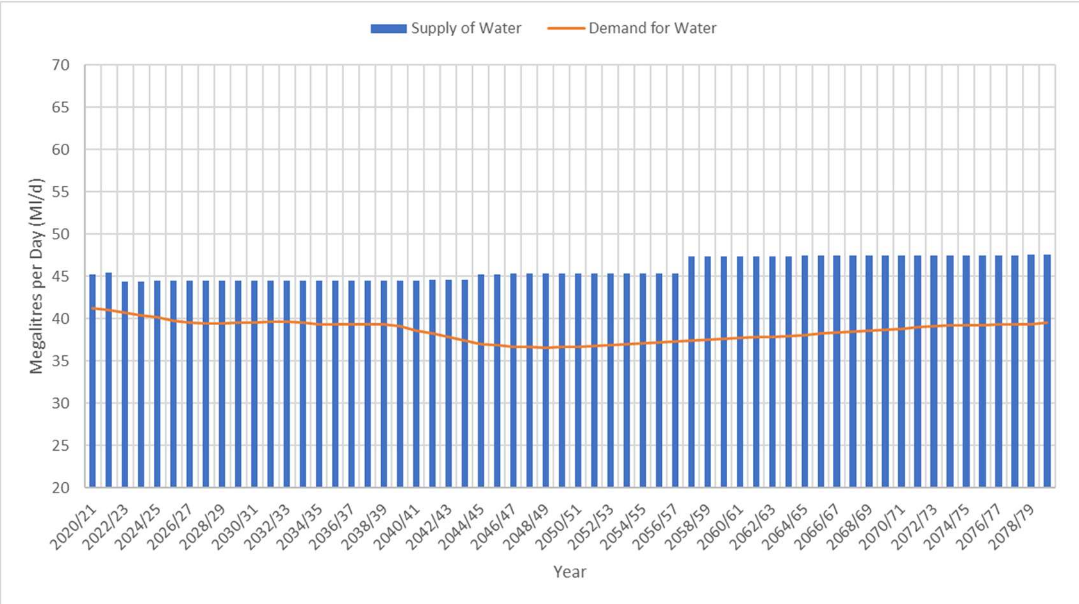


Figure 37: Southeast region final supply / demand water balance under average conditions (DYAA)

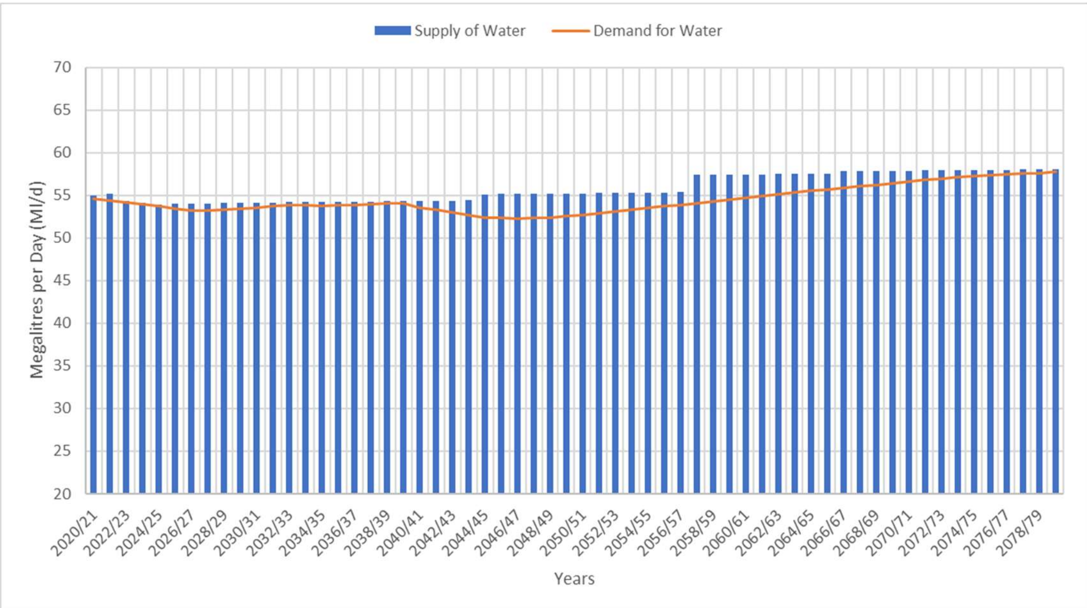


Figure 38: Southeast region final supply / demand water balance under peak conditions (DYCP)

