Final water resources management plan

Wessex Water

August 2019

Wessex Water
YTL GROUP

Summary

Ours is a position of great responsibility – we are entrusted with providing services that are essential to life and to the health of the local economy. It is our job to ensure that these services are resilient in the face of major social, political, economic and environmental changes such as climate change.

Our water resources management plan describes how we expect to balance the demand for water from our customers with available supplies and protect the environment over the next 25 years.

We consulted on the draft of this plan for 12 weeks between March and June 2018 and have prepared a statement of response report documenting all the representations made by stakeholders and our responses to them. We have made changes to our plan where appropriate and these are highlighted in this updated version.

Overview of this plan

Our last water resources management plan was published in 2014 and projected a surplus of supplies over demands for the full planning period. This updated plan similarly forecasts that, given the investments we have already made, we have access to enough water to meet the needs of our customers for at least the next 25 years without the need to develop new sources of water.

Nonetheless, we don't intend to stand still and are taking forward ambitious proposals to work with our customers and local communities so that together we can reduce the water we take from the environment, improve the resilience of our services and potentially support areas of the country where water scarcity is a growing problem.

We will also continue to work with partners at a catchment level to help safeguard the resilience of the ecosystems that provide us with our raw water supplies. This plan is fully integrated with our long-term drinking water quality and asset maintenance programmes.

About Wessex Water

Wessex Water is recognised as a leading water and sewerage company for customer service and environmental performance, but we intend to continue to be ambitious.

We have halved the leakage of water from our network, reduced abstractions to improve the flow in rivers and have not imposed a hosepipe ban since 1976.

Our customers are at the heart of everything we do and we aim to provide an exceptional service experience that is inclusive and accessible to all. We're one of only 10 companies in the UK to achieve the Institute of Customer Service's ServiceMark with distinction, the highest level of accreditation available to its 500-plus members.

We supply around 340 million litres of water a day to 1.3 million people and nearly 50,000 businesses via water retailers operating in the non-household market with high quality drinking water. Water is a basic requirement for life and our customers rely on us to provide a reliable wholesome supply for daily habits as simple as making a cup of tea and flushing the toilet.

To provide our services we use more than 70 sources and water treatment works and 11,800 km of water mains. But these assets are only part of our local water system – the water catchments that we operate within and the communities that we serve are of vital importance to the overall sustainability of our water services and the wider water environment.

We are committed to playing our part in protecting the wide range of special landscapes and habitats in our region. We want to continue developing partnerships with communities to help customers to enjoy and participate in the services we provide and the local water environment on which those services depend.

The investments that we have made in network infrastructure, source protection and promoting efficient water use has created a very resilient water supply system. Households and businesses in the Wessex Water region have enjoyed supplies without restriction (such as a hosepipe ban) for over 40 years.

Our services are resilient to a repeat of any of the drought events experienced in the last 100 years without the need to require customers to restrict their use. Therefore we would not expect to impose temporary use restrictions (hosepipe bans) more than once every 100 years on average. Similarly, we would not expect to impose non-essential use bans for commercial customers more than once in every 150 years on average.

This level of drought resilience is amongst the highest for all water companies in the UK and research with customers indicates they find it acceptable.

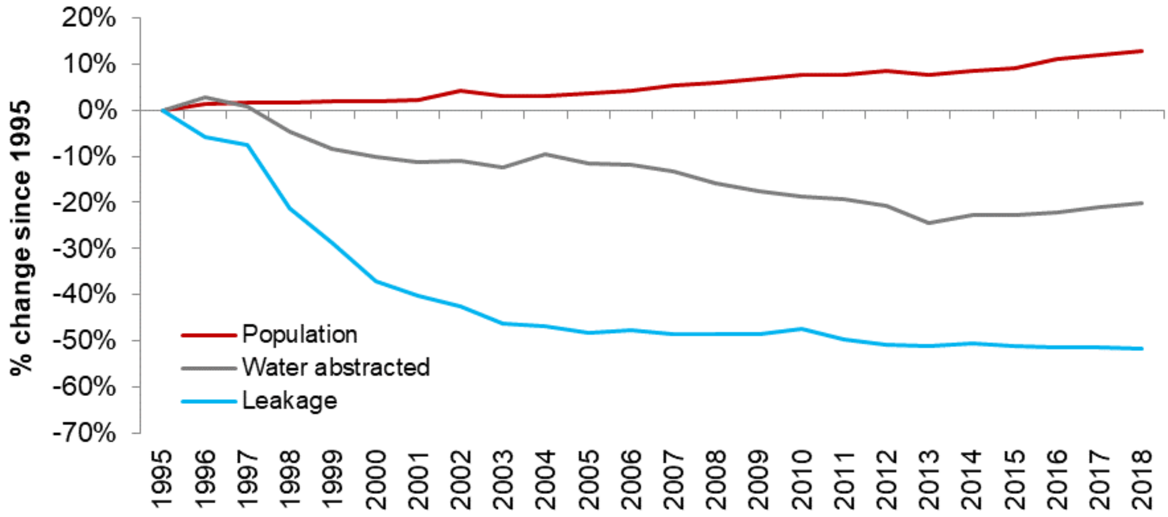
We are a long-term business and look to the future. We have good historical weather records in our region for the past 100 years. We have used these records to estimate the magnitude of more severe droughts that might happen only once in 200 years – our modelling shows that we would not need to restrict essential water use (i.e. implement rota cuts) at such times.

Challenges and our story so far

The Wessex Water region has faced above average population growth, deteriorating raw water quality and the need to reduce significantly abstraction licences to protect river flows. Our response has been timely investments in:

- developing a more **integrated supply network** including our water supply grid project
- **leakage reduction** of 50%; the industry average reduction has been around only 40%
- source protection through **catchment management** and developing strong partnerships with others who have an impact on the water environment
- supporting customers to **manage household demand** by promoting **metering** and **water efficiency** through behavioural engagement

This strategy has developed a robust water supply system that has supported environmental improvements and enhanced both operational and drought resilience.



What is a Water Resources Management Plan?

Water resources management plans set out how we will meet demand and protect the environment over the next 25 years. We prepare an updated plan every five years that is reviewed by our regulators, the Environment Agency, Ofwat and Defra. We also actively encourage other stakeholders to tell us what they think of our proposals.

The water resources planning process is based around a calculation of the balance between supply and demand. This is undertaken following technical analysis methods as set out in guidelines published by our regulators.

We prepare forecasts of demand taking account of population growth, property building, customer water use behaviours, industrial needs and leakage. At the same time we develop a forecast of supplies making an assessment of the impacts of climate change, the likely availability of our water sources and any abstraction licence changes that we need to make to protect the environment and improve river flows.

A headroom allowance is made for uncertainties in the forecasts and we then calculate whether enough water is available for each year of the 25 year planning period. If deficits are forecast to occur at any time then it is necessary to appraise a range of options to either manage demand down or increase available supplies and select the most appropriate measure(s) to restore the balance.

If the system is forecast to be in surplus through the planning period then no further action is required. Nonetheless we can choose to take forward new schemes to meet wider objectives related to government policy, customer preferences and/or environmental benefits.

This water resources management plan has not been produced in isolation. It is aligned with our drought plan that sets out our operational response to periods of dry weather and forms an important part of our wider business plan since it identifies water resource and demand management investments. The business plan that we will submit to our economic regulator, Ofwat, in September 2018 for the price control (customer bill setting) process will be consistent with this plan.

Water supplies

All of the water that we supply to customers comes from the local environment. Approximately 75% comes from boreholes and springs that tap into the chalk and limestone aquifers of Wiltshire and Dorset and 25% from reservoirs in Somerset. We take our responsibility to minimise the impact of abstraction very seriously. Ensuring abstraction licences are set at sustainable levels is critical to the overall viability of this water resources management plan and our wider business operations.

Over the past 20 years we have worked in partnership with the Environment Agency and others to investigate sources where there are concerns that the volume of water we are licensed to take has unacceptable impacts on local watercourses, groundwater levels and the wildlife that they support. Some investigations have led to reductions in the licensed volumes or other mitigation measures being made to ensure precious habitats in our region are protected. Most recently the 23.5 Ml/d reductions for the River Wylye and River Bourne tributaries of the Hampshire Avon chalk stream catchment that were made possible by the eight-year, £230m investment in our water supply grid project. This scheme, first proposed in our 2009 Water Resources Management Plan, will be fully complete in 2018. It delivers environmental improvements and enhances resilience for our customers without the need to develop new sources.

We recognise that ensuring the sustainability of abstraction licences is an ongoing process particularly to ensure compliance with the Water Framework Directive. A new group of 18 investigations will be undertaken in 2020-25 in accordance with the Environment Agency's Natural Environment Programme for the water industry.

Where the impacts of abstraction on the environment are uncertain and formal licence changes are not required but concerns exist within the local community, we are keen to explore innovative ways to reduce abstraction when possible. The Abstraction Incentive Mechanism (AIM) at our Mere source is an example of this. In 2013 we began working with the Environment Agency and the local community to reduce abstraction when groundwater levels fell below a threshold. Since this work began we've reduced the volume of water abstracted to export from the local catchment by around 60%. We plan to continue with the AIM scheme at Mere and are introducing a new AIM commitment to reduce abstraction from our Stubhampton source from 2020.

We were one of the first companies to pioneer the catchment management approach to protect our sources of water. Since 2005 we have been collaborating with farmers and land managers to reduce the application of nitrate fertilisers and pesticides in the catchments surrounding some of our water sources. These schemes better protect raw water quality without the need to install expensive treatment solutions. At several sources we are seeing the benefits of this work resulting in fewer periods of outage due to raw water quality deterioration. However, at three sites, despite working with farmers for ten years, we have not seen any reduction in the concentration of nitrates, which now threatens to breach the standard in drinking water. Our proposed solution is blending of the high nitrate water with low nitrate water from neighbouring sources. We do not see this as a failure of our overall catchment based approach, but rather the result of trying an innovative approach.

With regard to the pesticide metaldehyde, which is the active ingredient of the most common forms of slug pellets and not readily removed by conventional water treatment processes, our catchment management activities have successfully mitigated the risk of exceedances in the catchments of four surface water reservoirs. We are currently trialling EnTrade, a market-based tool to incentivise changes in farming practice, in a smaller catchment, with a view to applying this approach in the Tone catchment in the 2020-25 period.

This plan is fully integrated with our drinking water quality and asset maintenance programmes to ensure that our statutory drinking water quality obligations, regulated by the Drinking Water Inspectorate, are taken into account in the long-term planning of water resources. It is also consistent with our asset maintenance programme, for which one of the key planning objectives is maintaining capacity. We have a long term programme of strategic maintenance for our largest sources and water treatment works.

The efficient use of water

Wessex Water customers currently use an average of 131 litres of water every day which recent data suggests is one of the lowest averages by water company area in the country. Many people use less than this and typical usage in other European countries is often lower too suggesting more can be done to reduce per capita consumption.

We have a proven track record of successfully delivering programmes that support reductions in household water use and recognise the encouragement that industry regulators are giving water companies to further increase customer participation in water services.

We want to accelerate our work with customers on water efficiency and metering to reverse the recent rising trend in average use per person per day in our area and reduce it by 3 litres by 2025 (to 127 litres) and by a further 3 litres (to just over 124 litres) by 2045. These reductions mean we will abstract less and leave more water in the environment. This will help counteract demands from a growing population and the continued reduction in average household size which tends to increase the amount of water used per person.

It is well understood that households with a meter tend to use less water than those without. Our own 6,000 household tariff and metering study shone a light on how metering particularly reduces water wastage – customers that pay for the volume they use are more likely to fix dripping taps and leaky toilets and adopt water saving behaviours. We are mindful however that no-one should have to ration their water-use for affordability issues, so we have also been continuing to develop our industry leading assistance programmes for those who struggle to pay, and expect to extend our social tariffs to assist a further 50,000 low income households by 2025.

We included a change of occupier policy in our last water resources management plan. Since then we have also enriched our promotion of optional metering involving targeted mailshots and social media campaigns that make use of behavioural techniques to encourage take up. Having a meter is the new norm for Wessex Water customers; over two-thirds of households pay for water services based on the volume of water they use, compared to an average of 55% in the rest of the industry.

Our last water resources management plan set out proposals for our flagship Home Check water efficiency service. During a 45-minute home visit, Water Safe qualified plumbers fit water saving devices, such as eco-showerheads, repair easy to fix plumbing leaks and offer personalised behavioural advice at no charge to the customer. Each visit leads to savings of over 40 litres per household per day and has been very well received by customers. By 2020 we will have delivered the service to 20,000 homes in communities across our region.

Owing to the success of the current Home Check programme we plan to expand the service to reach more customers and particularly those for whom the affordability of their water bill is a key concern. In the 2020 to 2025 period we will deliver the service to a further 40,000 customers.

Digital engagement is growing in its reach and importance to us and our customers. We are currently enhancing our online services to help customers better understand their water use and to encourage repeat participation. Regularly engaging with customers will enable us to offer bespoke behavioural advice and offers for water saving devices of particular relevance to their household. Our digital services will enable customers to compare their usage with other similar households in their community – a well-recognised approach to support behavioural changes that lead to real reductions in consumption.

Experience from our smart meter trials suggests that personalised online water use engagement through social norming and self-reported water use habits may deliver comparable water savings to smart metering programmes. It is only by helping customers to understand their water use in terms of specific practices that we can help guide them to make choices to reduce their use. While high resolution smart metering data is useful for this purpose, it is customer engagement that will lead to real water savings; more data does not mean more impact.

Smarter forms of metering will undoubtedly feature in our future strategy but at the present time, with a surplus of water resources over water demands the benefits do not outweigh the costs. As technology improves, costs come down and the water resource situation across the UK evolves we anticipate a transition towards smarter metering in the next 10 years, and we will ensure that we learn from the experience of others as we develop our approach.

In combination, our water efficiency and metering programmes will ensure that by 2025 over 7 Ml/d of water will stay in the environment and not be needed to meet customer demand, by 2045 this saving will have reached 16 Ml/d.

Tackling leakage

By 2025 we will have reduced leakage by 62% from our 1995 level. This is a greater proportion than any company has achieved up to now.

With around 12,000 km of water mains and 600,000 service pipes we have 8,000,000 pipework joints, so it's inevitable that leaks will occur. But our management and investment strategy ensures we respond rapidly and that we are always driving down overall leakage.

We currently spend £16m a year on managing and reducing leakage and a further £12m each year replacing older water mains.

Every year we mend around 12,000 leaks – our leakage detection team are a highly skilled workforce that utilise a range of modern technologies and analysis methods to accurately identify leaks and schedule prompt repairs.

Leakage is an important issue for customers and we welcome the recognition from so many that they can participate in helping us to tackle leakage by reporting leaks that they spot to us. We fix over 75% of these customer reported leaks within one day and are targeting 90% by 2025.

Our current level of leakage is significantly below the 'sustainable economic level of leakage' meaning that reducing leakage further will cost more than the cost of producing the water. This, in part, due to our surplus situation.

We welcome the regulatory appetite for setting stretching performance commitments for leakage, providing these are: aligned with customer preferences; take account of the savings already delivered by current available technologies; and complement strategies to help customers reduce demand.

We undertook in-depth research with our customers in June 2017 on the core issue of leakage and efficient water-use, and found that:

- leakage has no direct negative impact on customers. Many could not recall ever having seen a leak and most have higher water priorities than leakage
- there is little appetite to see us invest to bring about further reductions in leakage over the next five years if this means that bills will rise for little overall leak reduction
- most customers are keen to see modest investments in innovation to help bring down leakage in the longer term
- there is interest in investment in education services with children and collaboration with customers to fix plumbing leaks in homes and improve awareness of water efficiency. Many customers recognise the role they can play in helping to manage the amount of water we take from the environment.

Our quantitative research techniques however suggested that there is customer willingness to pay for leakage reduction with a 15% reduction close to being cost beneficial.

Government and regulators (Defra, Ofwat and the EA) have since set an expectation that companies will reduce leakage by 15% by 2025 and continue to reduce leakage thereafter. In 2018 we have undertaken further research to gauge our customers' priorities. We found that, once leakage was set in the context of all the other service improvements we were proposing and the overall bill impact, customers accepted paying for further leakage reductions.

While we are ourselves in a surplus position for water resources it is clear from recently published Water Resources Management Plans that neighbouring companies would value this water more highly. Continued leakage reduction should enable greater resource to be traded with these companies in future, and this could help reduce bills for our own customers, further improving the cost-benefit ratio.