East region

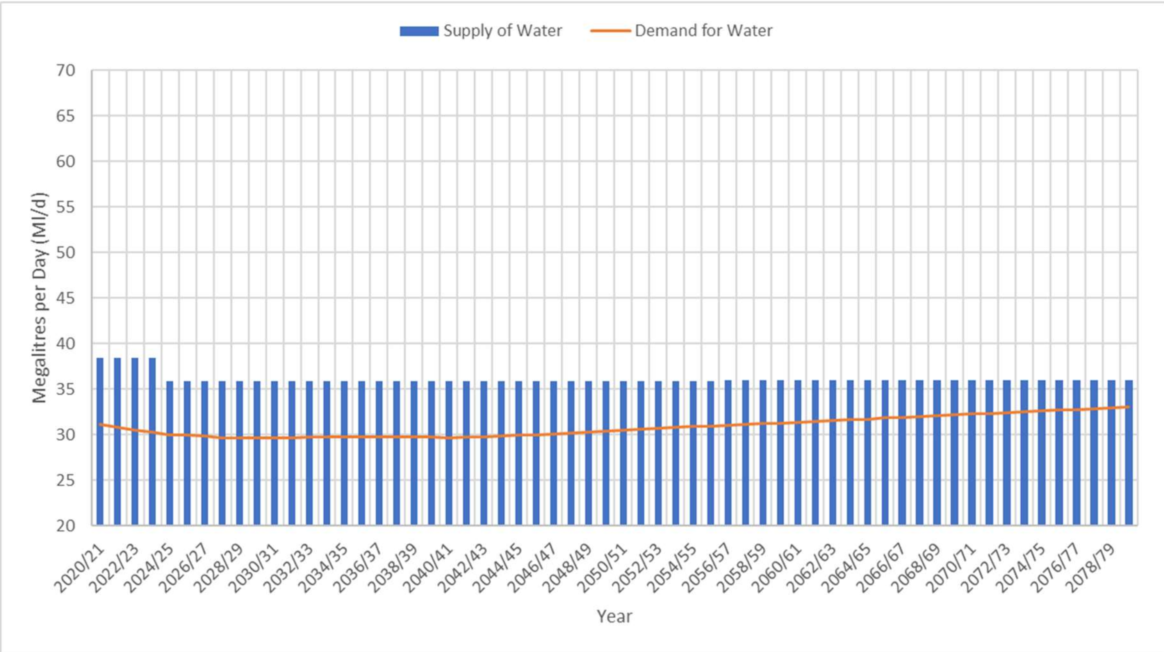


Figure 39: East region final supply / demand water balance under average conditions (DYAA)

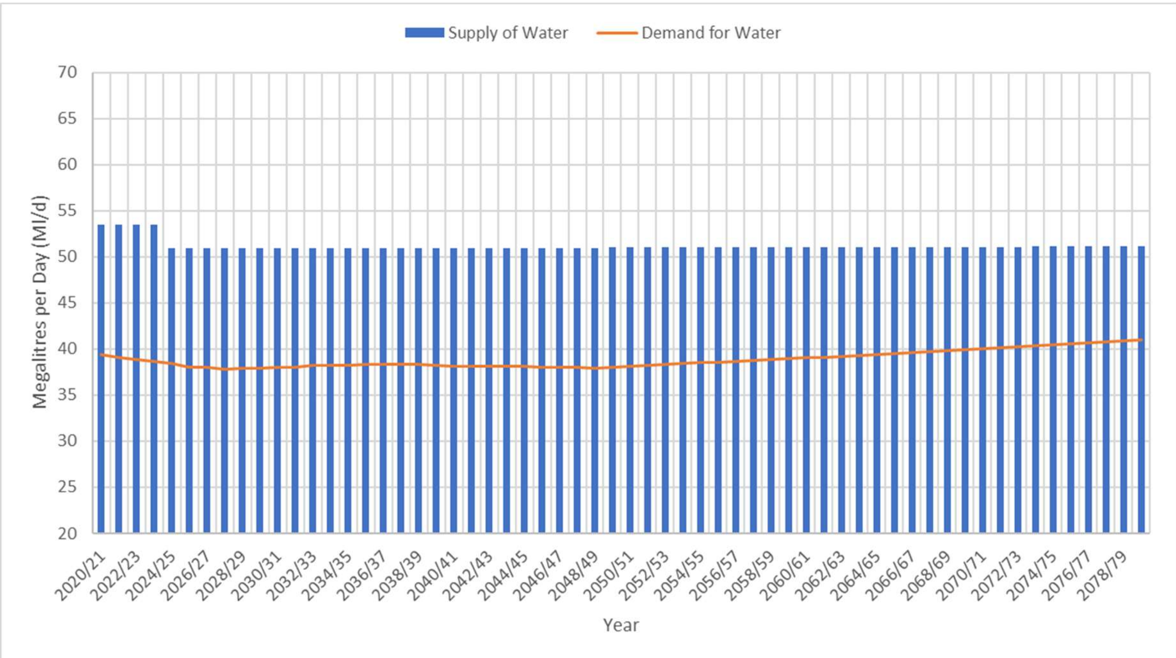


Figure 40: East region final supply / demand water balance under peak conditions (DYCP)

6.10 Drought levels of service

6.10.1 Table 28 shows our final levels of service in the event of a drought. It sets out the annual likelihood that we will need to place a restriction on water use or make use of drought permits or orders to temporarily increase the amount of water abstracted from our environment. Our rdWRMP will enable us to meet a 1 in 200-year drought without the use of drought permits or orders post March 2024. These are consistent with our Drought Management Plan

(November 2018). Table 29 provides a comparison of our drought levels of service before and after implementation of our rdWRMP. **Once we have introduced this new Level of Service then it remains constant for the duration of the Plan.**

Table 28: Our levels of service

Drought Measure	Current frequency in our DMP	Annual probability of implementation	Probability of implementation over 60 years (2020 to 2080)
Temporary Use Ban to restrict non-essential use	1 in 10 years on average	10%	There is a greater than 99% chance of needing this action over 60 years (2020 to 2080).
Ordinary Drought Orders further restricting non-essential use	1 in 40 years on average	2.5%	There is a 78% chance of needing this action over 60 years (2020 to 2080).
Drought Permits / Drought Orders for temporary abstractions	1 in > 40 years on average Will change to 1 in >200 years post March 2024, in line with rdWRMP, at next annual update of the DMP	<2.5% <0.5% post March 2024	There is less than 78% chance of needing this action over 60 years (2020 to 2080). Post March 2024 this will reduce to less than 26% chance of being needed over 60 years (2020 to 2080)
Emergency drought orders	Deemed an unacceptable drought response but could be used for short periods of time in localised areas as a result of a civil emergency		

Table 29: Summary of the current (fWRMP14) and proposed (rdWRMP19) future levels of service to drought

<table>
<tr><th rowspan="2">Normal year</th><th rowspan="2">Extended periods of dry weather</th><th rowspan="2">Plan</th><th colspan="7">Likelihood of implementation of restrictions
Increasing drought severity →</th></tr>
<tr><th>1 in 10 years (10% a.p) This is likely to be needed, possibly up to 6 times over 60 years (2020 to 2080)</th><th>Between 1 in 10 years to 1 in 40 years (2.5% to 10% a.p) There is between 78% and 100% chance of needing these actions over 60 years (2020 to 2080)</th><th>1 in 40 years (2.5% a.p) There is a 78% chance of needing these options over 60 years (2020 to 2080)</th><th>1 in 60 to 1 in 80 years (1.67% to 1.25% a.p) There is between a 53% to 64% chance of needing to use these actions over 60 years (2020 to 2080)</th><th>Between 1 in 60/80 years to 1 in 200 years (1.67% to 0.5% a.p) There is between a 26% to 64% chance of needing to use these actions over 60 years (2020 to 2080)</th><th>1 in 200 years (0.5% a.p) There is a 26% chance of needing to use these actions over 60 years (2020 to 2080)</th><th>Greater than 1 in 200 years (<0.5% a.p) There is less than 26% chance of needing to use these actions over 60 years (2020 to 2080)</th></tr>
<tr><td rowspan="2">No likelihood of restrictions</td><td rowspan="2">Monitor groundwater levels. Raise awareness and appeal for voluntary usage reductions as situation worsens.</td><td>Final plan WRMP14</td><td>Introduce Temporary Use Bans (TUBs)</td><td>Introduce Ordinary Drought Orders (ODOs) for non-essential use</td><td>Maintain:
• TUBs
• ODOs</td><td>Maintain:
• TUBs,
• ODOs

Introduce:
• Drought permits/orders for additional abstraction
• Emergency Drought Orders for restrictions on essential use</td><td>Maintain:
• TUBs
• ODOs
• Drought permits/ orders for additional abstraction
• Emergency Drought Orders for restrictions on essential use</td><td colspan="2">Potential for use of Emergency Drought Orders for standpipes and rota cuts in areas of significant water stress</td></tr>
<tr><td>rdWRMP19</td><td>Introduce Temporary Use Bans (TUBs)</td><td>Maintain:
• TUBs</td><td>Introduce Ordinary Drought Orders (ODOs) for non-essential use</td><td colspan="3">Maintain:
• TUBs
• ODOs</td><td>Maintain:
• TUBs
• ODOs

Introduce:
• Drought permits/orders for additional abstraction
• Emergency Drought Orders for restrictions on essential use</td></tr>
</table>

a.p = annual probability – this is the chance of a drought of this severity occurring in any given year.

N/B: As stated in our Drought Management Plan we consider the use of emergency drought orders for rota cuts and standpipes to be unacceptable. We consider that standpipes would only ever be deployed as a last resort in the event of a civil emergency and more than likely at a very local level for a short period of time to deal with a significant threat. In an event that the drought was to reach a level of severity requiring this action we would enact our Emergency Plan and restrictions would likely only need to be implemented in areas of significant water stress.

6.11 Alignment of our Plan with other companies' WRMPs

Introduction

6.11.1 Significant coordination has been undertaken between ourselves and other water companies when producing our respective rdWRMPs. This included coordination between the companies on approaches to adaptive planning, checking volumes of existing and proposed transfers and shared options to address deficits in supply-demand balance. We have carefully considered interdependencies between the plans, specifically where the options chosen in our rdWRMP impact the best value options for other water company WRMPs.

6.11.2 Technical Report 5.2 provides a detailed record of our work with all of our neighbouring companies and third parties.

Thames Water

6.11.3 We have liaised with Thames Water during the latter stages of our rdWRMP development (after the identification of our preferred strategic option) to ensure that our plans are fully aligned. Our plans are aligned in the following respects:

- The timing of the need for the SESR option and the sharing of yield between our two companies.
- The costs and development period of the SESR (shared 1/3 Affinity Water and 2/3 Thames Water, with the same 15 year development programme).
- The use of adaptive plans and the timing of the key decision point in 2023. Both our plans contain this decision point, and we have adaptive strategies that provide viable alternatives to provide resilience to customers if we do not jointly proceed with the development of the SESR at that point.

6.11.4 The assessment of flows in the River Thames as part of the above investigation undertaken by Thames Water, included the assumption that other licence users would be taking their full licence allocation and so the analysis includes consideration of Affinity Water's surface abstractions from the Thames at Chertsey, Walton, Egham and Sunnymeads at their full licence rate. The Environment Agency accepted the findings of the investigation resulting in a revision to the Lower Thames Control Diagram. A Closure Report on the Lower Thames Investigation was completed and agreed between the EA and Thames Water.

Anglian Water

6.11.5 Our rdWRMP is aligned with Anglian Water's WRMP in the following ways:

- The current modelling of the DO at GRAF is based on a 1:200 drought event, the two companies will work together to model the impacts of a 1:500 scale event going forward and will assess the potential impacts when that work becomes available.
- Both companies agree that should there be an impact on the deployable output of the Grafham source that would affect the operational ability of either company to supply

customers (e.g. outage or extreme drought) that they will work together to provide a solution for both parties, as at present.

- We have worked closely with Anglian Water to improve our understanding of the feasibility of new long-term imports to our Central region, above the existing Grafham import. This has been achieved through the inclusion of the South Lincolnshire strategic option in our adaptive plan as a strategic alternative to the SESR option

6.11.6 The Anglian Water rdWRMP includes an adaptive pathways approach, which includes a review of scenarios (including wider regional requirements) and options, in conjunction with Water Resources East, ahead of the next WRMP in 2023. In addition, Anglian Water is continuing the planning of up to six strategic supply options, so that they are ready for implementation if required. Anglian Water's programme is consistent with our own adaptive plan and the 2023 decision point to move forward or defer on a strategic supply option of regional significance.

6.11.7 It should be noted that in some cases the changes to the timing of transfer volumes will need to be adjusted for the Final WRMP submission with neighbouring companies. Where this is the case we will have agreed this ahead of the Final submission, subsequent to regulator approval to publish (see Technical Report 5.2 for further details).

Next steps

6.11.8 Though much has been done to improve alignment between company plans we do recognise that there remain residual inconsistencies between neighbouring company plans that include the differences between planning horizons, the way that drought return periods are calculated and assumptions around potential benefits to supply bases from new shared infrastructure. There is a clear commitment to improve on these inconsistencies at regional level, which is at the appropriate level to develop further plan alignment through WRSE and WRE ahead of our WRMP24 submission (See Chapter 7).

7 Regional collaboration and links to other plans

7.1 Introduction

7.1.1 In this section, we:

- introduce the regional and national water resources work and describe how our rdWRMP compares to the national and regional projects
- set out our approach to the development of water trading
- explain how this rdWRMP links to other types of plan.