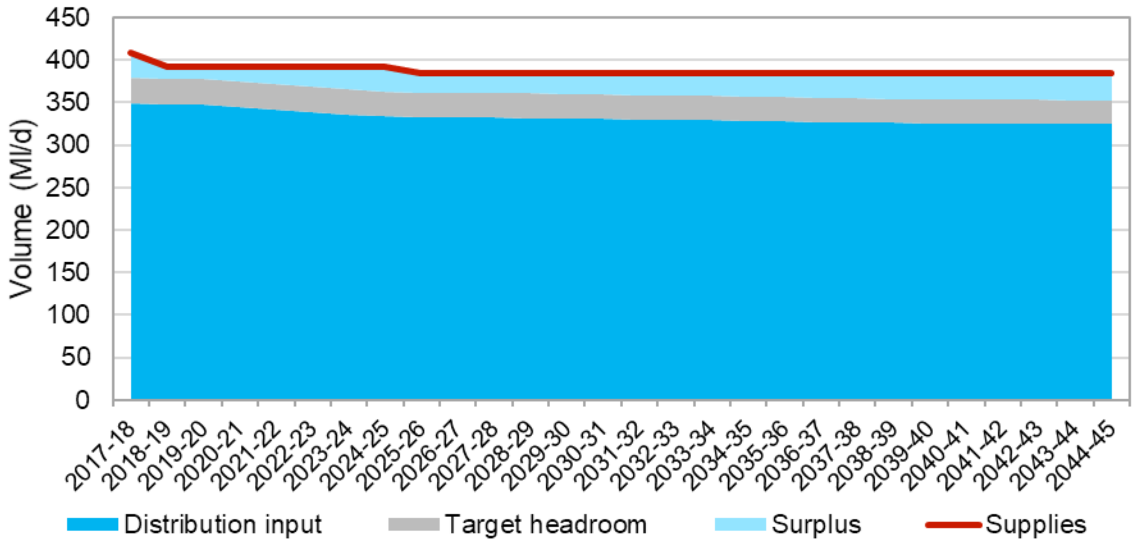
Taking all of this into account we will therefore reduce leakage by 15% by 2025.
This will require a step change in our activities, as well as innovation and continued customer support and engagement. Our proposals include:

- reducing losses from our distribution network through additional active leakage control, improved data collection and analytics, further sub-division of district meter areas, innovative pressure management
- reducing losses from customers' pipes through our enhanced metering programme as it is easier to identify leaks on properties that are metered
- promoting ways in which customers can contact us to report a leak via our leak stoppers telephone hotline or our website.

We expect to reduce leakage by a further 14% by 2045. We will continue to innovate and optimise our working practices.

<u>The balance between supply and demand</u>

Bringing together all the detailed information, relating to the many component parts of the supply, demand and headroom forecasts, predicts that we will have a surplus starting at 15 Ml/d in 2020 rising to 32 Ml/d by 2045.



Our forecasts include projected rates of housebuilding that take account of Local Authority plans (nearly 5,000 new homes a year), a population growth rate of 0.5% per annum and an allowance for the potential impacts of climate change. Our plan is 'water neutral' – it ensures that we will continue the downward trend in the amount of water we abstract despite growth in our area.

Supporting areas where water resources are more scarce

Investments in our network and continued demand management and engagement with customers has helped us develop a very resilient water supply system and a water surplus.

Not all areas of the UK experience the same level of water security. Both Water UK and the National Infrastructure Commission have identified that drought resilience may become an even more important issue for the water industry in the future and recommend the exploration of new water trading arrangements in combination with demand management schemes and new supply developments.

Our integrated supply grid gives us the opportunity to propose transfers of water into neighbouring areas where water is scarcer.

In 2017 we became a founding member of the West Country Water Resources Group that seeks to undertake regional water resource planning to identify optimum solutions for the region and, in particular, explore new trading opportunities. Potential new or revised transfers include transfers to:

- Southern Water: to partially address their deficits due to sustainability reductions.
- Bristol Water: for improved resilience.

We've already embraced an opportunity to enhance our resilience through a cross-border transfer arrangement in the south of our region near Poole. The arrangement provides resilience benefits to Wessex Water and South West Water (Bournemouth area) by maximising the use of existing assets.

Our work in the next period as part of the West Country Water Resources Group will see us continue the regional analysis of water resources planning and exploration of cross-sector solutions, including new trading opportunities, and region wide optimisation, to develop a regional plan, that will inform the development of our Water Resources Management Plan for 2024. This work will also include widening the group membership to non-water company sectors and helping the publication of information to promote future water markets.

Conclusions

This plan will ensure that a surplus of resources over demand will be maintained for at least the next 25 years whilst ensuring the environment is protected.

Our planned demand management measures will ensure the efficient use of water going forward and that the amount of water taken from the environment is minimised.

Customers are at the heart of this plan and their views and aspirations have been embedded into our plans for enhanced metering and water efficiency services that will see average per capita consumption fall and a leakage strategy that will continue to deliver reductions in a way that is affordable.

We are actively exploring new trading opportunities to support parts of the country where water scarcity is more of an issue than it is in our region.

Contacting us

If you would like to discuss any specific water resources planning questions please contact us at: water.resources@wessexwater.co.uk

For further details please visit our website www.wessexwater.co.uk/waterplan where the full water resources management plan is available to download.

Commercial confidentiality
In the publication of this Plan we are required to exclude any matters of commercial confidentiality and any material contrary to the interests of national security. Our Plan does not contain any information that is commercially confidential. In the version of the Plan we are publishing on our website we have excluded some of the technical appendices relating to the location of key assets on the advice of our certifier for emergency planning in the interests of national security.

Contents

See Annex L for a full reference list; documents highlighted in bold in the reference list are available as appendices to this plan.

1 Introduction

1.1 What is a WRMP and regulatory planning requirements

The aim of a Water Resources Management Plan (WRMP) is to set out how we as a water company will maintain a balance between the demand for water and the supply of water whilst protecting the environment for the next 25 years.

Water companies have a statutory duty to prepare an updated Plan every five years. Plans are submitted to Defra and reviewed by our regulators, the Environment Agency and Ofwat, and are also subject to public consultation. The Plan is also a key component of our Business Plan for the regulatory price review as it identifies water resources investment needs.

The water resources planning process is based around a calculation of the balance between supply and demand.

We prepare forecasts of demand taking account of population growth, property building, customer water use behaviours, industrial needs and leakage. At the same time we develop a forecast of supplies, making an assessment of the impacts of climate change, infrastructure constraints and abstraction licence changes required to protect the environment and improve river flows.

A headroom allowance is made for uncertainties in the forecasts and we then calculate whether enough water is available each year for at least the next 25 years. If deficits are forecast to occur at any time then it is necessary to appraise a range of options to either manage demand down or increase available supplies and select the most appropriate measure(s) to restore the balance.

If the system is forecast to be in surplus through the planning period then no further action is required. Nonetheless we can choose to take forward new schemes to meet wider objectives related to government policy, customer preferences and/or environmental benefits.

The legislation that sets out the requirement for water companies to prepare and maintain a Water Resources Management Plan is contained in Section 37 A to D of the Water Industry Act 1991, as amended by Section 62 of the Water Act 2003.

This plan has been produced in accordance with the following primary guidelines:

- Defra (2016) guiding Principles for Water Resources Planning
- Water Resources Planning Guidelines, issued by the Environment Agency (last interim update July 2018), which have been produced in collaboration with Defra, The Welsh Government, and Ofwat.
- The Water Resources Management Plan (England) Direction 2017.
- Additional supplementary guidelines issued by the EA.
- UKWIR WRMP 2019 Methods – Decision Making Process: Guidance
- UKWIR (2016) WRMP19 Methods – Risk Based Planning.

The development of this Plan has also been undertaken with reference to the Water Resources Management Plan Regulations 2007, the Water Resources Management Plan Direction 2012, and additional UKWIR reports, as referenced to by the Environment Agency's Water Resources Planning Guidelines.

Our compliance with each requirement of the Water Resources Management Plan Direction 2017 is provided in Annex G.

To support the Water Resource Planning Guidelines the Environment Agency collated the requirements of the Guidelines into a single 'checklist' of 269 items. We have completed this checklist to demonstrate our compliance with the guidelines and have included it in Annex H.

1.2 Links with other plans

This water resources management plan has not been produced in isolation – its development is fully integrated with both the company's **strategic direction statement**[1] that documents our 25-year vision and the development of our **business plan** for the 2019 price review including the new water resources price control.

Drought plan

This water resources management plan is complemented by our drought plan. A water resources management plan is a strategic plan that considers a long-term timeframe whereas a drought plan is a short to medium-term plan that sets out the actions we would take before, during and after a drought if one were to occur under present circumstances.

Our drought plan was submitted for public consultation in spring 2017, and has fed directly into the production of this plan, primarily through the evaluation of the performance our supply system to a range of drought events, both observed historical events, and events more severe than those that have occurred in the last 100 years (see Section 10.1).

Links with plans produced by others

This Plan has also been influenced by plans produced by others including River Basin Management Plans, with particular regard to sustainable abstraction licencing (Section 4.4), and local plans produced by Local Authorities with particular regard to housebuilding rates over the planning period (Section 5.3).

Another influence on the development of this Plan has been the strategy and vision for the water environment and associated services as set out by Government, regulators and other organisations – see Section 9.3 for further details.

1.3 Assurance

The Wessex Water Board has approved the submission of this plan including the analysis of a supply demand surplus. It confirms that it supports the proposals contained in this Water

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Resources Management Plan and that these are in line with its strategic approach to delivering resilient water services in the long term.

We commissioned a specialist consultant to undertake peer review of the development and testing of drought scenarios (Section 3.2) – this element of the plan includes the application of new methods that we had not implemented in previous plans and so warranted additional expert scrutiny.

During pre-consultation, we discussed the methodological approaches for key elements of the Plan with the Environment Agency. Our Auditors, Mott MacDonald, also undertook an assurance review that this Plan meets the requirements of the regulatory guidelines.

1.4 Structure of this document

This Plan is divided into sections as below:

- Section 1 (this section) introduces the context of water resources planning and the regulatory requirements.
- Section 2 discusses the customer research and consultation of the plan.
- Section 3 describes the water supply system that comprises not only the network of sources and pipes but also the communities we serve and the wider environment and catchments. This section also documents the approach we've taken to develop this plan to ensure our methods are proportionate to the risks we face.
- Section 4 explains the development of our supply forecast including the analysis of sources yields, deployable output modelling, climate change impact assessment and source outage analysis.
- Section 5 outlines the development of our demand forecast including the assessment of appropriate population and property growth rates, household water consumption, commercial demand analysis and leakage projections.
- Section 6 outlines our assessment of an appropriate headroom allowance to account for the uncertainties in our supply and demand forecasts.
- Section 7 reviews the baseline balance between supply and demand.
- Section 8 documents how we have assessed the resilience of our system and this plan.
- Section 9 examines options and proposed investments in light of the baseline supply demand balance and in particular reviews metering, water efficiency and leakage options.
- Section 10 explains how we have examined various scenarios to stress-test and explore the sensitives of our forecasts and the impact on the supply demand balance.
- Section 11 presents the final planning supply demand balance including the selected options and reviews the need for a Strategic Environmental Assessment.
- Section 12 concludes the Plan and looks ahead to the development of the next plan in 2024.
- Sections 13 – 24 contain annexes that support this Plan.

2 Customer research and consultation

2.1 Pre-consultation with regulators and stakeholders

Pre-consultation of this Plan was undertaken between April 2016 and November 2017. During this time we engaged with regulators and other stakeholders to discuss the overall planning process, analysis methods, forecasting methods, initial outputs and the key emerging issues for the draft Plan.

In December 2016 we wrote to our regulators, statutory consultees, and wide range of stakeholder groups to inform them of our development of this plan, and invited them to comment on any changes they would like to see to our existing plan or additional issues they would like us to consider in the development of the new draft Plan. Annex J documents the organisations we contacted, a summary of the comments received, and where they have been addressed in this plan.

2.1.1 Statutory pre-consultation

In December 2016 we wrote to Defra by email to let them know that we were undertaking pre-consultation on our draft Water Resources Management Plan.

Environment Agency

We have a positive working relationship with regional and national Environment Agency staff. We regularly discuss a variety of water resources issues. Extensive liaison has occurred with Environment Agency staff during the pre-consultation period, on both the development of this plan, and in the development of our drought plan. We held pre-consultation meetings on 11 April, 13 June, 15 July, 18 October, 19 December 2016, 20 January, 13 June, 25 August, 29 September, and 19 October 2017. During these meetings, we presented and discussed the issues set out as method discussion topics by the EA. Annex H details the topics discussed during these meetings, and comments received on the methods applied in this plan.

Ofwat

We met with Ofwat in July 2017 to present an overview of our approach to developing this this plan following the requirements set out in the briefing pack provided to us. A representative from the Environment Agency for comment. Following the meeting we shared further clarifying information on our problem characterisation, residual risk areas, and identification of feasible options.

Drinking Water Inspectorate

In February 2017, during a regular liaison meeting with the Drinking Water Inspectorate (DWI), we presented our approach for developing this plan – we have taken the DWIs guidance on accounting for water quality in long term water resources planning into account in the development of this plan – see Section 4.5.

2.1.2 Neighbouring water companies

In December 2016 we wrote to our neighbouring water companies (Thames Water, Southern Water, South West Water and Bristol Water) by email to start pre-consultation on our draft Water Resources Management Plan.

We have been in regular contact with Bristol Water, Southern Water and Thames Water during the pre-consultation period to discuss the need and potential for bulk supply transfers, which are considered more fully in Section 10.2.4.

We are a participant in the recently formed West Country Water Resources Group comprising water companies and the Environment Agency. The group was formed in 2017 to discuss common water resource issues and explore future opportunities to ensure the best use of resources both within our region and out of region by transfer to other companies. Two meetings have been held during pre-consultation in August and October.

The group aims to develop a shared understanding of:

- the current and future availability of water resources for each water company
- options available for resource development in each water company area including any related environmental issues (i.e. Water Framework Directive no-deterioration and invasive non-native species).
- potential options available for future water transfers/trades

2.2 Customer research that has informed this plan

Understanding our customers and their priorities for our business, the wider water environment and our local community is a core activity for us, not just in the preparation of strategic plans like this one but also as part of our day-to-day activities.

To help inform the development of this Water Resources Management Plan (and also the company's 25-year strategic vision and the 5-year investment plan) the following core research areas have been used:

- Our strategic direction statement research
- Our young people's panel
- Our willingness to pay research
- Our bespoke research on resilience
- Our bespoke research on leakage
- Our business plan game
- Our continuous engagement feedback
- Our overall business plan acceptability testing

The sections that follow briefly summarise the objectives, timing and methods used while Section 9 presents findings from these research areas that specifically influenced the selection of options for our final plan.

Strategic direction statement research

Objectives: To canvas the views of domestic and non-domestic customers, staff and stakeholders at the outset of business planning cycle:

- To take a temperature check of both economic confidence and current expectations of service providers
- To check and challenge Wessex Water's long term vision, as set out in its strategic direction statement, The Way Ahead 2015-40

Timing**:** March – April 2016 (qualitative), May – July 2016 (quantitative).

Method**:** Qualitative and quantitative, carried out by consultants Blue Marble.

The qualitative phase comprised:

- 3 x 3 hour deliberative events with **household customers**
- 4 x 1.5 hour group discussions with **future customers** aged 20-29
- 4 x group discussions and 10 depth interviews with **non-household customers**
- meetings plus 8 x 45 minute telephone depth interviews with **stakeholders** (Wessex Water Partnership and Catchment Panel members[2])
- 5 x group discussions with Wessex Water **staff** (Bath, Nailsea, Yeovil).

The quantitative phase comprised 5,692 completed interviews:

- 600 ad-hoc telephone interviews amongst a representative sample of Wessex Water bill payers
- 250 telephone interviews using the flexi-section of the Wessex Water Tracking survey (representative sample of Wessex Water bill payers)
- 1,350 postal responses from a survey included in the Wessex Water magazine
- 1,092 online responses from the Wessex Water magazine survey
- 2 separate surveys using the Wessex Water online panel (894 completes in May, 769 completes in June)
- 737 online surveys from staff.

Leakage

Objectives:

- To explore attitudes towards leakage, both top of mind and after deliberation

[2] The Wessex Water Partnership monitors and reports on Wessex Water's delivery of our current investment programme against its outcomes and performance commitments. It also provides advice and challenge on policy areas such as customer engagement, customer service, affordability, tariffs and the company's preparation for the next price review. It is independently chaired and members of the panel include representatives from the Environment Agency and Consumer Council for Water.

The Catchment Panel meets quarterly to review and challenge Wessex Water on environmental performance and progress towards delivery of our current environmental programme against outcomes and performance commitments. It also provides advice and challenge on policy areas and the company's preparation for the next price review. Members of the panel include representatives from the Environment Agency, Natural England, the National Farmers Union, RSPB, WWF-UK and academia.

- To co-create revised performance commitments and promises that are acceptable to customers (e.g. investing in R&D to find better ways to fix leaks, reducing leakage or maintaining it at a steady level, committing to fix leaks within 24-hours)
- To co-create communications about leakage, to use when describing the issue to less well informed customers. To include appropriate use of language (e.g. "leakage" or "non-revenue losses"?), comparative information, and overall messaging.