7.1.2 Regional collaboration provides an opportunity to develop strategic regional scale solutions across multiple company areas. These may be more effective or efficient than local solutions or may reduce overall environmental impacts.

7.1.3 Collaboration within the wider context of the East and South East of England is an important consideration for all our supply regions. They all share water in some way with other water companies, and our preferred plans or potential adaptive solutions for all regions involve collaboration with other water companies or other strategic partners from outside of our immediate company area.

7.2 Regional co-ordination

7.2.1 In this section, we outline the work of the Water Resources in the South East and Water Resource East groups on regional water resource planning.

Water Resources in the South East (WRSE)

7.2.2 WRSE is an alliance of the six south east water companies, the Environment Agency, Ofwat, Consumer Council for Water, Natural England and Defra, to develop long term plans for securing water supplies in the south east. The water companies are:

- Affinity Water
- Portsmouth Water
- SES Water
- South East Water
- Southern Water
- Thames Water

7.2.3 The WRSE undertakes cross-boundary modelling across multiple companies to identify schemes which would be beneficial for the South East on a regional scale. Since fWRMP14, WRSE has extended its modelling approach to test resilience, by:

- modelling supply and demand to beyond worst historic drought severity; and
- testing the resilience of regional portfolios of options to increasing demand and sustainability reductions with and without the use of drought orders and drought permits.

7.2.4 The WRSE modelling process is iterative and multi-phased, allowing for output reviews, modifications and additional options to be added.

7.2.5 During our development of the rdWRMP decision-making process we chose to align our economic modelling approach with that of the WRSE. That meant we:

- used the same 'aggregated' EBSD method for least-cost economic modelling, and applied scenarios to it using aggregated methods (i.e. single supply-demand balances for each of the discrete future scenarios that we considered)

- where appropriate, we used the same stochastically generated data sets to calculate the impact on our resources of severe (1 in 200 year) drought events

- aligned all of our underlying economic modelling assumptions with WRSE.

7.2.6 Since the dWRMP we have updated our supply, demand and options inputs to the WRSE model. This includes updating our demand management options, the removal of Chalk groundwater options in our Central region and updating information and costs for the strategic regional options.

7.2.7 We have compared our rdWRMP with the WRSE Phase 5 results which were released in January 2019. The Phase 5 results included:

- 11 least-cost scenarios
- one sensitivity model run per company
- a set of preferred rdWRMP regional runs where the start dates for each option were included and
- one set where the model was allowed to select the timing of the preferred rdWRMP options.

7.2.8 Table 30 provides a comparison of our rdWRMP preferred programme with the WRSE Phase 5 least cost Scenario 4 (S4) and the equivalent preferred plan regional scenario where the strategic option timing is fixed (Se4-1c).

7.2.9 The latest modelling contained within WRSE Phase 5 Scenario 4 selects:

- medium demand
- severe drought DO (1:200)
- 50% uncertainty of sustainability reductions
- use of TUBs
- no use of drought orders
- no use of drought permits

7.2.10 Set 4-1c uses the same parameters except that SESR option is a forced selected in the 2030s. Table 1 shows that the WRSE Phase 5 least-cost Scenario 4 results are closely aligned with our rdWRMP.

Table 30: Comparison of our rdWRMP preferred programme with the WRSE Phase 5 least cost Scenario 4 and the equivalent preferred plan regional scenario

Option Type	rdWRMP options	WRSE Scenario 4 (S4)	WRSE S4 Key comments	WRSE Preferred Plan S4 (Set4-1c)	WRSE Preferred Plan S4-1c Key comments
Demand Management	11	13		13	
Groundwater	8	3		6	
Network Constraint Removals	1	2		2	
Company Transfers	3	4		7	
Inter-company Transfers*	4	5	Initial strategic regional options selected in the 2030s	6	Initial strategic regional options selected in the 2030s
Surface Water Options	1	1		2	
ASR	0	0		0	
Effluent re-use, desalination, treatment works	0	2	Strategic new treatment works	1	

7.2.11 We further note that:

- in all the regional model runs a strategic regional option is selected for Affinity Water. In most cases this is by the 2030s or 2040s

- the first strategic option selected in our rdWRMP (the SESR option) is selected in all but one of the regional least cost runs (S11). Our 'backup' option of the GUC transfer is selected in seven out of the 11 regional model runs.

7.2.12 WRSE acknowledges that its current modelling approach is too simple to reliably determine the timing and order of strategic developments. For example, the current, simple EBSD modelling does not account for the fact that the opportunity cost associated with constructing large options (from generating spare capacity) varies depending on how much alignment there is between the timing of need between different companies. That timing depends on uncertainties in:

- supply (climate change and sustainability reductions)
- demand (growth and PCC) and
- benefits from supply and demand side options.

7.2.13 WRSE intends to address these issues and have details on the preferred regional timing of options prior to our key 2023 first adaptive decision point and draft WRMP24 publication.

Water Resources East (WRE)

7.2.14 WRE brings together regulators, companies, retailers and individuals in the water, agriculture, power and environmental sector to develop an affordable, sustainable and resilient regional approach to water resource management. The water companies are:

- Anglian Water
- Cambridge Water (South Staffs)
- Essex and Suffolk Water (Northumbrian)
- Affinity Water (East).

7.2.15 WRE has developed a model that simulates the key supplies of water and demands for water based on the system configured to start at the end of AMP7 (i.e. 2025). The purpose of the regional simulator is to help inform the decision-making process and is central to the implementation of WRE.

7.2.16 The regional simulator is the means of assessing the vulnerability of the system (at the end of AMP7), initially testing whether the AMP7 system will perform adequately for a range of future scenarios. It is used to identify and short-list portfolios of interventions and for the stress testing of these candidate portfolios.

7.2.17 Initial WRE modelling suggests that future demand could lead to increased discharges in certain catchments, which may in time form the basis for future options to re-circulate this water for supply and thus create more sustainable catchments. The way the model represents 'boundary conditions' is important, especially the boundary between WRE and WRSE (which is shared with our Central region).