Timing: May- August 2017

Method:

- Research workshops designed and facilitated by Populus; all stimulus material developed for use at workshops was reviewed by the Wessex Water Partnership
- Two stage deliberative workshops using co-creation with 24 customers, Wessex Water staff involved in both workshops
- The first workshop involved briefing customers on key leakage subject areas and discussing specific aspects
- The second workshop involved co-creation by customers of leakage performance promises and communications.

The promises and communications generated by the co-creation process were then tested with:

- 8 depth interviews with seldom heard customers
- 8 non household interviews
- 20 short hall test "pop up" interviews with customers.

<u>Resilience</u>

Objectives:

- To explore what type and level of events/scenarios they expect Wessex Water services should work to be resilient to, both now and 10-15 years in the future (e.g. flood, drought, cyber-crime),
- To understand what customers think is acceptable resilience planning across different risk scenarios
- Explore customer preparedness to pay for resilience activities
- To gain insights into what language is best to use to communicate the concept of resilience to our customers.

Timing: February – April 2017

Method:

- Research workshops designed and facilitated by Blue Marble
- 6 x 1 hour friendship paired in depth interviews using a 'Listening Project' approach, i.e. friends discussing future scenarios in private conversation, observed through a two way mirror

- Film to introduce the topic: expert voices including customers, Wessex Water staff and stakeholders. Extensive stimulus development using four areas (supply interruptions, water restrictions, environmental damage, sewer flooding) with context boards and different future scenarios with investment choices
- 4 x 3 hour deliberative events held in community venues (20 participants in each)
- 2 x 2 hour groups with economically vulnerable customers.

Young people's panel

Objectives: to gain insight from future bill payers in an engaging way that is meaningful to this audience. To test service expectations from this generation and gain insight into emerging research issues. Wessex Water was the first company to use this innovative approach with young people.

Timing: First cohort September – December 2016, second cohort September – November 2017.

Method**:** Over 20 young people aged 16-18 were selected from applications from across the Wessex Water region, invited to two day long board meetings at Wessex Water headquarters. Sessions were facilitated by Blue Marble.

The first session immersed the young people in Wessex Water's business, through mini interviews with executives, tours of the building and small group work on a live business task. The second session involved the young people pitching their ideas to a panel of senior executives.

The 2016 task was to develop new ways to encourage customers to take up meters, and to develop customer services initiatives for the future. In 2017 the task is about sewer misuse; to change the way young people think about what they put down the drain/toilet.

Willingness to pay research

Objectives: To estimate customer valuations of incremental service improvements, relating to proposed areas of investment. To use the results in triangulation with other methods of stated and revealed preference.

Timing: September 2016 – November 2017

Method**:** Quantitative surveys carried out by specialist consultants Accent. We partnered with Bristol Water (whose water supply customers are typically our waste water customers) to provide efficiency by collaboration for this research.

Customer surveys were undertaken in two stages. The stage 1 survey questionnaire was designed around two interlinked exercises: (1) a 'MaxDiff' exercise that asked which service issues would have the most, and least, impact on respondents if they were to be affected by them; and (2) a 'Package' exercise focussed on high level trade-offs between service improvements or deteriorations and changes in the level of the bill. Stage 1 surveys comprised:

- 10 depth **cognitive interviews** (5 household customers, 5 non household customers)
- 702 **pilot interviews** (household and non-household)
- 2,165 **household interviews** across Bristol, Bournemouth and dual supply area (1,963 online, 202 face to face in home with seldom heard customers[3])
- 650 **non-household interviews** across Bristol, Bournemouth and dual supply area (using Computer Assisted Telephone Interviewing)

The stage 2 survey was designed around two core Stated Preference exercises; a "Community engagement MaxDiff exercise" and a "Water resources management exercise" including their willingness to pay. Stage 2 surveys comprised:

- 10 depth **cognitive interviews** (5 households, 5 non households)
- 126 **pilot interviews** (76 x household online, 50 non household face to face)
- 652 **households interviews** (552 online, 100 face to face with seldom heard customers)
- 300 **non-household interviews** (using Computer Assisted Telephone Interviewing)

Additionally we have undertaken a literature review on existing research into the public's understanding of "local" in the context of rivers.

Business Plan game

Objectives: to use an innovative and engaging method to gain insights on customer priorities and customer valuations.

Timing: launched in October 2017.

Method: online survey "game" using six animated characters. The game educates through a reminder of the water cycle and the use of an animated screen at the end showing the impact of the respondents' choices. See https://game.wessexwater.co.uk/.

Overall business plan acceptability testing

Objectives: develop a robust statistical view of the acceptability of the plan across different age and socio-economic characteristics, residential and non-residential customers, and explicitly explore customers' views on leakage, to reflect revised bill levels and the 15% leakage reduction level.

[3] Seldom heard customers: A criteria framework was developed comprising the following customer subgroups: Very low income: Long term unemployed or living on the state pension (socio-economic group E), Disconnected: No access to the internet (either at home, on a mobile or at work) Age disconnected: 70 years or older and unlikely to be digitally engaged, Literacy: Unlikely to complete and engage with an online survey due to literacy issues, language: First language is Somali or any other non-English

Timing: January 2018 to May 2018

Method:

During phase 1:

- 3 qualitative engagement events of 3 hour length, comprising 48 household customers and 16 non household customers; 12 depth interviews with customers with vulnerabilities; and 12 depth interviews with stakeholders (including two retailers).
- Quantitative phase comprising 997 computer interviews, 407 online surveys 743 Have Your Say online panel surveys, and 150 face to face surveys with customers with vulnerabilities and business customers.

During phase 2:

- 791 face to face computer interviews, and 307 online surveys with domestic customers.
- Additional engagement through Wessex Water magazine, online surveys and social media, and roadshow events.

2.3 Public consultation on the draft plan

This draft Plan was submitted to the Secretary of State (Defra) on 30 November 2017. A Water Resources Management Plan comprises a technical report (this document), a non-technical summary (the Executive Summary of this report), a suite of Excel base water resources planning tables and technical supporting appendix reports.

Defra gave us permission to publish this draft Plan for public consultation, which ran from 9 March 2018 for 12 weeks, closing on 1 June 2018. On 18 May, during the consultation period, we also held a stakeholder workshop entitled: The Efficient Use of Water. A key aim of the workshop was to host discussion on the most efficient use of water in the region and explore through discussion potential trade-offs between trading, water efficiency and the environment, and how the currently plan addresses these broader issues.

We received ten consultation responses on the plan, which we have responded to in a separate Statement of Response report, and where appropriate we have updated our plan (this document and the tables) to take account of stakeholder comments.

Our full draft final plan, including all the technical appendices has been made available to statutory consultees (Defra, Environment Agency and Ofwat).

The next step in the statutory process is that our Statement of Response report and this revised draft Plan will be reviewed by the Secretary of State and we will be directed as to whether we can publish the Plan as a final version, whether further information is required or if an inquiry should be held.

3 The water supply system

3.1 Our region

We supply 1.3 million people in the south-west of England with high quality drinking water. Our region is predominantly rural but includes the urban areas of Bath, Chippenham, Dorchester, Bridgwater, Poole, Taunton, Salisbury and Yeovil (Figure 3-1).

Figure 3-1: The Wessex Water region

To supply our customers we use more than 70 sources and over 11,800 km of water mains to treat and distribute approximately 340 million litres of water each day (Ml/d). Our sources range in capacity from less than 0.6 Ml/d to 45 Ml/d although we have a prevalence of small sources – over 50% have an average output of less than 6 Ml/d.

The main river catchments in the region include the Hampshire Avon, Bristol Avon, Frome, Stour and Parrett. The majority (75%) of the water we abstract for public water supply comes from groundwater sources. Important aquifers for us are located under Salisbury Plain, the Cotswolds and the Dorset Downs. The remainder of our water supplies (25%) come from impounding reservoirs located in Somerset.

Our region contains a wide range of important landscapes and habitats and we are committed to playing our part in their protection at all times. The maximum volume of water that can be taken from each source (typically each day and each year) is specified in their abstraction licences which are granted by the Environment Agency. The conditions on a licence are the main way of ensuring that our abstractions do not have an unacceptable impact on the environment. For more information on abstraction licensing including recent and upcoming changes to current licences see Section 4.4

The volume of water we abstract from the environment to supply to our customers has been steadily reducing since the mid-1990s. Annual average volumes of water that we put into our supply system have reduced from around 425 Ml/d in 1995 to approximately 340 Ml/d today. For more information on recent and forecast demand patterns see Section 5.

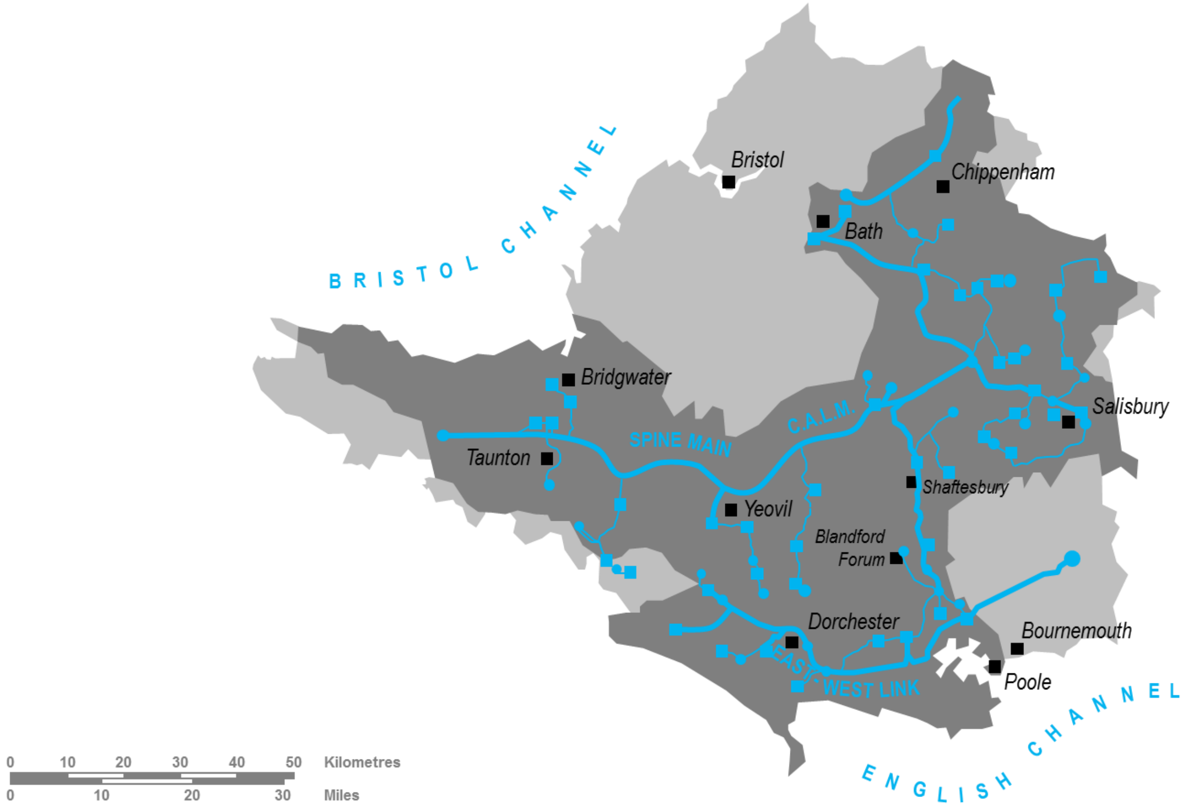
3.1.1 Water supply network

Our water supply network consists of a number of major transmission systems allowing us to move from areas of surplus to meet demand in the wider supply area (Figure 3-2). Our integrated network provides customers with a very resilient water supply service. Key network connections include:

- Transfer of water east from our major surface reservoir sources in Somerset to demand centres in the centre and north of our region, via the Spine Main and Central Area Link Main (CALM), Whilst this is our most common mode of transfer, in drier weather we have the ability to reverse this transfer, and move water from the groundwater sources in the east of the area towards north Somerset.
- Movement of water south into north Bath from groundwater sources in Malmesbury and the Great Oolite aquifer near Chippenham.
- Transfers across the East/West link main in the south of our supply system, transferring water from the Poole region, across to Dorchester and Weymouth, and from Dorchester to Poole.
- Most recently (2010-2018) our integrated GRID project has added new pipelines to connect sources in the south of our region (Corfe Mullen area) to Salisbury in Wiltshire via Blandford and Shaftesbury. This scheme, first proposed in our 2009 Water Resources Management Plan, enables us to reduce abstraction at environmentally sensitive sources in the upper Hampshire Avon Catchment, improve resilience for our customers without the need to develop new sources.

The GRID project involved over 50 individual schemes with investment totally £230m over eight years. It has not just included investment in traditional asset infrastructure, but also investment in innovative technology, referred to as ‘The optimiser’ – which models the operation of the GRID and the demand placed upon it up to 72 hours in advance, repeating this modelling at least hourly to account for potential operational or customer demand changes. The optimiser automatically recalculates the best way to operate the network to mitigate the outage, and improves the resilient operation of our water supply system.

Figure 3-2: Integrated water supply network showing strategic mains, sources and reservoirs



3.1.2 Community engagement

We supply 1.3 million people and nearly 50,000 businesses with water. Water is a basic requirement for life and our customers rely on us to provide a reliable wholesome supply for daily habits as simple as making a cup of tea and flushing the toilet.

We are keen to encourage customers to participate and enjoy the water services we provide. Our water efficiency and metering programmes support customers in reducing their water usage to manage their bills and lessen their impact on the environment (further details are given in Sections 5.6.4 and 9.3.1).

The communities we serve are diverse and multiple and our approach to engagement is correspondingly varied. We recognise that customers are more inclined to respond when it is convenient for them to do so and relayed in a format they wish to interact with.
Our popular schools' education programme helps us engage with future generations on water efficiency and the value of natural resources and continues to illustrate how it is possible to deliver educational content that includes aspects of environmental impact and social responsibility in an enjoyable and instructive way that can help shape attitudes, understanding and actions in later life. At present around 150,000 children participate in the sessions we offer every 5 years.

Each year we also go out on the road and attend community events to promote important advice around saving water and preventing blockages. These roadshow events also help us to collect valuable feedback from our customers alongside our social media channels and information filled customer magazine which reaches over one million customers.

Our Wessex Watermark awards provide funding to support environmental projects helping to improve the local area through grassroots community action across the Wessex Water region.

We also reach-out and support our most vulnerable customers by funding and working in partnership with Citizens Advice Bureaux, debt advice agencies and other charities, encouraging the uptake of social tariffs and discounts where possible. Additionally, we support our staff to volunteer in the community and match any fundraising that they undertake for local charities.

Our website contains a water use calculator which helps customers to understand how much water their daily habits use and offers personalised advice on saving water and devices suitable for their home. Around 7,000 customers use the calculator every year.

We think that for the majority customers the principle of saving water is not just about lowering bills but it is a sensible approach in general and good for the environment. We believe that in many instances helping customers to achieve this aim is about offering the best advice and ‘nudging’ customers on how to act. To this end the launch of our enhanced online water calculator in autumn 2017 will give a more powerful and intuitive experience. This will improve our ability to segment and personalise interactions. Importantly, this approach will also allow us to link water use with its impact on other aspects of their household bills, in particular the use of energy to heat water. We think this appreciation of the bigger picture will help inform customers and spur them into changing actions and habits that benefit them and the wider water system and catchments.

Digital engagement is set to grow in its reach and importance to us and our customers. In 2018 we will amalgamate the water calculator dashboard into our billing portal thereby improving the service offering and the likely uptake by customers. Our current e-billing provision reaches 50,000 customers per annum, increasing by 20,000 each year and we believe this approach will grow its reach considerably.

In a similar proactive vein, we plan to extend our successful Home Check programme where we contact customers directly and offer then a full water use audit, small leak fix and equipment installation. In the 2020-25 period we plan to deliver the service to a further 30,000 customers (see Section 9.3.1 for more details).

We are also keen to bring related offers together so customers can benefit in a coordinated, one-stop manner. For example, our new enhanced metering option is called the ‘meter cashback guarantee’. It offers customers who opt for a meter the chance to revert back to unmeasured charges after two years with a refund of any bill difference if they have paid more with a meter. We will use this as an opportunity to offer Home Check type services to help and encourage them to reduce their water use so that they save money.

With a more holistic approach in mind, we are also looking at how we can work more closely with whole communities to allow customers to participate in our services and not just receive them. This citizen-themed project will start as a town specific trial and look at enhanced community and customer engagement. The project will seek to strengthen customer understanding of their local water environment and water systems and take a multi-behavioural approach rather than our more commonly used approach our engaging on a single issue at a time.

3.1.3 The wider environment and catchments

While water resources zones are the key geographical area over which a water company manages the balance between supply and demand, our water supply area also covers a number of hydrological catchments. A hydrological catchment is the watershed area where falling rainfall drains into a river, and including groundwater springs, streams and rivers. The impact that our water abstractions have on the natural environment is more appropriately assessed at a catchment scale, where we need to account for the impact that our reservoirs and groundwater abstractions have on the amount of water available in the environment.

Many different stakeholders influence catchment water quality and quantity, and have different responsibilities around water quality, flooding, land management and amenity. This can include Local Authorities, farmers, angling clubs, water companies and environmental regulators.

To make a real difference there needs to be an integrated approach to sharing knowledge and delivering improvements between stakeholders that will protect the water, land and people in the long-term. Combining our efforts in a strategic manner and making decisions based on a good evidence will help us to make progress and protect our catchment for future generations. Working collaboratively can help to identify the problems, solutions and threats to the water environment, often promoting low cost and innovative solutions.

Through our catchment approaches we aim to achieve:

- sustainable farming, development, water use and sewage treatment that supports healthy rivers and groundwater across the Wessex water region
- recognition of the ecosystem services that the catchment can provide and an adequate payment to those that manage the land to provide these services
- improvement to biodiversity habitats both in the form of naturally functioning rivers, floodplains and wetlands and appropriately located woodland and low-input grassland
- national environmental standards for the benefit of wildlife and users of these waters.

Catchment-based strategies are now a business as usual approach to protect our service levels and enhance the environment; often this means we are able to deal with the source of the problems not the symptoms.

Ensuring the sustainability of the abstraction licences that we hold is critical to the long term viability of our activities. Over the last 20 years we have worked in partnership with the Environment Agency and others to investigate sources where there are concerns that the volume of water we are licensed to take has unacceptable impacts on local watercourses, groundwater levels and the wildlife that they support. Some investigations have led to reductions in the licensed volumes or other mitigation measures being made to ensure precious habitats in our region are protected. This is an ongoing process particularly to ensure compliance with the Water Framework Directive. A new group of 18 sites will be investigated in 2020-25 in accordance with the Environment Agency’s Natural Environment Programme for the water industry. See Section 4.4 for further details.

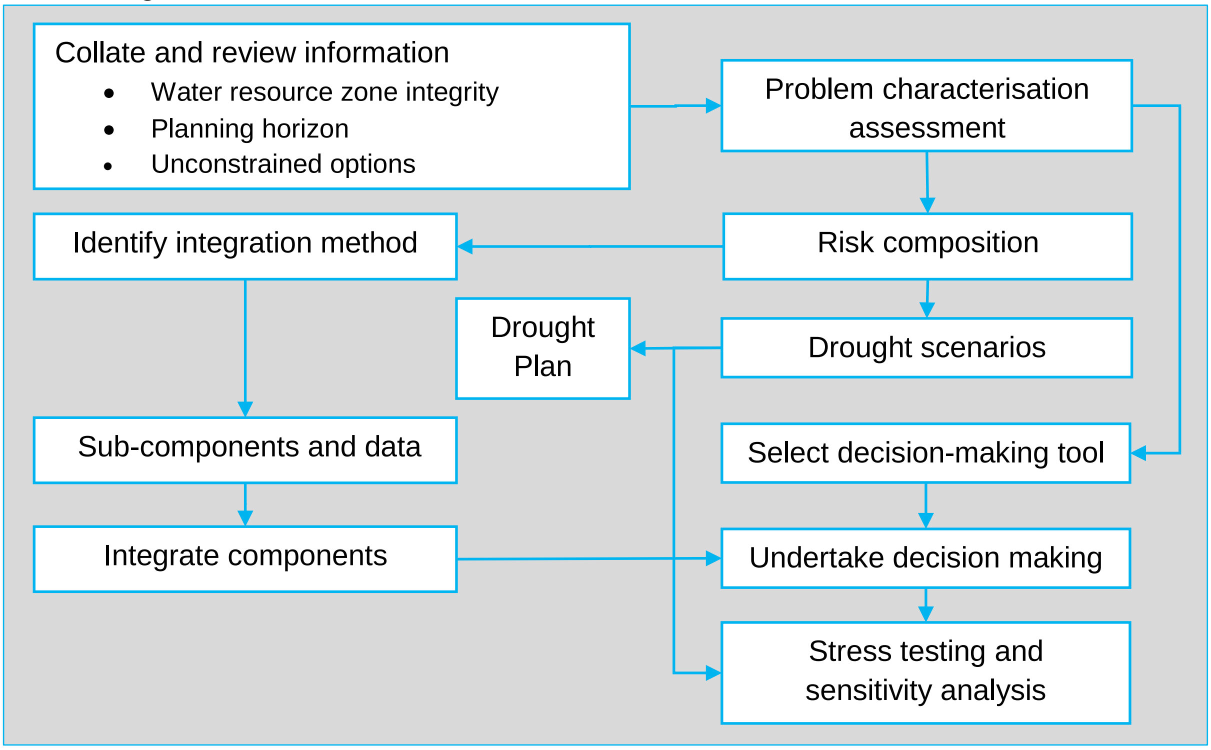
3.2 Overview of approach for developing the plan

We have used UKWIR's *Decision making process* framework (UKWIR 2016[4]) and the '*Risk based planning'* guideline (UKWIR 2016[5]) to develop this Plan. These best practice guidelines, recommended by the Environment Agency, have helped us to:

- Understand the problem we need to solve (termed *problem characterisation*) and select an appropriate decision making (*options appraisal*) method
- Decide on an approach to including risks in your plan and the methods that will be used for evaluating drought risk (termed *risk composition*)
- Decide on supply, demand, outage and headroom methods appropriate for the chosen options appraisal method and risk composition.

The decision-making guidance (UKWIR 2016) provides a framework to help identify and apply a proportional approach to develop water resources management plans in terms of the approach to decision-making, and the way risk is addressed in the plan. Figure 3-3 shows a simplified overview of the decision making and risk-based framework for developing this Plan this is consistent with the methodologies included in the decision making and risk based planning guidelines.

Figure 3-3: Decision making framework for investment appraisal and optimisation methodologies



The first stage in developing this plan was to collate and review existing planning information to understand the scale of the problem potentially faced, in particular our previous plan, to inform our approach. The information collated at this first stage was used to inform our water resource zone integrity assessment, our proposed planning horizon, and our problem

[4] UKWIR (2016) Decision-making process guidance
[5] UKWIR (2016) Risk-based planning guidelines

characterisation assessment. The review of unconstrained options is presented in Section 9.4

3.2.1 Water resource zone integrity assessment

The geographical unit for water resources planning is the water resource zone. The water resources planning guidelines[6] define a water resource zone as an area within which the management of demand and supply is largely self-contained (apart from bulk transfers). Within a zone supply infrastructure and demand centres are generally integrated to the extent that customers in the zone experience the same level of risk of supply failure, and consequently customers share the same level of service. The guidance recognises that there may be some limitations in meeting these requirements in all circumstances but suggests that significant numbers of customers should not experience different levels of risk within the same zone.

Prior to investment in our integrated GRID project, we operated four water resource zones (north, south, east and west). The GRID connected up our distribution system and so our last Plan was developed on the basis of a single water resource zone. This was supported by the water resource zone integrity assessment that we undertook as part of the preparation of our last Plan and was approved by the Environment Agency.

We have reviewed and updated our assessment of water resource zone integrity for this Plan in June 2017. We discussed this during pre-consultation with the Environment Agency and once again confirmed it is appropriate to develop this Plan with a single zone. The water resource zone integrity assessment in included in Annex B.

3.2.2 Planning scenarios and horizons

Our previous Plan was developed with a dry year annual average and dry year critical period scenarios. Evaluation of historical figures for the water we put into supply (Figure 5-6) shows that we experience peak week demands typically between June and September and/or sometimes coinciding with Bank Holidays. These tend to occur during warmer and drier weather, due to the relationship between weather and demand (Figure 5-5). Our water supply system of treatment works, pipelines and service reservoirs, including new assets associated with our integrated grid, are designed to manage peak seven day demands. For this plan, we therefore decided that it was prudent to continue to use both Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP) scenarios.

Our previous Plan was developed with a 25-year planning horizon from 2015 to 2040, which is the recommended minimum horizon. Our final planning forecast indicated that we would be in surplus in 2040 and unlikely to move into deficit soon after. Therefore, for this Plan we deemed it appropriate and proportionate to once again undertake forecasting for 25 years. Our problem characterisation assessment (Section 3.3.3) identified that we did not expect to be considering significant supply-side investments that would require significant lead-times, and this was confirmed by our baseline supply demand balance to 2045 once analysis was complete (Section 7).

[6] Environment Agency (2016) Water resource zone integrity: supporting document for the Water Resource Management Plan Guidelines

We note however the recommendation in Water UKs *Long term planning framework*[7] to consider longer-term planning horizons and in Section 10.2.5 we consider a scenario that extrapolates our supply, demand and headroom forecasts by extending trends to 2059/60, giving a 40 year planning horizon.

3.2.3 Problem characterisation assessment

The important first step in developing a water resources management plan is characterising the 'problem' that is expected to be faced this helps to ensure analysis approaches are proportionate to the challenges encountered. We used the UKWIR *decision making process guidance* (2016) to identify the likely scale and complexity of our planning problem, the vulnerability to various strategic issues and uncertainties and to select the most appropriate analysis methods and options. The problem characterisation assessment is summarised in this Section, and can be found in full in Annex D. This assessment was discussed with the Environment Agency during the pre-consultation phase in December 2016.

The problem characterisation assessment consists of two elements:

1. **Assessing strategic needs**: how big is the supply-demand balance problem over the planning period?
2. **Complexity factors**: how difficult is this problem to solve?

Each element consists of a series of questions; each question is scored from 0 to 2 based on the level of concern over the issue. The scores are then combined to identify the level of vulnerability, and the appropriate complexity of methods that should be used to develop the Plan. Our responses to the questions drew upon information from our last Plan, more recent data arising from annual regulatory returns and the annual review of the water resources management plan, and also considered outputs of the Water UK Long Term Planning Framework Project (2016).

In assessing strategic needs, we identified no significant concerns (score of 0) relating to our supply, demand and investment risks that could significantly affect customer service. This assessment draws on the surplus forecast in our last Plan up to 2040, and on the conclusions of the Water UK project[7], which identified that Wessex Water is very resilient to the risk of severe drought. In the complexity factors assessment we identified some moderately significant concerns (score of 3), relating to the performance of the supply system to more severe droughts than had been observed in the historical record; potential reductions in supply relating to sustainability reductions; and uncertainties around the sensitivity of demand to drought conditions.

<u>Level of concern and model complexity, and decision making tool</u>

As per stage 4.1 of the UKWIR guidance, our strategic needs and complexity factors scores were combined into a matrix to identify an appropriate level of modelling complexity (Table 3-1.). The assessment identified us as having a **low level of concern.**

[7] Water UK (2016). Water Resources Long Term Planning Framework (2015-2065)

Table 3-1: Problem characterisation output to identify "model complexity"

		Strategic Needs Score ("How big is the problem")			
		0 (none)	**2 (small)**	**4 (medium)**	**6 (large)**
Complexity Factors Score ("how difficult is the problem")	**Low (<7)**	**X**			
	Medium (7-11)				
	High (11+)				

Green = low level of concern; Amber = moderate level of concern; Red = high level of concern.

For a low level of concern situation, the guidance states:

'Current' approaches (EBSD[8]) should be adequate. Specific complexities to assist in the derivation of deployable output and the incorporation of uncertainty for example, can be examined through the steps recommended in the parallel *Risk Based Planning Methods* project (UKWIR 2016).

Given our low level of concern it is therefore proportionate that we use conventional EBSD approaches as our decision making tool, if decisions are required to be made following the outcome of our supply-demand balance calculations

3.2.4 Risk composition and links to drought plan

In addition to defining the decision-making tool to be used, the problem characterisation also informs what *risk composition* should be taken, which in turn determines the Level of Service and how this water resources management plan links with our drought plan.

The risk composition indicates how drought risk and resilience are incorporated into the analysis by defining how uncertainty is dealt when creating the data inputs for the decision making tool. The risk composition is one of the most important steps in the risk-based planning process and requires the selection of one of three choices:

- **Risk composition 1** "conventional" – Plan only considers drought patterns and severities that have been observed within the historical record.
- **Risk composition 2** "resilience tested" – An extended method where, as well as using the historical record, the drought risk is examined by testing the supply system to events beyond the historical record. This method allows for some representation of links between the water resources management plan and the drought plan.
- **Risk Composition 3** "fully risk-tested" – analysis is undertaken to understand how drought supply demand risk varies continuously with the probability of drought occurrence, allowing testing against a full range of droughts. This approach allows explicit links between the water resources management plan and the drought intervention measures within the drought plan to be tested.

[8] Economics of Balancing Supply and Demand – sets out a range of aggregate WRMP methods used to identify the problem, formulate an appropriate modelling approach, and select a solution method, with AISC (cost) ranking being the simplest.

We undertook our problem characterisation assessment at the same time (winter 2016) as developing our last drought plan. The problem characterisation indicated a low level of concern, which justifies the selection of risk composition 1. We chose, however, to adopt risk composition 2, for the following reasons:

- Risk composition 2 allows us to make clearer links between our water resources and drought plans, as it considers the impact of more severe events on customer service and the imposition of supply side drought management measures (drought permits and orders).
- The regulatory drought planning guidelines state that we should understand what drought events our supply system is vulnerable to and the probability of such events occurring, which will include events more severe than in the historical record.
- Although the *water resources long term planning framework* report identifies that we are at low risk, the study also identified deficits in neighbouring company supply areas, suggested that new water-trading relationships might be established in the future, where it might be beneficial to evaluate transfer potential under more extreme droughts.
- Finally, our longer term vision for developing for water resources planning (Section 12) is of incremental adoption of more advanced and robust methods, to help avoid step-changes in required methodology, and to help ensure a firm evidence base to underpin subsequent planning decisions. Adopting risk composition 2 therefore represented a proportional step forwards in our planning process.

On the basis of adopting risk composition 2, we developed a set of plausible drought events, the generation of which is described in more detail in Section 10.1.1. These events were also used in our drought plan, which was developed and submitted to Defra in March 2017; public consultation on the plan was undertaken in the summer of 2017; and we submitted our statement of response and draft final plan in October 2017. The benefits of drought plan measures on our deployable output under more severe drought events (e.g. demand restrictions and supply side drought permits), is also considered in more detail in Section 10.1.

Following adoption of risk composition 2, and development of plausible drought events for our drought plan, the Environment Agency water resources planning guidelines were modified with the inclusion of a 1 in 200 reference level of service[9]. We therefore used a plausible drought event equivalent to a return period of 1 in 200 for this reference level of service.

<u>Design event</u>

We chose the 1975/76 drought event, consistent with our previous water resources plan, as our design event. The event was chosen as it is our most severe drought on the historic record, which was re-confirmed through our work on our drought plan (2017), and is also shown in Section 10.1 when evaluating our supply-demand balance under a range of drought scenarios. The event is a multi-season drought event, which our system is most vulnerable to compared to single season droughts given that our water supplies come predominantly from groundwater sources.

[9] Environment Agency (2017) Water Resources Planning Guideline: Interim Update, April 2017.

3.2.5 Integration method and component methods

Based on the low level of concern identified from the problem characterisation, we chose to adopt current EBSD approaches as our decision-making tool. The integration method is then required to determine how components of the supply-demand balance (supply forecast, demand forecast, and outage allowance) will be incorporated into the decision-making tool. In our previous plan we adopted a conventional basic target headroom approach with an aggregated supply-demand balance calculation. Based on this approach, and our risk composition, we considered two integration methods:

- **Basic target headroom method –** deterministic supply-demand balance with separate outage and target headroom allowance, consistent with risk composition 1.
- **Scenario-based method –** generation of multiple scenarios of supply and demand, to inform sensitivity analysis, which may be used for real options decision making, and to evaluate performance of different investment portfolios under alternative events, and can be used as the basis for sensitivity analyses, consistent with risk composition 2.

We initially chose the basic target headroom integration method for calculating our supply-demand balance for our design event (1975/76). However, following the requirement from the Environment Agency to consider our supply-demand balance under an alternative 1 in 200 reference level of service event, we then adopted a scenario-based approach in our stress testing and sensitivity analysis, by evaluating our final supply demand balance under a range of drought events.

The methods applied in the development of this plan – specifically in the components used to develop our supply, demand, outage and headroom assessment as inputs to our method for integration and decision-making tool, are detailed in Section 4 (Supply Forecast, including outage), Section 5 (Demand Forecast), and Section 6 (Headroom assessment). The methods are consistent with our options appraisal method and risk composition. The suggested methods topics were discussed with the EA during our pre-consultation meetings, and also presented and discussed with Ofwat (Section 2.1.1).

3.3 Drought resilience statement and levels of service

In order to communicate our risk of being vulnerable to droughts in a clear and structured manner to customer and stakeholders, we have considered the UKWIR risk-based planning guidelines, and developed two statements to describe our supply/demand balance risks to customer: The Level of Service Statement, and Drought Resilience Statement.