7.2.18 Currently, there are no significant implications from the WRE modelling on our rdWRMP19 conclusions. However, for WRMP24 WRE modelling will become an important check on our long-term decisions for the South Lincolnshire reservoir and options for trading in WRZ8 (should this be necessary).

Next steps for regional collaboration

7.2.19 Since the submission of the draft WRMPs, government, regulators and senior water industry representatives have been working together and discussing the future of resilient water supplies and the potential for greater regional coordination. In the lead up to the publication of our rdWRMP those discussions have led to the development of a national framework for water resources. The national framework aims to:

- provide strategic direction to water resources planning,
- include water users outside the water industry and
- promote collaboration.

7.2.20 Alongside the work at national scale, WRSE have been developing their objectives and programme of work in order to meet its regional contribution to the national strategic water resource need. Both WRSE and WRE will engage across regional boundaries and WRSE will also be assessing the potential to engage across sectors. During AMP7, WRSE intends to build on the significant body of investigation work and approaches developed to date. The WRSE group will be producing a regional resilience plan for AMP7 based on resilience and adaptability. The WRSE programme is being aligned to inform individual WRMP24 submissions in the South East of England.

7.3 The National Water UK study

7.3.1 The National Water UK Study (Water UK, 2016) project was established to provide analysis to support a national, strategic and long-term view of water needs across the whole country.

7.3.2 The primary aim of the study was to develop a strategy and framework for the long-term planning of water resources at a national level, up to 50 years into the future, and in doing so to assess the long-term water needs and the available options to meet them.

7.3.3 The following conclusions were drawn by the study:

- there is a significant and growing risk of severe drought impacts arising from climate change, population growth and environmental drivers
- that there is a strong case for government to promote a consistent national minimum level of resilience for water resources
- the investment needed to increase resilience is 'modest' compared to the potential costs from drought and flood and therefore there is an economic benefit of increased resilience
- a twin-track approach is required by companies, which includes supply enhancement and transfer (between companies) and demand management, as being the best strategic mix for the future resilience to drought
- there is a strong case for 'adaptive planning' to support company WRMPs, including 'trigger points' prior to the 2040 and 2065 horizons analysed in the report.

7.3.4 The major conclusions of the study relating to Affinity Water were that:

- our area is among five areas in the country where the impacts of reductions in abstraction, from licence reduction to protect the aquatic environment, would be most significant to a water company's supply-demand balance.
- the modelled demand management savings were reliant on significant behavioural change and the study note that they were ambitious and potentially risky.
- 'extended' demand management requiring behavioural change, metering related initiatives and greater efficiency in leakage control are required to meet future challenges.
- 'enhanced' water efficiency involving the use of household level water re-use and wide spread mains replacement for leakage were not cost beneficial, or required to maintain long term supply/demand balances.

7.3.5 Our rdWRMP19 features the future provision of strategic infrastructure of regional scale and is therefore consistent with the national long-term strategy for national scale water resource resilience. Our rdWRMP19 proposals for water efficiency are also broadly aligned, although under our 'Aspirational' future we will be looking for ways to introduce some household level water re-use within new developments, if policy support is available.

7.4 Future development of water trading

7.4.1 In this section, we outline our approach to facilitating the development of water trading.

Water trading options

7.4.2 We are currently analysing a cross-sector option to use water currently being utilised in the energy industry (referred to as the Didcot – RWE Licence Trading option). This would extend the concept of conjunctive use across sectors and would potentially involve a licence-sharing scheme to benefit customers of both the energy and water industries through efficient transfer of capacity during non-coincident periods of utilisation.

7.4.3 Whilst the option is at an early stage of development, we are continuing to explore the potential to utilise the option and we are following the same process of option screening and feasibility as our other rdWRMP options. The option does nevertheless represent an interesting opportunity.

7.4.4 We are interested in opportunities to trade with any party that either wishes to take from us, or offer to us, a reasonable volume of reliable, sustainable and cost-effective water resources. During pre-consultation for our draft WRMP19 we invited offers for trading new supplies under our current procurement process.

7.4.5 We have developed a Bid Assessment Framework ("BAF") to support the market for water resources, demand management and leakage services. It provides the framework for potential bidders to understand the context, scope, principles and process by which third party providers can bid to supply us with these services and gives confidence that third party bids will be assessed fairly alongside in-house solutions.

7.4.6 Our BAF includes development of a new "Water Trading Portal" to act as a repository of information, publicise new opportunities and serve as a single point of reference for potential bidders. It explains clearly the stages of our procurement process and how this will interact with development of our future water resources management plans. It also explains that third party and in-house options for new supplies of water are assessed using the EBSD model based on multi-criteria analysis.

7.4.7 Our BAF sets out two routes for procuring demand management services from third parties. We may seek these in a traditional manner where we have determined the nature of the demand management service we wish to procure. However, we also want to seek "demand management options" where bidders are invited to propose solutions for delivering a defined volume of demand reduction. These will be assessed using the EDBD model based on multi-criteria analysis and again we will publish standardised criteria to enable bidders to understand how their options will be assessed.

Consistent transfer pricing

7.4.8 We have also developed a specific operational accounting tool for our operational zones from District Meter Area level upwards to facilitate a transparent access price. The Activity Based Costing model collates all maintenance and replacement costs associated with our infrastructure and non-infrastructure assets to build accurate and reliable site and transfer prices per zone.

7.5 Links to other types of plans

7.5.1 In this section, we consider how our rdWRMP links to other plans.

PR19 Business Plan

7.5.2 Our rdWRMP is consistent with our Business Plan which was submitted to the economic regulator Ofwat on 3 September 2018, within which we set out our future investment requirements for 2020 to 2025 (AMP7). That draft Business Plan is currently being updated as part of the regulatory process, and will fully reflect all of the investment proposals contained in this rdWRMP. Our understanding of customer preferences used to develop this rdWRMP has also been partly based on the customer engagement programme contained within the PR19 Business Plan, particularly in relation to long term issues such as resilience and attitudes towards the selection of regional solutions.