The levels of service statement describes the frequency at which we expect interventions such as Temporary Use Bans to be required, and the drought resilience statement is intended to reflect the hydrological risks that drought imposes on the supply system.

The investments that we have made in network infrastructure, source protection and promoting efficient water use has created a very resilient water supply system. Households and businesses in the Wessex Water region have enjoyed supplies without restriction (such as a hosepipe ban) for over 40 years.

Drought resilience statement

Our services are resilient to a repeat of any of the drought events experienced in the last 100 years without the need to require customers to restrict their use.

We have tested our future plan against a range of plausible future drought severities (Section 10.1), and are confident they represent a good balance between cost, environment and resilience to severe droughts.

Levels of service statement

We would not expect to impose temporary use restrictions (hosepipe bans) more than once every 100 years on average. Similarly, we would not expect to impose non-essential use bans for commercial customers more than once in every 150 years on average.

We have good historical weather records in our region for the last 100 years. We have used these records to estimate the magnitude of more severe droughts that might happen only once in two hundred years – our modelling shows that we would not need to restrict essential water use (i.e. implement rota cuts) at such times. We would therefore expect to implement rota cuts less than once in every 200 years, on average.

The implementation of demand reduction measures (preferred options; Section 9.9), will lead to an increased surplus across the region. However, we do not forecast a change in levels of service following the implementation of demand reduction levels.

This level of drought resilience is amongst the highest for all water companies in the UK and research with customers (Section 9.2.3) indicates they are satisfied with this.

Table 3-2: Levels of service

Level of service	Average likelihood	Probability of occurrence in 25-year planning period
Temporary use restrictions (hosepipe bans)	Once every 100 years (1%)	22 %
Non-essential use ban	Once in every 150 years (0.67%)	15 %
Emergency drought orders (rota-cuts)	Less than once in every 200 years (<0.05%)	<12 %

Section 10.1 provides further details of the plausible drought event testing.

Customer research

Based on our customer research undertaken during the development of this plan, most customers feel current levels of investment to maintain supplies without restrictions such as hosepipe bans are acceptable, with the emphasis that customers should be encouraged to use water efficiently at all times (see Section 9.2 and Section 2.2).

3.3.1 Reference level of service – 1 in 200 drought event

The planning guidelines state that we should set out a reference level of service that would mean resilience to a drought with at least an approximate 0.5% chance of annual occurrence (i.e. approximately a 1 in 200 year drought event). Resilience in this context would be avoiding emergency drought orders that allow restrictions such as standpipes and rota cuts.

In Section 10.1 we have evaluated the performance of our supply system, including with the effects of our preferred options, under a range of plausible drought events, including under events more severe than observed with in the historic record. Section 10.2 provides further details about how we have calculated our deployable output under these scenarios, and the assumptions made in these calculations.

From those events modelled, we have chosen as our reference 1 in 200 design event, the severe 1975/76 event, which is the same length as the 1975/76 event, but marginally worst in terms of rainfall deficit. Under this scenario, we can provide resilient supplies without the need for emergency drought orders such as standpipes and rota cuts throughout our planning period.

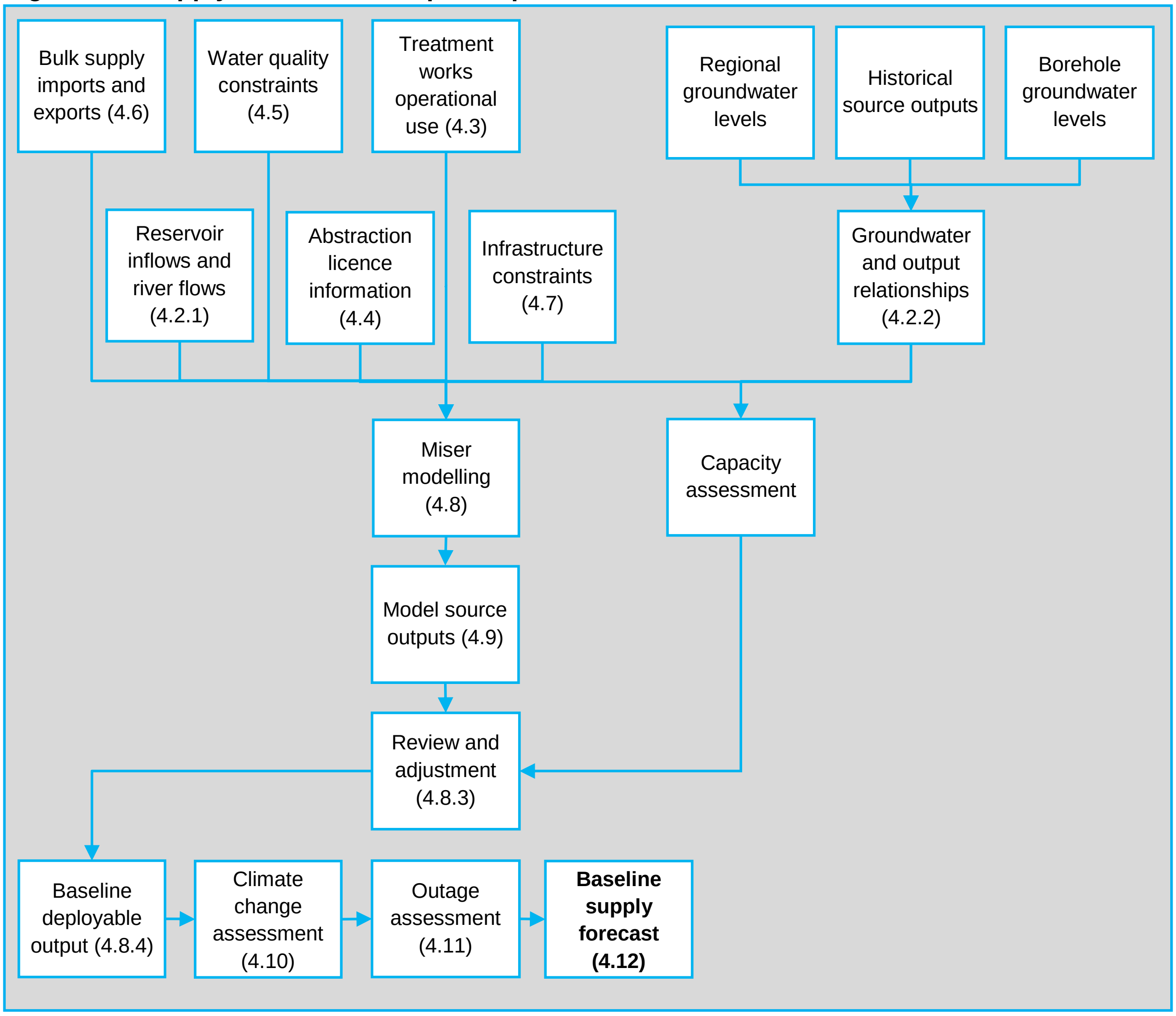
4 Supply forecast

4.1 Overview of supply forecasting approach

To develop a forecast of available supplies for the planning period several detailed analyses and modelling assessments are required. Our approach was developed with reference to the joint regulator Water Resources Planning Guideline and the 2012 UKWIR study on *water resources planning tools*[10]*,* The UKWIR (2014) *handbook of source yield methodologies*[11], and the UKWIR (2016) risk-based planning guidelines[12].

This chapter explains the information and processes used to underpin our supply forecast. An overview of the process is presented in Figure 4-1 which references to the sections of this chapter where each element of the assessment is explained.

Figure 4-1: Supply forecast development process



[10] UKWIR (2012). Water Resources Planning Tools 2012 (WR27), Deployable Output Report. Halcrow Group Ltd, ICS Consulting, Imperial College and University of Exeter Centre for Water Systems.
[11] UKWIR (2014) Handbook of Source Yield Methodologies. Report Ref. No. 14/WR/27/7
[12] UKWIR (2016) WRMP 2019 Methods – Risk Based Planning Report. Ref. No. 16/WR/02/11

The core of a supply forecast is the assessment of deployable output, which is defined as the output of a source, group of sources or bulk supply under dry weather conditions as constrained by abstraction licences, infrastructure, hydrology and hydrogeology, and water quality. We use our Miser model to assess baseline deployable output. An overall baseline supply forecast is then derived once allowances for the potential impacts of climate change and outage have been made.

Using Miser allows us to follow a water resource zone assessment framework for deployable output calculations of a conjunctive use system.

We have applied the approach detailed in this section for calculating our deployable output for our design event, the 1975/76 drought. We have also applied the same approach to derive our deployable output under our design event to also calculate deployable output under our plausible drought scenarios, which have been used for scenario testing of our final supply-demand balance (Section 11).

Our baseline and final supply forecasts do not include the benefits of supply side drought orders.

The robustness of the deployable output assessment depends upon the application of robust inputs (i.e. the assessment data set) to the Miser model. In the development of this Plan, we have reviewed and updated where necessary all the information specified in Figure 4-1.

The structure of this chapter is as follows:

- Section 4.1 sets the context of the supply forecast by discussing annual rainfall patterns, drought frequency and the availability of data sources
- Sections 4.2 to 4.7 outline the input information used in the Miser modelling including:
    - Individual source yields – including reservoir modelling and groundwater and output relationships
    - The operational use of water at treatment works
    - Abstraction licence information including sustainability reductions
    - Water quality constraints
    - Bulk supply imports and exports
    - Source decommissioning and uprating
- Section 4.8 explains the Miser modelling process and the derivation of baseline deployable output and levels of service
- Section 4.9 outlines the assessment of the impact of climate change
- Section 4.10 outlines the outage assessment
- Section 4.11 then describes the overall baseline supply forecast.

4.2 Historical rainfall, hydrology and drought vulnerability

From a water resources perspective, a drought is defined as a water shortage resulting from an extended period of dry weather. The extent to which a given period of dry weather leads to water shortages depends on how a period of below average rainfall affects the amount of water in rivers, reservoirs and groundwater, which in turn affects the amount of water available for public water supply. Therefore, in order to consider the drought vulnerability of the Wessex Water supply area, we need to understand how rainfall variability leads to variations in river levels and groundwater levels, which in turn affects water availability for public water supply.

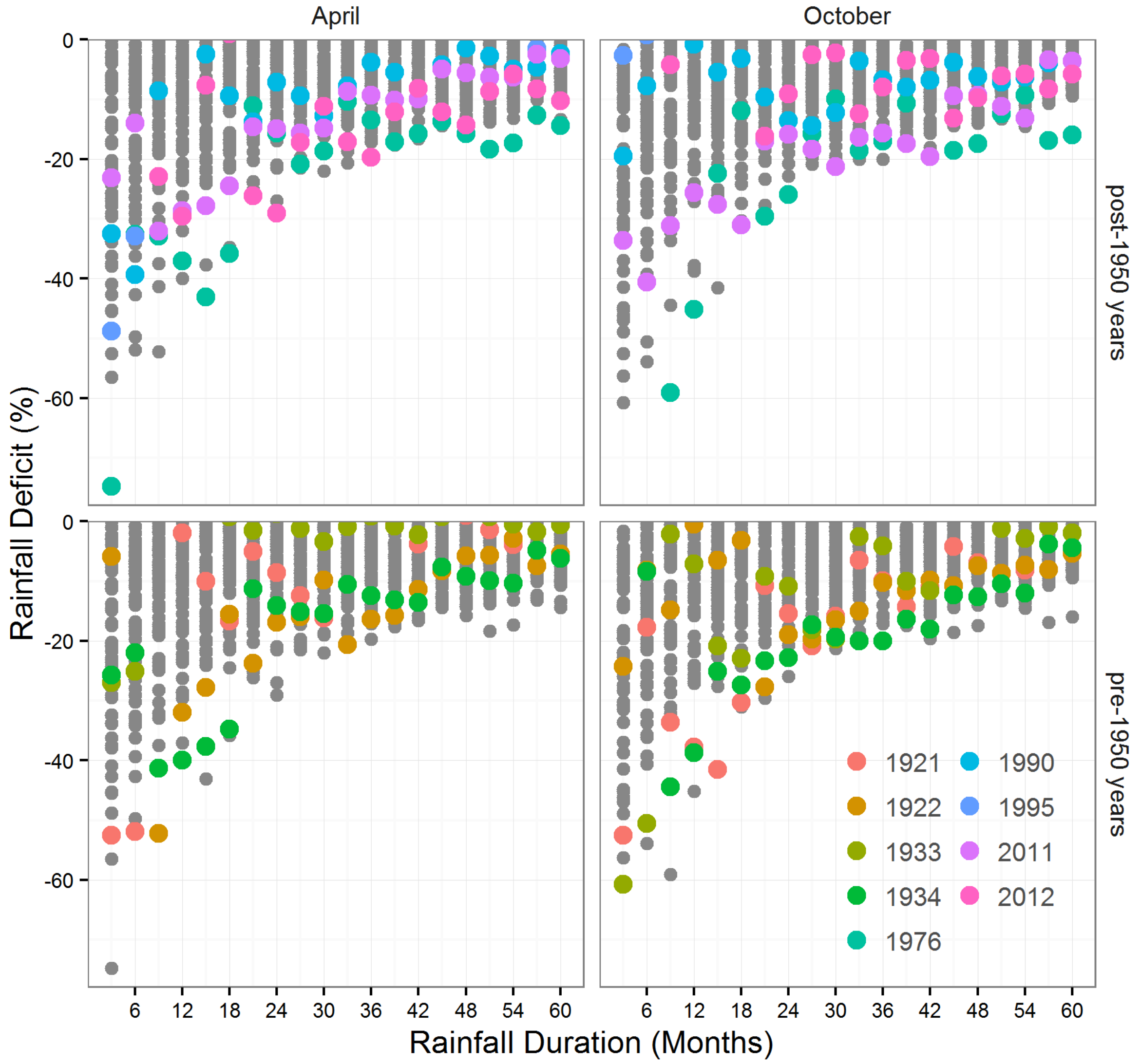
4.2.1 Rainfall

Mean annual rainfall for the Wessex Water region in the last one hundred years was 906mm (1911-2016), and over the last 30 years averaged 923 mm (1987-2016). There is considerable inter-annual variability around the mean with an annual standard deviation of 143 mm. The extent to which periods of below average rainfall lead to water resource shortages and drought conditions depends on three key metrics, which are typically used to classify meteorological droughts:

- **Deficit** – the absolute magnitude of rainfall deficit compared to average rainfall.
- **Duration** – the duration which rainfall is below average conditions.
- **Start date** – time in the year at which the deficit starts.

Figure 4-2 shows how rainfall deficit – a period of below average rainfall - varies as a function of the time-period over which the deficit is calculated, with selected years highlighted. We have considered drought deficit durations starting from both April and October to see when summer and winter deficits occurred.

Figure 4-2: Rainfall deficit as a percentage of mean rainfall plotted as a function of duration for October and April start months.



Grey points: each point is a year from 1911-2016 (same points appear in all sub-plots). Coloured points indicate specific years (see key), separated for clarity, into post-1950 (top row) and pre-1950 (bottom row). Note: the years indicated in colour correspond to the year in which the rainfall duration ends. For example, the worst 18, 30, 39, and 42-month rainfall deficits starting in October all ended in 2011. The worst 12-month rainfall deficit starting in April ended in 1934, and saw a deficit of 40% when compared to the long term average rainfall for all 12 month periods starting in April from 1911-2016.

The graphs confirm that rainfall deficits tend to be larger, as a percentage of mean rainfall, for shorter duration events. As rainfall duration increases, so percentage deficits decrease compared to the mean. The worst summer rainfall deficits occurred in 1976 and in 1921. The driest winters occurred in 1933 and from 1975 to 1976. For longer duration droughts starting in April, 1976, 1934, and 2012 consistently appear with high deficits, and for longer duration droughts. Starting in October, high deficits occurred in, and leading up to, 1976, 2011 and 1934. The year 1976 is a notable dry period when Wessex Water last imposed water use restrictions. Figure 4-2 indicates that the magnitude of rainfall deficit that occurred in 1976 was the result not only of a dry summer, but that the five years leading up to the drought were the driest five years on record. Therefore, the historic records shows rainfall deficits across multiple consecutive seasons.

4.2.2 Hydrology

Groundwater levels and reservoir storage typically reach their lowest levels in October and November before higher rainfall in late autumn and winter, coupled with lower evapotranspiration rates, replenishes water storage (Figure 4-3; Figure 4-4). Groundwater tends to be slower to respond to rainfall and not recover as quickly as reservoir storage. The highest annual groundwater and reservoir levels are typically observed in February and March, following winter rainfall.

Exceptions to this typical annual pattern are sometimes observed; for example, the winter leading into 2012 was relatively dry, and failed to replenish groundwater storage at the usual time (Figure 4-3). Significant rainfall early in the summer that followed led to increased summer groundwater levels, which also prevented significant drawdown of our reservoir storage (Figure 4-4).

Figure 4-3: Groundwater levels in example years for Woodyates, Ashton Farm and Allington boreholes

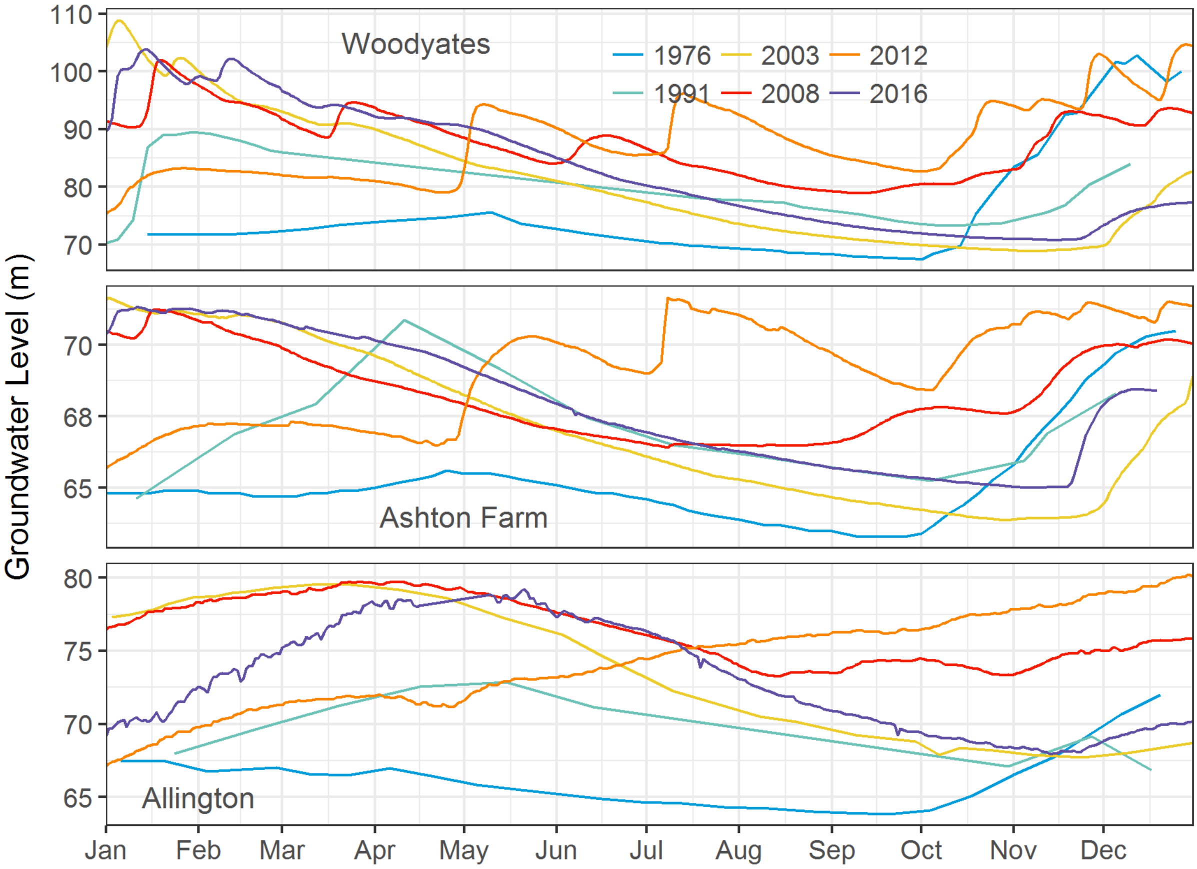


Figure 4-4: Total reservoir storage (excluding Wimbleball) in example years

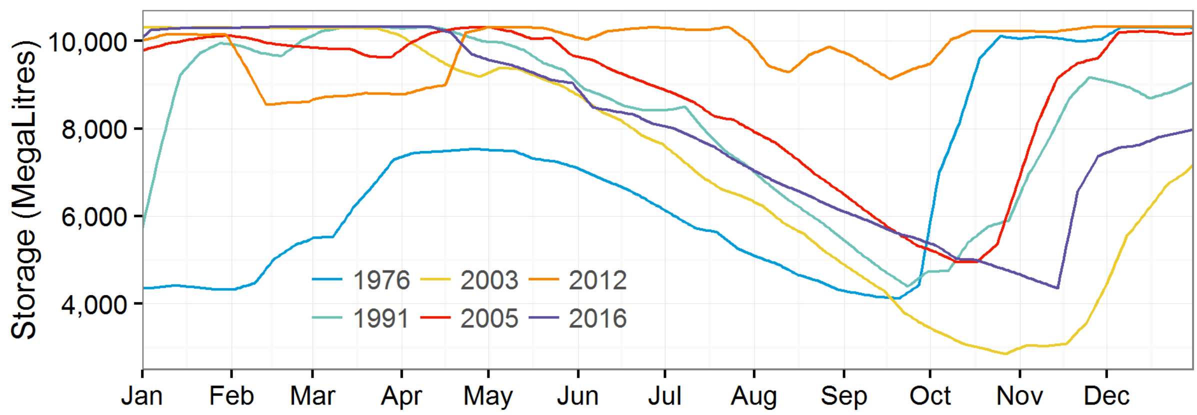
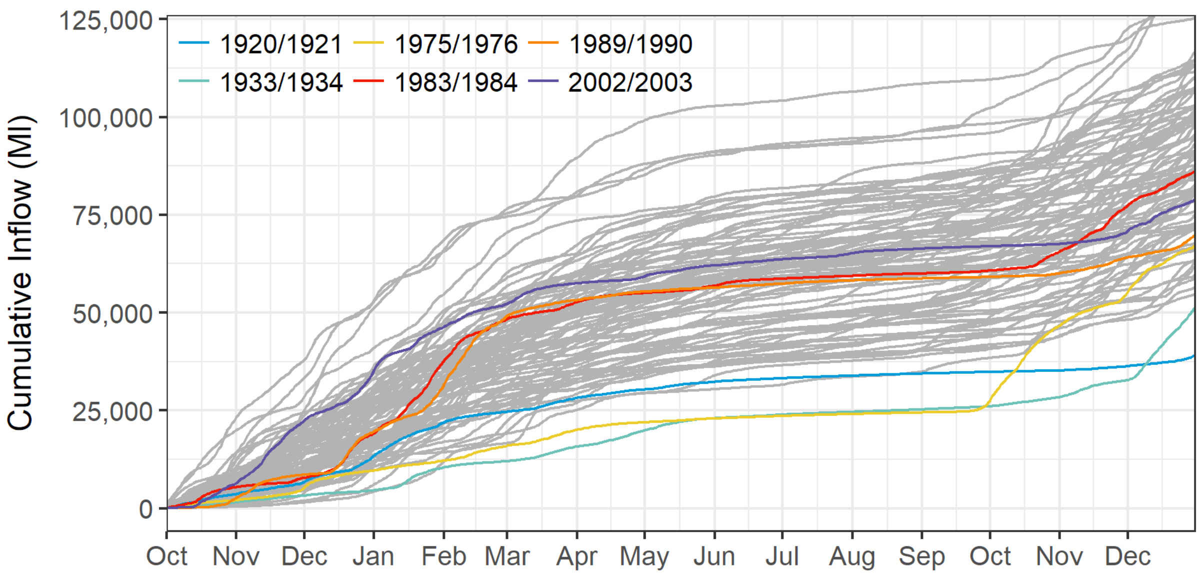


Figure 4-5 shows cumulative simulated[13] reservoir inflows for all 15-month periods starting October from 1911 to 2016, with selected dry periods and years with dry summers highlighted. Figure 4-6 shows the lowest simulated groundwater levels at the Woodyates groundwater borehole, with the lowest levels recorded in the winters of 1921/22, 1933/34, 1975/76, 1990/91, 2003/04, and 2011/12. The periods from 1975/76 and 1933/34 are notable for a lack of groundwater recovery over the winter period. Therefore, we see that the largest rainfall deficit periods (Figure 4-2) also lead to the lowest discharge and groundwater levels.

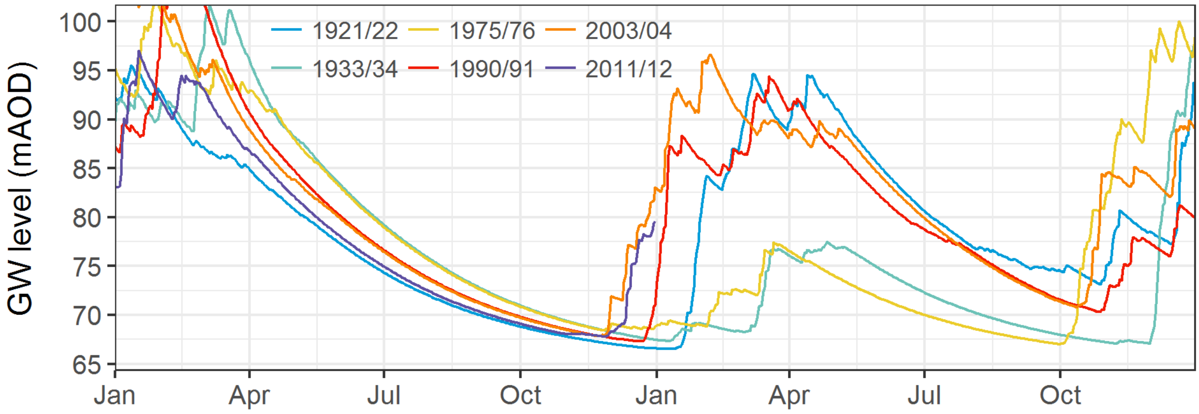
Figure 4-5: Cumulative simulated inflows into all* impounding reservoirs for (1911-2016), with selected years highlighted



* Reservoirs included: Ashford, Clatworthy, Durleigh, Fulwood, Hawkridge, Sutton Bingham, and Wimbleball.

[13] The methodology for calculating inflows is explained in section 4.2.4.

Figure 4-6: simulated groundwater level at Woodyates regional borehole for years with lowest groundwater level



4.2.3 Groundwater and output relationships

The output of our sources are constrained either by their hydrogeology or by their abstraction licence and/or infrastructure limits.

Licence and infrastructure constrained sources may have a hydrogeological yield that could exceed the daily or annual licenced volume even under drought conditions and/or their output is limited only by infrastructural constraints such as treatment plant capacity Information on the constraints on these sources is applied to Miser; see Section 4.8 for further details.

Sources that are hydrogeologically constrained have a drought yield that is limited by low groundwater levels, borehole pump capacity, aquifer transmissivity, clogging of the rising main or the well screen condition/design. Essentially, there is either less water available in the aquifer than the licence conditions permit and/or the fluid dynamics of the movement of water through the aquifer and boreholes do not allow the licensed volume to be withdrawn from the aquifer – even though the aquifer is not empty.

The impact of these hydrological constraints varies between wet years and dry years, and as a dry year or drought progresses. When conditions are wet, and groundwater levels are high, the hydrological constraint will be small, or possibly non-existent relative to the source's licence. However, as groundwater levels recede through a dry summer and especially into a drought the hydrological constraint will become more and more limiting on the available output from a source.

As part of the development of our last plan, we contracted consultants Hyder to support us in analysing the hydrological constraints of our sources. From this work, we developed 'the Handbook of Source Yield Information', which has been used to improve our groundwater modelling, and our groundwater yield assessment for this plan.

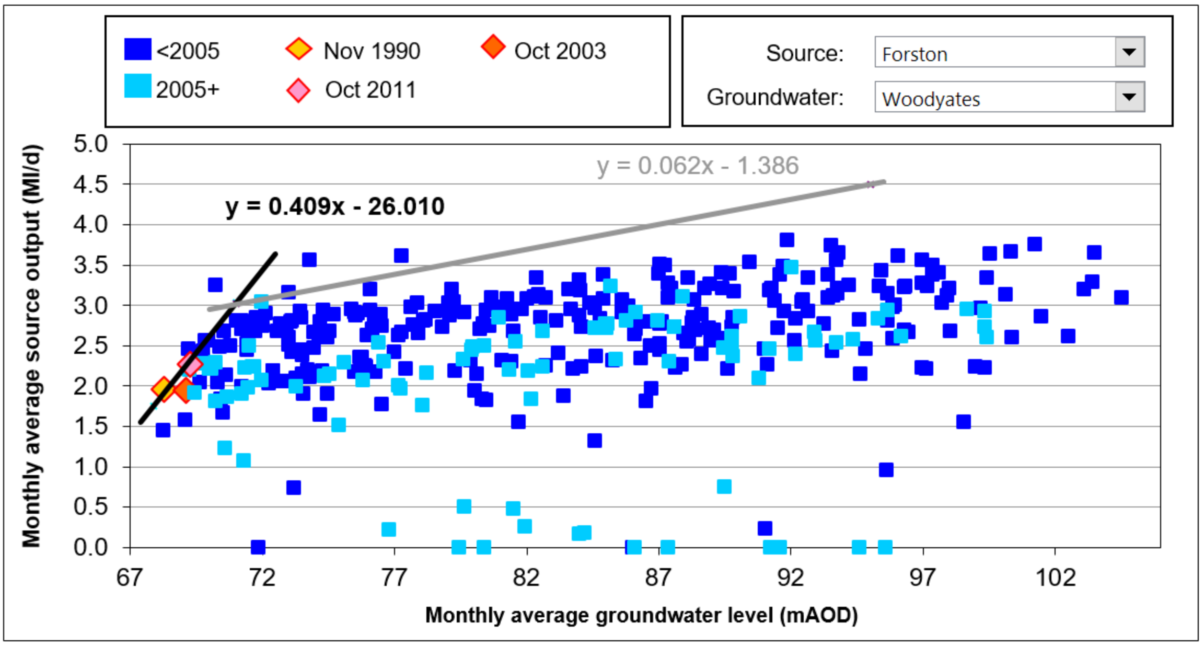
An analysis method was developed that is consistent with the approach outlined by the UKWIR 2000 report and recommended by the Water Resource Planning Guidelines and the 2012 UKWIR project WR27. Key information for each source was analysed and graphs plotted of site-specific data including monthly source output, daily source output and groundwater levels (where available), and instantaneous source output (15-minute data). The data was inspected to identify trends and relationships; for example, changes in demand on the source, or source output decreasing through the summer months as the groundwater level falls. An estimate of the maximum output under drought conditions was also tested by the production of a 'summary diagram' akin to the UKWIR methodology using manual water level data and total daily source output. Based on this data the Deepest Advisable Pumping Water Level (DAPWL) and a drought curve were then plotted, and a baseline estimate of output derived from the intersecting point of the two lines.

The UKWIR methodology for defining the drought available yield of a source relates to when water levels fell to their all-time minimum values in the area of the source, as indicated by nearby observation boreholes. However, we believe this is too simplistic and that the relationship between groundwater level and source yield over a range of groundwater levels, not just the drought groundwater level, is necessary.

We have therefore developed a method to represent the hydrogeological constraint based on the mathematical relationship between monthly source output and average monthly groundwater level measured at one of three regional observation boreholes. The representation of the hydrogeological constraint is applied to the Miser model defined by one or two straight-line equation(s) of the form y=mx+c. The lines are typically drawn through the upper bounds of the data on the scatter graph, but their position is also informed by the understanding of the source gained from the review of key data for the source. Defining these relationships in Miser allows source outputs to be appropriately constrained under dry weather conditions for the calculation of deployable output and for operational planning scenarios.

An example graph for the Forston source is shown in Figure 4-7. This relationship predicts that under the lowest groundwater level at Woodyates of 67.9 m AOD an output of 1.75 Ml/d would be available from the source.

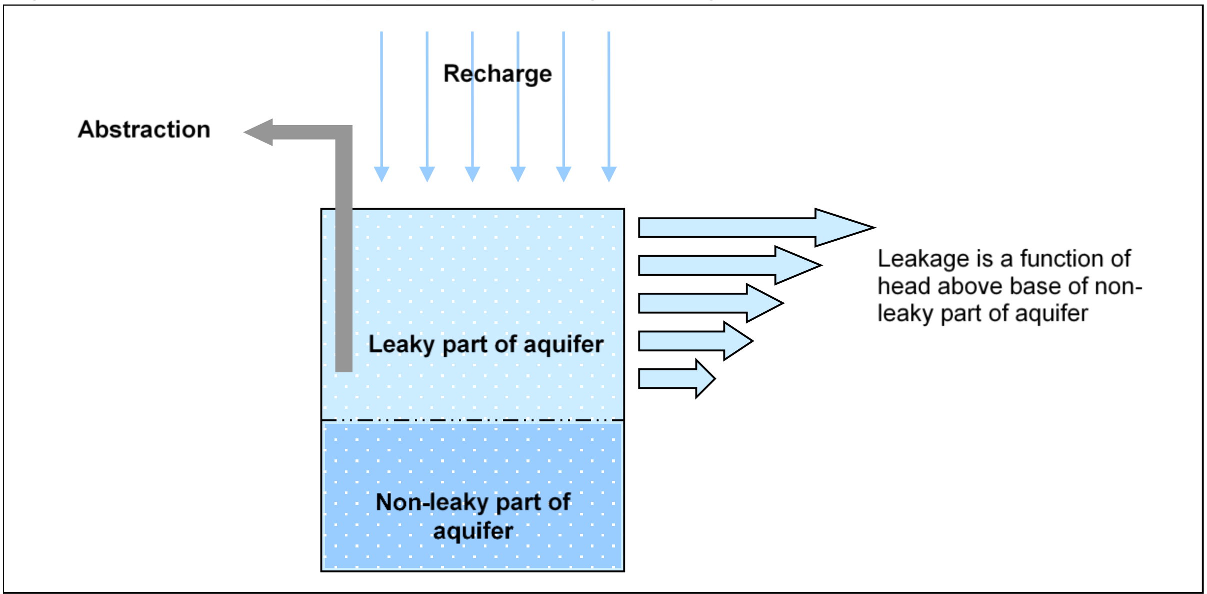
Figure 4-7: Example correlation between monthly source output and Woodyates groundwater level for Forston



The above methodology makes the assumption that abstraction from a groundwater source will not affect the overall level of groundwater storage, and therefore the yield available in the forthcoming weeks or months. For springs, this assumption is correct and it is also a reasonable assumption for sources where the abstraction is small relative to the overall flux of groundwater through the aquifer. It may not be such a reasonable assumption where the level of abstraction is such that it could have a significant effect on the water levels in the aquifer block. We have identified two aquifer blocks where this may be the case: the Chalk around Chitterne in Wiltshire and the Great Oolite around the Ivyfields and Lacock sources near Chippenham.