The Water Industry Strategic Environmental Requirements

7.5.3 The Water Industry Strategic Environmental Requirements (WISER) document, provides steer from Natural England and the Environment Agency on strategic priorities for the next Price Review. It describes the environmental, resilience and flood risk expectations for Water Company Business Plans. Technical report number 1.4.2. that accompanies this Plan shows the expectations in the WISER document relating to our WRMP and how we already meet or plan to meet these objectives in our planning.

Drought Management Plan

7.5.4 Our current Drought Management Plan (DMP) was published in November 2018, covering five years until 2023. The purpose of the DMP is to demonstrate how we plan to monitor and manage future drought related events, reduce the demand for water and mobilise extra resources, whilst minimising the need to implement drought orders and permits and ensuring security of supply. It is an operational plan, setting out the policy and steps we would take during a drought. The WRPG states that WRMPs should be appropriately linked to a company's DMP, and we have ensured this through the calculations of supply side availability and the savings on demand through customer side restrictions within this rdWRMP.

EA drought planning process

7.5.5 Where our WRMP links to our DMP, this in turn links to the EA drought planning process. We worked closely with the EA to develop our DMP, and this ensured consistency between actions identified within the respective plans. The document, 'Drought response: our framework for England (Environment Agency, 2017a)', sets out how the EA works with government, water companies and others to manage the effects of drought on people, business and the environment. It sets out who is involved in managing drought and how the EA and stakeholders work together to act to manage drought.

River Basin Management Plans

7.5.6 We have regard to the River Basin Management Plans when exercising our functions, including producing our WRMP. The purpose of a River Basin Management Plan (RBMP) is to provide a framework for protecting and enhancing the benefits provided by the water environment. RBMPs are published by the EA.

7.5.7 The last publications were in 2015 and were therefore reflected in our previous WRMP14 Plan, covering the current 2015 to 2020 period. We continue to support the development of the current RBMPs. Our supply area covers three river basin districts (RBD); the Thames, South East and Anglian RBD. The environmental objectives of WFD are to:

- prevent deterioration of the status of surface waters and groundwater.
- achieve objectives and standards for protected areas.
- aim to achieve good status for all water bodies or, for heavily modified water bodies and artificial water bodies, good ecological potential and good surface water chemical status.

7.5.8 We have taken account of these objectives when making decisions that could affect the ecological status of the water environment. Our rdWRMP19 recognises that:

- the objective of no deterioration requires that new or modified abstractions should not adversely affect the status of a water body.
- the aim of achieving good status should not be inhibited by existing abstractions.

7.5.9 The objectives of these three RBMPs have been reviewed in conjunction with our rdWRMP19 options and proposed sustainability reduction strategy for AMP7. In combination with the abstraction reductions, we are also delivering in partnership with the EA and other catchment partners, an extensive programme of morphological mitigation (river restoration and habitat enhancement works), one of the largest in the water industry. Further details on this work are included in Technical Report 1.4.1.

Local Plans

7.5.10 Our supply area is expected to witness significant population growth in the future. We have estimated that our population is forecast to increase in the order of 12% by 2025, 27% by 2045 and 51% by 2080 (equivalent to approximately 1.8 million more people in our supply area). As a result, we have undertaken work to forecast the total water demand in our supply area over our chosen planning period, to assess whether an imbalance exists between supply and demand (see section 3 for further detail). This work has taken account of the housing and population estimates contained within local plans, using water industry standard best practice methods.

8 Board assurance and governance

8.1 Introduction

8.1.1 In this Statement, as a Board, we set out how we have effectively overseen the preparation of this rdWRMP, and how we have assured ourselves that our rdWRMP represents the most cost effective and sustainable long-term solution for managing and developing water resources so as to be able, and continue to be able, to meet the Company's water supply obligations under Part III of the Water Industry Act 1991.

8.2 Governance

8.2.1 We have established a Water Resources Management Plan Committee to help us discharge our responsibilities as a Board with respect to development of our rdWRMP. The Committee comprises:

- Tony Cocker (Committee Chairman)
- Chris Bolt (Non-executive Director)
- Tony Roper (Non-executive Director)
- Pauline Walsh (Chief Executive Officer)
- Tim Monod (Director of Legal and Assurance)
- Chris Offer (Director of Regulation and Strategy)

8.2.2 The Committee invited individuals from the project team to attend Committee meetings as non-members including Marie Whaley (Interim Director of Asset Strategy), Doug Hunt (Project Director) and Julie Smith (Head of Legal Services).

8.2.3 The Committee provided oversight and scrutiny of development of this rdWRMP to ensure it represents the most cost effective and sustainable long-term solution and meets legal requirements and relevant guidelines.

8.2.4 The Committee will continue to meet until the Company's WRMP19 is published. The Committee Chairman reports to the Board on its proceedings after each meeting.

8.3 Assurance

8.3.1 The Committee reviewed and approved the assurance plan for this rdWRMP developed by the project team and supported by external specialist providers.

8.3.2 We have obtained technical assurance from Atkins Limited with respect to preparation of our rdWRMP and its adherence to the Water Resources Planning Guidelines and the Water Resources Management Plan (England) Direction 2017. A report from Atkins Limited detailing its findings will be published alongside our final WRMP19.

8.3.3 We have also obtained technical assurance from Ricardo Energy & Environment of the SEA, HRA and the WFD assessment. A report from Ricardo Energy & Environment setting out its findings will be published alongside our final WRMP19.

8.3.4 Our rdWRMP has also been subject to legal assurance, with specific reference to the requirements of SEA and HRA.

8.4 Summary

8.4.1 We have reviewed this rdWRMP and the assurance reports provided by Atkins Limited and Ricardo Energy & Environment and comments and views provided by Counsel following legal review.

8.4.2 We are satisfied that the rdWRMP represents the most cost effective and sustainable long-term solution for managing and developing water resources so as to be able, and continue to be able, to meet the Company's water supply obligations under Part III of the Water Industry Act.

8.4.3 We are further satisfied that our rdWRMP takes account of all statutory drinking water quality obligations, and that it includes plans to meet our statutory obligations in this respect in full. We approve the rdWRMP on behalf of the Board.

Tony Cocker

Chairman

Appendix: List of Technical Reports

	Category	ID	Title
	MAIN REPORT	1	Revised Draft Water Resources Management Plan 2020-2080
1	SUPPLY	1.1	Deployable Output and Climate Change Impact Assessment
		1.1.1	Deployable Output and Drought Plan links
		1.2	Climate Change Assessment report - Basic and intermediate (HRW)
		1.3	Climate Change Vulnerability Assessment
		1.4	Sustainability Reductions
		1.4.1	AMP6 NEP Progress and Summary of WINEP PR19 Schemes
		1.4.2	WISER Addendum
		1.5	Water Resource Zone Integrity
		1.6	Drought Management Plan 2018
		1.7	Problem Characterisation Report
2	DEMAND	2.1	Household Demand Forecast - MLR Modelling Report
		2.2	Household Demand Forecast - Micro-Component Report
		2.3	Domestic Housing and Population Forecast
		2.3.1	Population, Household and Dwellings Forecasts (Experian)
		2.4	Non-Household Demand Forecasting Summary Report
		2.5	Dry Year Annual Average (DYAA) and Critical Period Factors Analysis
		2.6	Metering Cost Benefit Analysis
		2.7	Overarching Demand Forecast Report
3	RISK AND UNCERTAINTY	3.1	Outage
		3.2	Headroom
4	OPTIONS AND EBSD	4.1	Unconstrained Options Report - Supply Options
		4.2	Unconstrained Options Report and Screening Results - Demand Management Options
		4.3	AECOM Screening Methodology (Supply Options)
		4.4	LRMC Cost Model Update
		4.5	Supply Side and Constrained Options Report Vol 1
		4.6	Supply Side and Constrained Options Report Vol 2
		4.7	Water Demand Management Framework - Assessment of Demand Options
		4.8	Leakage Strategy Report
		4.8.1	ELL and SELL Determination 2016
		4.9	Economics of Balancing Supply and Demand Modelling and Decision Making Process
		4.10	SEA Scoping Report v1
		4.10.1	SEA Scoping Report v2
		4.11	SEA Environmental Report
		4.11.1	SEA Environmental Report Appendices
		4.12	Habitat Regulations Assessment
		4.13	Water Framework Directive Report
		4.14	Supply 2040
5	REGIONAL MODELLING	5.1	National and Regional Water Resources Modelling Report
		5.2	Water Company and Third Party Bulk Transfers
6	REPORT PRODUCTION	6.1	WRP Tables and Commentary & Exception Report
7	CONSULTATION AND ENGAGEMENT	7.1	Engaging with Customers, Communities and Stakeholders

Abbreviation list and Glossary

ADO	Average Deployable Output – the average output of a source.
AMP	Asset Management Plan / Period – five-yearly cycle covered by a water company's business plan.
AONB	Area of Outstanding Natural Beauty – an area of land protected by the Countryside and Rights of Way Act 2000 to conserve and enhance its natural beauty.
Annual Return	Annual performance report provided by a water company to Ofwat.
BAF	Bid Assessment Framework – our framework for potential providers of water resources, demand management and leakage services, explaining how we will ensure we fairly assess third party bids for these services against in-house solutions.
CAMS	Catchment Abstraction Management Strategies – assess the amount of water available in each river catchment.
CaMKOx	Cambridge -Milton Keynes-Oxford development corridor.
Capex	Capital Expenditure – the money that is used to fund the installation of new water infrastructure.
CCG	Customer Challenge Group – independent local groups of customer representatives and other stakeholders established established for the price review process to provide challenge to water companies' business plans.
CRT	Canal & River Trust – a charity looking after 2000 miles of waterways.
CSA	Customer & Stakeholder Analysis – a technique for stakeholder identification and analysing their needs.
DCO	Development Consent Order – the means of obtaining planning permission for developments categorised as Nationally Significant Infrastructure Projects.
DEFRA	Department for Environment, Food and Rural Affairs.
DI	Distribution Input – the amount of water entering the distribution system.
DO	Deployable Output – the output of a commissioned source or group of sources assessed under drought conditions.
Drought Order	An authorisation granted by the Secretary of State under the Water Resources Act 1991, which imposes restrictions upon the use of water and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis in the event of a drought.
Drought Permit	An authorisation granted by the Environment Agency under the Water Resources Act 1991, which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis in the event of a drought.

DMA	District Metered Area – a collection of water mains in an area that are isolated such that there is only one (or sometimes more) feed, this feed is metered and the volume of water supplied to the area or zone can be regularly monitored to check for leakage.
DMP	Drought Management Plan – a statutory plan which sets out how the company will supply water in the event of a drought situation.
DWI	Drinking Water Inspectorate – the DWI is responsible for assessing the quality of drinking water in England and Wales, taking enforcement action if standards are not being met, and appropriate action when water is unfit for human consumption.
DYAA	Dry Year Annual Average – the annual average value of demand or deployable output or other parameter over the course of a dry year.
DYCP	Dry Year Critical Period – the time in a dry year when demand is greatest, often taken to be the peak week.
EA	Environment Agency – a non-departmental public body with statutory functions relating to protection of the environment.
EBSD	Economics of Balancing Supply and Demand – a model used in water resources future planning
GARD	Group Against Reservoir Development.
GES	Good Ecological Status – the principal objective for most water bodies under the Water Framework Directive, defined as a slight variation from undisturbed conditions.
GLA	Greater London Authority – the developed regional governance body of London with jurisdiction over both counties of Greater London and the City of London.
GUC	Grand Union Canal – a canal linking London to Birmingham.
HDZ	Hydraulic Demand Zone – zone characterised by having discrete supply and storage arrangements with strategic inter zone transfers.
HRA	Habitats Regulations Assessment – an assessment of the effect of a plan or project on a protected European site carried out under the Conservation of Habitats and Species Regulations 2017.
HS2	High Speed 2 – a high speed railway connecting London to Birmingham, the East Midlands, Leeds and Manchester that is currently under construction within parts of the Affinity Water supply area
INNS	Invasive Non-Native Species – a species that does not occur naturally in an area and that becomes so abundant that is damages biodiversity and often causes substantial economic or health problems.
l/h/d	Litres per head per day – a unit of measurement detailing in litres how much water each customer uses each day
LoS	Levels of Service – a measure of the likelihood of applying restrictions on customers during drought conditions or taking additional measures such as increasing abstraction from a particular source or reducing augmentation. They set out how