For these aquifer blocks a single point groundwater model has been constructed within Miser which simulates the observed water levels in the observation borehole at Chitterne and in Allington observation borehole near Chippenham. The simulation includes recharge, abstraction for public water supply and “leakage” to rivers. The leakage to rivers is itself a linear function of the simulated groundwater level above a threshold level. A reasonable calibration of historic water levels has been obtained using this approach. The conceptual basis of the single point models is illustrated in Figure 4-8. The models were developed in Excel first, including calibration of historical groundwater levels against model levels and then applied in Miser.

Figure 4-8: Conceptual representation of a single point groundwater model



4.2.4 Reservoir inflows and river flows

Surface water sources represent approximately 25% of our water resources, and are primarily in the west of our supply region. Reservoir storage, compensation flow and the use of pumped storage are all simulated, alongside the requirements of stream support, in our Miser model. The key data input to the Miser model to simulate these system components is river flow time-series for reservoir inflow catchments, and for catchments from which we extract pump storage and that trigger stream support (Appendix G contains an extract from our Miser model representing Durleigh and Ashford reservoirs).

Reservoir inflows are not automatically gauged at our sites[14] but they can be derived using a variety of standard techniques including: rainfall-runoff modelling; mass balance calculations using reservoir outflows and level observations; regionalisation of inflows[15]; and spot gauging at critical periods (e.g. low flows). Previously we have developed stand-alone Excel based models for each reservoir, which can be used to calculate inflow sequences since 1975 for input to Miser. The models typically use a mass balance calculation when the reservoir is off full and use a regression equation to link the inflow to the flow measured at a gauging station on a nearby watercourse when the reservoir is full. It is not necessary to naturalise the derived inflow sequences as none of our reservoirs are located downstream of significant artificial influences.

Given the requirements of this plan, we revisited our inflow modelling, and developed hydrological models so that we can:

[14] Although there are observed inflows for parts of the Wimbleball reservoir catchment area, from which we abstract a key source of water.
[15] Regionalisation is the name given to a broad range of methods developed in the field of hydrology for predicted river flows in ungauged basins. The methods use similarity of catchment characteristics between similar or nearby gauged catchments to develop predictive relationships for the flow characteristics (or model parameters to predict the flow characteristics) of the ungauged catchment.

- Extend backwards the hydrological record for reservoir inflows and groundwater levels under historical drought events, for which observed records were not available (e.g. back to 1921 drought event).
- Calculate actual evapotranspiration for the water supply area as input to the aridity index calculation used to derive our plausible drought event set (Section 8.2).
- Simulate river flows and groundwater levels for plausible drought events generation, as an input to our system simulation model, Miser, to simulate how the supply system would perform under more severe droughts.

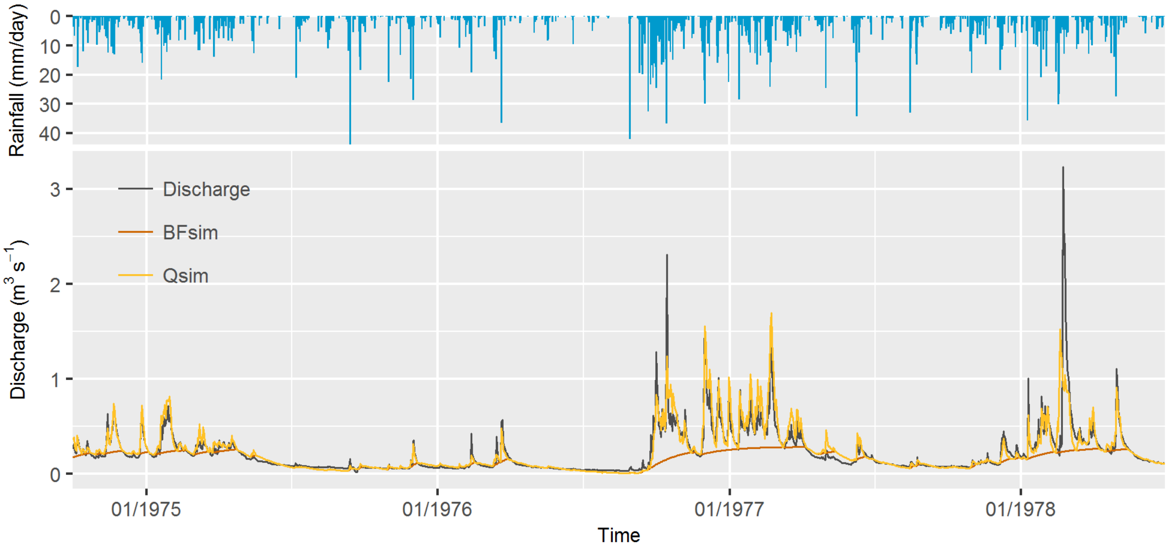
In order to satisfy the above requirements, hydrological models were calibrated for the following catchments in the Wessex water area:

- **Reservoir catchments –** to predict inflows to reservoirs under droughts.
- **Groundwater catchments** – used as input to calculate groundwater recharge to estimate borehole yield at groundwater sources (Section 4.2.2).
- **Stream support catchments –** where low flow conditions, which are likely under droughts, trigger stream support.
- **Abstraction licence catchments –** catchments where low river levels affect the amount of water we are licenced to abstract.

For the above catchments, the widely applied conceptual HBV hydrological model was applied to simulate catchment hydrological response. To calibrate the model for each catchment, 100,000 model simulations were run, with Monte Carlo parameter sampling. For each model run, a number of calibration performance metrics were calculated, based on aspects of the hydrological response (e.g. performance at low flow, water balance, groundwater level), depending on the catchment of interest.

The specific calibration objective used to select the model parameter set for generating Miser inflows for each catchment was chosen based on the specific requirements of the model. For example, for reservoir catchments, capturing total inflow is most important (e.g. winter recharge), alongside performance at low flows during dry summer periods, whereas the exact timing and magnitude of winter high flows is less important. Similarly, for catchments where river flows are used to trigger stream support, the timing of crossing the thresholds for stream support is most important, whereas being able to predict high flows, particularly during winter, is not relevant to the application of the model. The chosen parameter set was either taken from the best performing model run for a specific objective, or by exploring the pareto front trade-off between different objectives (e.g. water balance and low flow performance). Figure 4-9 shows an example calibration of the HBV hydrological model for the Currypool catchment.

Figure 4-9: Comparison of observed (Discharge) and modelled (Qsim) river discharge for the Currypool stream during the 1975/76 drought event. BFsim is the modelled baseflow discharge.



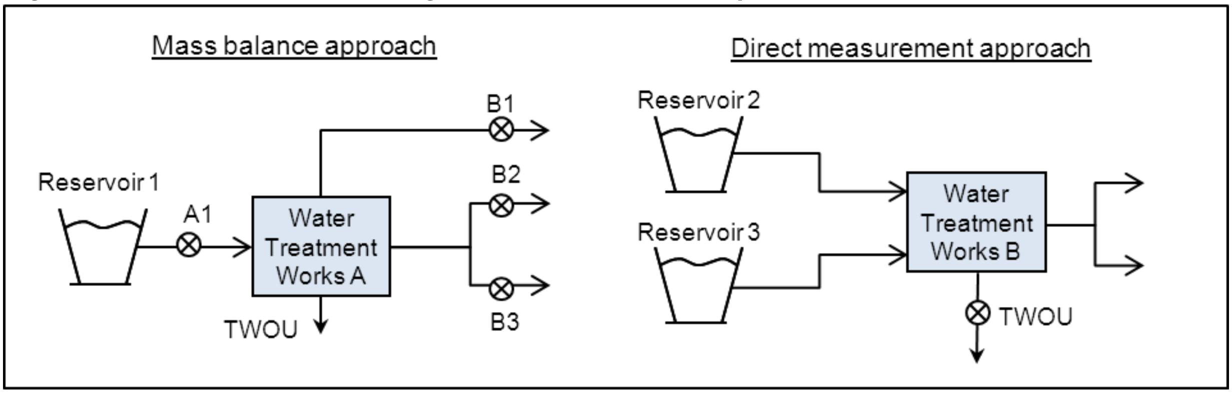
4.3 Treatment works operational use

Treatment works operational use (TWOU) is water abstracted from sources that does not enter distribution as it is 'used' during treatment processes. At most sites these losses are small and related only to the volume of water passing through water quality monitors that is not recovered. Filter backwashing at iron removal plants results in modest usage of 1.5% of produced water. The largest TWOU volumes are associated with surface water treatment plants (where usage ranges from 1.3 - 12%). At some sites the used water is discharged into the local watercourse under permissions granted by a Discharge Consent from the Environment Agency; at other sites the water enters the sewer system and is treated at a wastewater treatment works and then returned to a stream or river.

It is important that TWOU is accounted for in the calculation Water Available For Use (WAFU). For our surface water sources which have the most significant operational use volumes the proportion of abstracted water used by treatment processes is applied as a 'source constraint' in Miser, as per Figure 4-10.

The percentage value of the constraint for each surface water treatment plant is calculated as a mass balance of the flow into the works less the flow out of the works for all sites except one (Maundown WTW). For this works, water that has been operationally used is measured as it is discharged to a local watercourse. Figure 4-10 illustrates the mass balance approach for an example water treatment works. TWOU is equal to A1 – (B1 + B2 + B3).

Figure 4-10: Schematic illustrating how treatment works operational use is calculated



A schematic for each our surface water treatment works is provided in Annex F.

Accounting for TWOU within the Miser model means that the deployable output values that we quote for each source are net of water used operationally. The figures used in the planning tables 1.BL Licences are inclusive of all operational use. Table 4-1 provides the TWOU values for surface water treatment works.

Table 4-1: TWOU for surface water treatment works

Treatment works^	Source(s)	TWOU as % of output*	Treatment Works Operational Use (Ml/d)$
Ashford	Ashford and Hawkridge Reservoirs	6.0	0.56
Durleigh	Durleigh Reservoir	12.0	1.74
Fulwood	Leigh and Luxhay Reservoirs	9.0	0.59
Maundown	Wimbleball and Clatworthy Reservoirs	1.3	0.76
Sutton Bingham	Sutton Bingham Reservoir	2.1	0.16
Total	-	-	3.81

^ Nutscale / Porlock not included as due to be decommissioned.
* Percentage use applied in Miser.
$ Implied from dry year annual average deployable output for source.

In our annual analysis of TWOU that is a component of the calculation of distribution input for Regulatory Reporting, we also make an assessment of the volume of water that is used operationally by the following:

- **Membrane treatment works**: associated with membrane wash cycles; accounted for 0.023 Ml/d in 2017/18.
- **Iron treatment works**: associated with filter backwashing; accounted for 1.5% of works output, 0.076 Ml/d in 2017/18.
- **Water quality monitors and running to waste**: associated with flow through water quality monitors at all sites and when abstracted water is 'run to waste' (typically because it does not meet the necessary quality parameters, i.e. short lived turbidity peaks). This component accounted for 0.742 Ml/d in 2017/18 based on an estimate of the total number of water quality monitors (at all sites) and their flows rates and nominal volume for sources running to waste.

The operational use volumes stated above collectively amount to 0.84 Ml/d and are not allocated to individual sources within Miser and so it is appropriate to account for this volume separately in the supply forecast.

In the context of the 25-year planning period we considered whether upcoming maintenance programmes at any of our surface water treatment works would significantly affect the appropriateness of using past TWOU throughout the period but concluded that operational uses would not be significantly impacted.

4.4 Abstraction licences, sustainability reductions and deterioration risks

All of the water that we supply to customers comes from our local environment. Approximately 75% of our water supplies come from boreholes and wells that tap into the chalk and limestone aquifers of Wilshire and Dorset and 25% from reservoirs in Somerset. Our region contains a wide range of important landscapes and habitats and we take our responsibility to minimise the impact of abstraction very seriously.

The main way of ensuring our water supply activities do not have an unacceptable adverse impact on the environment is through abstraction licensing. Our licences specify the maximum amount of water that can be taken each day and each year and in some cases also link abstraction rates to flow thresholds in local watercourses. For example, for one of our groundwater sources in Dorset, the licence allows us to abstract up to 4.5 Ml/d if the flow in the river is greater than 12.9 Ml/d. When the flow drops below 12.9 Ml/d we must reduce our abstraction to no more than 3.4 Ml/d, thereby helping to protect the river at times of lower flow.

At other sites, when river flows are low we add water to the river, and this is termed stream support. In the upper reaches of the Bristol Avon catchment we can increase flows by more than 30 Ml/d using water taken from boreholes that are nearly 100 metres deep. In the early 1990's the river used to run dry in the summer, but stream support now helps maintain a good flow through the town of Malmesbury even in the driest of years

Licence information for all sources is specified within Miser so that deployable output modelling (see Section 4.9) takes account of these constraints on source outputs.

In our deployable output assessment, we have not included any changes to deployable output from abstraction reform. Our planning tables identify sources that have unused licence volumes according to our deployable output assessment.

4.4.1 Licence changes – made and pending

At some sources concerns have been raised that the existing licences do not adequately protect the environment – in response we have worked in partnership with the Environment Agency and Natural England to investigate the issues and identify mitigation measures where appropriate. Table 4-2 summarises the investigations we have undertaken and the outcomes from the studies. It should be noted that several of the investigations have identified unacceptable impacts and the Environment Agency have then required changes to licence conditions (i.e. reductions) or other mitigation measures to be made.