	often on average we expect that we will need to take a specified step in response to a drought
MCA	Multi-criteria analysis – using multiple criteria to assess key risks.
Ml/d	Mega litres per day – one million litres per day. Just under half the volume of an Olympic swimming pool.
MLR	Multi-linear Regression – most common form of linear regression analysis. Used to explain the relationship between one continuous dependent variable and two or more independent variables.
NERC Act	Natural Environment and Rural Communities Act 2006.
NIC	National Infrastructure Commission – non-ministerial government department responsible for providing expert advice to HM Government on the pressing infrastructure challenges facing the UK
NGO	Non-Governmental Organisation – a non-profit organisation that operates independently of government, typically one whose purpose is to address a social or political issue.
NYAA	Normal Year Annual Average - the annual average value of demand, deployable output or other parameter over the course of a normal year.
OBHs	Observation boreholes – a borehole drilled to monitor groundwater levels
Ofwat	The Water Services Regulation Authority, or Ofwat, is the body responsible for economic regulation of the privatised water and sewerage industry in England and Wales.
Opex	Operational Expenditure – money that is used to fund the day to day operation of the water company.
PCC	Per Capita Consumption – the volume of water consumed per household customer per day.
PDO	Peak Deployable Output – the maximum output of a commissioned source under periods of peak (summer) demand.
PHC	Per Household Consumption – the water consumption that is consumed by a household in one day.
RBD	River Basin District – means the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is the main unit for management of river basins under the Water Framework Directive.
RBMP	River Basin Management Plans – a plan produced for a river basin district under the Water Framework Directive setting out information about water bodies within that river basin district, their environmental objectives and measures to be taken to achieve those environmental objectives.

SACs	Special Area of Conservation – area of land designated under the Habitats Directive (Directive 92/43/EEC) to protect habitats and species considered to be European interest.
SEA	Strategic Environmental Assessment – an assessment of the environmental impacts of certain plans and programmes likely to have significant effects on the environment carried out under the Environmental Assessment of Plans and Programmes Regulations 2004.
SIC	Standard Industrial Classification – a system for classifying the nature of a company's business by a four-digit code used by government agencies.
SoR	Statement of Response – a document explaining how we have considered representations on our draft WRMP prepared under the Water Resources Management Plan Regulations 2007.
SPA	Special Protection Area – a designation under the European Union Directive on the Conservation of Wild Birds (Directive 2009/147/EC).
SPL	Supply Pipe Leakage – leakage from pipes that customers are responsible for.
SSSI	Site of Special Scientific Interest – an area of land designated under the Wildlife and Countryside Act 1981 as being of special interest by reason of its flora, fauna or geological or physiographical features.
THR	Target Headroom – the minimum buffer to cater for supply-side and demand-side uncertainties in the overall supply demand balance
TRACE	Track down Reliability Availability Cause and Effect – an outage recording system used at Affinity Water
TUB	Temporary Use Ban – demand management action which temporarily restricts non-essential use of water by customers during a drought (formerly a 'hosepipe ban')
UKWIR	UK Water Industry Research – UKWIR was set up by the UK water industry in 1993 to provide a framework for the procurement of a common research programme for UK water operators.
WAFU	Water Available for Use – the total volume of all the water that we are able to produce and make available to supply customers the water that is available for supply within each WRZ. It is equal to the DO, minus outage, minus treatment losses plus or minus the net imports and exports from the WRZ.
WATCOM	Water Consumption Monitor – our stratified sample of unmeasured households established in 1997 and since used to assess unmeasured household consumption.
WFD	Water Framework Directive – European Union Directive 2000/60/EC, which establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater.
WINEP	Water Industry National Environment Programme – a programme of investigations and actions for environmental improvement schemes.

WISER	Water Industry Strategic Environmental Requirements – a document published by the Environment Agency and Natural England which provides a strategic steer to water companies on the environment, resilience and flood risk for business planning purposes.
WRMP	Water Resources Management Plan – a plan prepared by a water company under Section 37A to Section 37D of the Water Industry Act 1991 setting out how the water undertaker will manage and develop water resources so as to be able, and continue to be able, to meet its obligations under Part III of the Water Industry Act 1991.
WRPG	Water Resources Planning Guideline - Interim Update (July 2018) published by the Environment Agency. It is designed to help water companies prepare their WRMP in accordance with relevant statutory requirements and, where appropriate, government policy.
WRE	Water Resources East – a multi sector regional planning group. WRE brings together regulators, companies, retailers and individuals in the water, agriculture power and environmental sector to develop an affordable, sustainable and resilient regional approach to water resource management.
WRP Tables	The water resources planning tables forming part of this rdWRMP containing the information required by the WRPG.
WRSE	Water Resources South East – an alliance of the six south east water companies, the EA, Ofwat, Consumer Council for Water, Natural England and Defra, to develop long term plans for securing water supplies in the south east.
WRAS	Water Regulations Advisory Scheme – The scheme is operated by UK water suppliers to contribute to the protection of public health by preventing contamination of public water supplies and encouraging the efficient use of water by promoting and facilitating compliance with the Water Supply (Water Fittings) Regulations 1999.
WRZ	Water Resource Zone – the largest possible zone in which all water resources, including external transfers, can be shared and hence an area in which all customers will experience the same risk of supply failure from a water resource shortfall.
WSP	Water Saving Programme – our programme of work to reduce household consumption. It includes switching customers from unmeasured charges to metered charges (compulsory metering), home water efficiency checks and the provision of water savings devices and educational materials.
WTW	Water Treatment Works – facilities belonging to a water company that treat water to prescribed standards for drinking water.