Table 4-2: Recent investigations on the impact of abstraction on the environment

Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
AMP2 (1995-2000)	River Piddle	Briantspuddle	**Impact of abstraction unacceptable –** when river flows are low abstraction now reduced by up to 9 Ml/d and this water is used for stream support instead
AMP3 (2000-2005)	Chalfield Brook	Holt	**Impact of abstraction unacceptable –** stream support trigger raised to a higher flow threshold to increase mitigation
	Currypool Stream	Ashford	**Impact of abstraction unacceptable –** increased compensation flow at Currypool
	St Catherine's Valley	Monkswood, Oakford, Batheaston	**Impact of abstraction not significant – no licence change required**
	South Winterbourne	Winterbourne Abbas	**Impact of abstraction not significant – no licence change required**
	River Marden	Calstone	**Impact of abstraction not significant – no licence change required**
	Semington Brook	Luccombe	**Impact of abstraction unacceptable –** source abandoned and licence revoked
AMP3 & AMP4 (2000-2010)	Tributaries of the Upper Bristol Avon	Malmesbury sources	**Impact of abstraction unacceptable –** licence to be reduced by 4 Ml/d and up to 22.5 Ml/d of additional stream support to be provided. **See also section below this table.**
	Codford Brook	Chitterne	**Impact of abstraction unacceptable –** licence reduced by 14 Ml/d and up to 5 Ml/d stream support to be provided
	River Piddle	Alton Pancras	**Impact of abstraction unacceptable –** licence reduced by 1.3 Ml/d for public water supply and up to 2.5 Ml/d stream support to be provided
AMP4 (2005-2010)	River Bourne	Clarendon	**Impact of abstraction unacceptable –** licence to be reduced by 11 Ml/d in 2018
		Newton Toney	**Impact of abstraction unacceptable –** licence for public water supply to be reduced by 1.5 Ml/d and instead provided as stream support in 2018
	River Wylye	Brixton Deverill	**Impact of abstraction unacceptable –** licence to be reduced by 5 Ml/d in 2018
		Codford	**Impact of abstraction unacceptable –** licence to be reduced by 6 Ml/d in 2018
	River Avon SAC	23 individual sources (including those listed above for River Bourne & River Wylye)	**Impact of abstraction not significant other than for the sources identified for the River Bourne and the River Wylye – licence changes as above.**
	Shreen and Ashfield Water	Mere	**Impact of abstraction not significant – no licence change required** (see Section 4.5.4 on AIM for further information)
	Avon Valley SPA	Blashford	**Impact of abstraction not significant – no licence change required**

Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
	Fonthill Brook	Fonthill Bishop	**Impact of abstraction not significant – no licence change required**
	Upper River Yeo	Milborne Wick, Bradley Head, Lake & Castleton	**Impact of abstraction not significant – no licence change required**
	Stowell Meadow SSSI	Tatworth	**Impact of abstraction not significant – no licence change required**
	Bracket's Coppice SAC	Corscombe	**Impact of abstraction not significant – no licence change required**
	Middle River Stour	Black Lane, Sturminster Marshall, Shapwick & Corfe Mullen	**Impact of abstraction not significant – no licence change required**
	Exmoor & Quantock Oakwoods SAC	Nutscale	**Impact of abstraction not significant – no licence change required**
	Tadnoll Brook (Dorset Heaths SAC/SPA)	Empool	**Impact of abstraction not significant – no licence change required**
	Cannington Brook	Ashford	**Impact of abstraction not significant – no licence change required**
	Isle of Portland to Studland SAC	Belhuish & Lulworth	**Impact of abstraction not significant – no licence change required**
AMP5 (2010-2015)	River Avon SAC	Clarendon, Newton Toney, Brixton Deverill & Codford.	**Baseline monitoring of the impact of licence changes to be made in 2018.**
	Heytesbury Brook	Heytesbury	**Impact of abstraction not significant – no licence change required**
	Teffont Brook	Fonthill Bishop	**Impact of abstraction unacceptable** – daily licence to be reduced by 1.5 Ml/d in 2018
	Upper Hampshire Avon (western)	Bourton, Bishops Cannings & Chirton	**Impact of abstraction unacceptable** – daily licence to be reduced to current 'summer' limit all year at Bishops Cannings and Bourton (reductions of 1.15 Ml/d and 2 Ml/d respectively) in 2018. River restoration measures also to be undertaken on SSSI stretch.
	Bere Stream (SSSI and BAP)	Milborne St Andrew	**Impact of abstraction not significant – no licence change required**
	Biss Brook	Upton Scudamore boreholes and springs, and Wellhead	**Impact of abstraction unacceptable** – daily licence of Upton Scudamore boreholes to be reduced by 5.4 Ml/d and hands-off flow for springs abstraction to increase from 1.0 to 1.5 Ml/d in 2018
	River Wey	Friar Waddon	**Impact of abstraction not significant – no licence change required**
	Sutton Bingham Stream	Sutton Bingham	**Investigation showed the need for trials in AMP6 involving variations in compensation flows, introduction of spate flows and river restoration measures.**
	Upper River Tone	Clatworthy	**Impact of abstraction not significant – no licence change required**

Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
	Durleigh Brook	Durleigh	**Investigation showed the need for trials in AMP6 involving variations in compensation flows, introduction of spate flows and river restoration measures.**
AMP6 (2015-20)	Durleigh Brook*	Durleigh	**Investigation ongoing: trialling spate flows to drive ecological improvements** – no licence change required.
	Sutton Bingham Stream*	Sutton Bingham	**Investigation ongoing: introducing sediment to drive ecological improvements**– no licence change required.
	Cannington Brook/Currypool Stream*	Ashford and Hawkridge	**Investigation ongoing: monitoring of flows and ecology to understand impact** – no licence change expected.
	Horner Water	Nutscale	**Source abandoned: investigation** ceased and abstraction licence reduced **to** 1.5Ml/d.
	Upper Hampshire Avon (western)	Bourton, Bishops Cannings & Chirton	**River restoration to improve channel morphology.**
	Devils Brook	Dewlish	**Investigation ongoing:** monitoring of flows and ecology to understand impact – no licence change expected.
	Lam Brook	Compton Durville	**Impact of abstraction unacceptable** –abstraction licence reduced to 2.5 Ml/d
	River Tarrant, Pimperne Brook, North Winterbourne	Shapwick, Corfe Mullen, Sturminster Marshall, Black Lane, Stubhampton	**Investigation ongoing:** monitoring of flows and ecology to understand impact. Potential reduction in licence at Stubhampton of 0.5-1 Ml/d (see section 4.4.3 below).
	Maiden Bradley Brook	Dunkerton	**Investigation ongoing:** monitoring of flows and ecology to understand impact – no licence change expected.
	River Jordan	Sutton Poyntz	**Investigation ongoing:** monitoring of flows and ecology to understand impact – no licence change expected.
	River Avon SAC	Clarendon, Newton Toney, Brixton Deverill & Codford.	**Investigation ongoing:** Ecological monitoring of the impact of licence changes to be made in 2018.

* One or more of the water bodies with this investigation are classified as Heavily Modified Water Bodies (HMWB) under the Water Framework Directive.

4.4.2 *Proposed water resource investigations for 2020-2025*

In the period 2020-25 we will be completing the environmental investigations set out within the Water Industry National Environment Programme (WINEP). The WINEP identifies the actions that we must undertake to deliver our environmental obligations and is developed by the Environment Agency and Natural England in consultation with us. The actions may include changes to our abstractions driven by environmental legislation, for example to meet River Basin Management Plan objectives under the Water Framework Directive, or water resource investigations where more evidence is required to determine the impact of our operations.

The WINEP is updated to reflect new information and new versions are released at key stages during the development of our water resources and business plans. In September 2017 we received the second release (WINEP2), the outcomes of which were included in our draft WRMP in November 2017. Since publication of the draft plan, WINEP3 was released in March 2018. The changes made between WINEP2 and WINEP3 have been incorporated into the revised final plan. Table 4-3 shows the water resources investigations and actions identified within WINEP3.

Table 4-3: Water resources investigations and actions in WINEP3 for 2020-25

River / environmental feature	Source	Measure type
River Otter	Otterhead	Options Appraisal
Ashford Reservoir and Currypool Stream	Ashford	Adaptive Management
Upper Hampshire Avon (western)	Bishops Cannings	Investigation and Options Appraisal
Pimperne Brook	Black Lane	Adaptive Management
Upper Hampshire Avon (western)	Bourton	Investigation and Options Appraisal
Hampshire Avon	Chirton	Investigation and Options Appraisal
Devils Brook	Dewlish	Sustainability change
Durleigh Brook	Durleigh	Adaptive Management
Hampshire Avon	Durrington	Investigation and Options Appraisal
South Brook (Bristol Avon)	Goodshill	Investigation and Options Appraisal
Chalfield Brook (Bristol Avon)	Holt	Investigation and Options Appraisal
Bristol Avon	Ivyfields	Investigation and Options Appraisal
Bydemill Brook (Bristol Avon)	Lacock	Investigation and Options Appraisal
Ozleworth Brook, Horsley Stream, Nailsworth Stream	Luckington, Stanbridge, Tetbury*	Investigation and Options Appraisal
River Isle	Pole Rue	Investigation and Options Appraisal
River Till	Shrewton	Investigation and Options Appraisal
River Tarrant	Stubhampton	Sustainability Change
River Jordan	Sutton Poyntz	Land Management/ Habitat Restoration/ Physical Improvement

*Luckington, Stanbridge, and Tetbury are stream support sources.

4.4.3 Future sustainability reductions

We have worked closely with the Environment Agency through the WINEP process to identify any potential changes that could be required to our licences to ensure they are sustainable, and we have discussed appropriate timescales to implement sustainability changes with the Environment Agency. Since the publication of the draft WRMP, we have discussed changes to our plan resulting from the release of WINEP3.

Under WINEP3, two sites were included as confirmed sustainability changes; Dewlish and Stubhampton. Dewlish will see a 3 Ml/d reduction in the daily licence to 6.09 Ml/d (from 9.09 Ml/d) at times when flow in the Devils Brook requires the stream support to be running. There will be no change to the annual licence. At Stubhampton, following discussion with the EA and the River Tarrant Protection Society we have agreed to operate the source under an Abstraction Incentive Mechanism to achieve a reduction in abstraction without a legal change to the licence. See Section 4.4.4 for a full description of the abstraction strategy for Stubhampton. Our supply-demand balance has been updated to reflect these changes, where our planning tables now include a reduction at Dewlish but not at Stubhampton.

The water resources planning guidelines recommend we assess the impact of possible future sustainability changes on our plan through scenario testing. We have reviewed the potential for future sustainability changes that could arise from the investigations that will be undertaken between 2020 and 2025, and have made an assessment about what a ‘low’, ‘likely’ and ‘high’ reduction volumes could be for each source (Table 4.4). These indicative volumes were discussed and agreed with the Environment Agency during pre-consultation and revised following publication of WINEP3 and further discussion with the Agency.

The assessment drew upon quantitative and qualitative information that is available prior to the investigations taking place – they are therefore reasonable for scenario testing purposes but will be subject to change once the investigations are complete and the requirements of the revised Common Standards Monitoring Guidance are confirmed.

The impacts that the alternative scenarios could have on our final supply demand balance are explored in Section 10.2.1.

Table 4-4: Sustainability reduction scenarios that could be implemented from 2025

Source	Licence (Ml/d)		Potential reduction (Ml/d) DYAA			Potential reduction (Ml/d) DYCP		
	Daily	Annual*	Low	likely	high	low	Likely	high
Bishops Cannings	1.15	1.15	0	0	0.39	0	0	0.78
Bourton	2.1	2.1	0	0	0.11	0	0	0.22
Chirton	2.27	1.5	0	0	0	0	0	0
Compton	3.9	2.73	0	0	0.75	0	0	1.5
Durrington	6.55	4.93	0	0	0.35	0	0	0.7
Deans Farm	12	11.87	0	0	0	0	0	0
Shrewton	2.27	2.27	0	0.37	0.76	0	0.74	1.51
Pole Rue	4.54	4.54	0	0.5	0.75	0	1	1.5
Otterhead	11.36	2.49	0	0	0.5	0	0	1
Ivyfields	18.7	14	0	1	1.5	0	2	3
Lacock	9.1	7	0	1	1.5	0	2	3
Dunkerton Springs	6.82	4.54	0	0	0.5	0	0	0
Holt	17	11	0	2	4	0	0	0
Total	**97.76**	**70.12**	**0**	**4.87**	**11.11**	**0**	**5.74**	**13.21**

*expressed as a daily average

4.4.4 Abstraction incentive mechanism

Abstraction investigations like those described earlier in this section can be inconclusive or the impact assessed to be small, or despite the lack of impact assessed on a scientific basis, there remains significant local community concern about the impact of abstraction.

In such cases, and where there is flexibility in a system to use other sources, the operation of an abstraction incentive mechanism (AIM) can be a useful tool to achieve reductions in abstraction without formally changing an abstraction licence. An AIM provides an incentive for a water company to reduce its abstraction from a particular source when abstraction is happening at a sensitive time – i.e. during periods of low river flows.

If necessary, due to a lack of water availability at other sources in the system, abstraction can occur from the source at the full licence but the company will have to pay an additional cost for doing so. Although this may involve some abstraction at times when river flows are low, ecological systems are usually robust enough to mitigate the impact of temporary abstractions even during periods of low flow.

We introduced a trial AIM scheme at Mere in our last Plan and AIM has been implemented here since April 2015. Since the application of the AIM programme at Mere we've reduced the volume of water abstracted to export from the local catchment by around 60%. This is described further below. This Plan proposes the continuation of the AIM at Mere for the next 5-year period from 2020-25.

We have also taken the opportunity to review whether other sites are suitable for the application of an AIM scheme[16]. and particularly whether it would be a good short or long term option for of the sites included in the WINEP – this is explored later in this section.

Application of AIM at Mere

The Mere source in the Stour catchment was identified as being at risk of causing deterioration to Water Framework Directive status and being of concern to local residents. We investigated the impacts of abstraction at Mere from 2005-08 as part of the Environment Agency's Restoring Sustainable Abstraction programme. The conclusion of this study was that effects of abstraction were not significant enough to require a reduction in licenced volumes.

Mere is an ideal site for an AIM approach:

- Abstraction does have some impact on river flows. Although this has not been shown to be environmentally damaging the AIM incentive would be focussed exclusively on times when this is most likely, i.e. when groundwater levels are low.
- It recognises the locals concerns over the impact of abstraction.
- The incentive encourages the use of other sources where the environmental impact is less, for example Sutton Bingham reservoir to the south of Yeovil.
- There is no impact on the source's deployable output or contribution to overall system resilience in the event of source outages. Thus, AIM does not cause or bring forward any source, or infrastructure costs, relating to supply demand balance deficits.
- It works very well with demand management and community engagement
- The difference in the short run marginal costs of the sources involved is modest, about £64/Ml.

The AIM for Mere involves reducing the export of water from the Mere source out of the catchment to a maximum of 100 Ml/a while groundwater levels are below a specified threshold (103.75mAOD) measured at the local observation borehole (Burton OBH). This represents a significant reduction from the previous average transfer during this period of 462 Ml/a. The incentive on us is that if we exceed the 100 Ml/a target we must pay a cost per Ml for the excess. In addition, we agreed with the local community organisation, the Mere Rivers Group (MRG)[17], that the 'export' would also be reduced if streamflow in either the Ashfield and/or Shreen dropped below 2 Ml/d.

AIM has been applied at Mere since April 2015. We monitor groundwater levels and stream flows on a daily basis to enable appropriate management actions to be taken in a timely manner. Figure 4.7 shows the groundwater levels measured at Burton OBH. In 2016/17, the groundwater level measured at Burton OBH fell below the trigger threshold on 19 July and we restricted our export from this source to a sweetening flow only at this time. The groundwater level did not rise above the threshold until 31 January 2017, which was 53 days later than in 2015/16 due to the drier than average weather.

[16] Ofwat (2017). Delivering Water 2020: consultation on PR19 methodology.
[17] The Mere Rivers Group is a local action group, formed in 2011.

Since applying AIM at Mere we have reduced the export from the source during the AIM period of lower groundwater level as shown in Table 4-5 and Figure 4.8. Unfortunately, we exceeded the 100 Ml/a target in 2015/16 and 2016/17 because of water quality outages at neighbouring sources. Nonetheless abstraction was significantly below the historical average in these years (39% and 80% of pre-AIM average respectively). In 2017/18 we exported just 30 Ml from the catchment thereby meeting the 100 Ml/a target, despite entering the low flow period on 15 June due to a drier than normal winter. We expect to meet the target regularly in future years due to the greater degree of flexibility we have to move water around our network now that our integrated grid is fully commissioned, as of March 2018.

We meet annually with the Mere Rivers Group to discuss performance of the AIM and liaise with them regularly through the year to communicate changes to abstraction at the source.

Figure 4-11: Groundwater levels at Burton observation borehole near Mere source

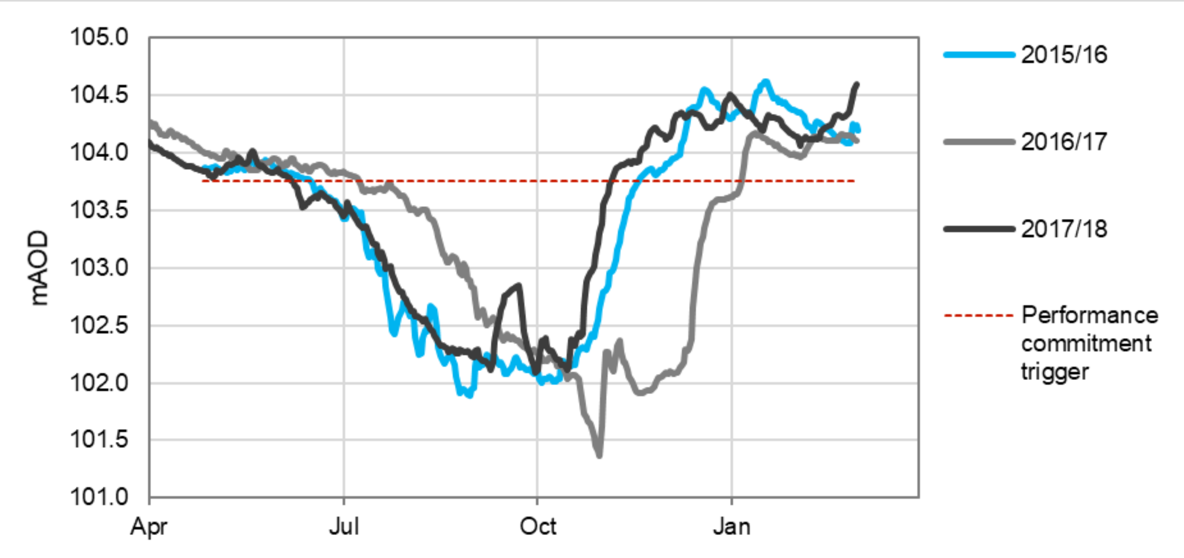


Figure 4-12: Exports from Mere during the AIM period

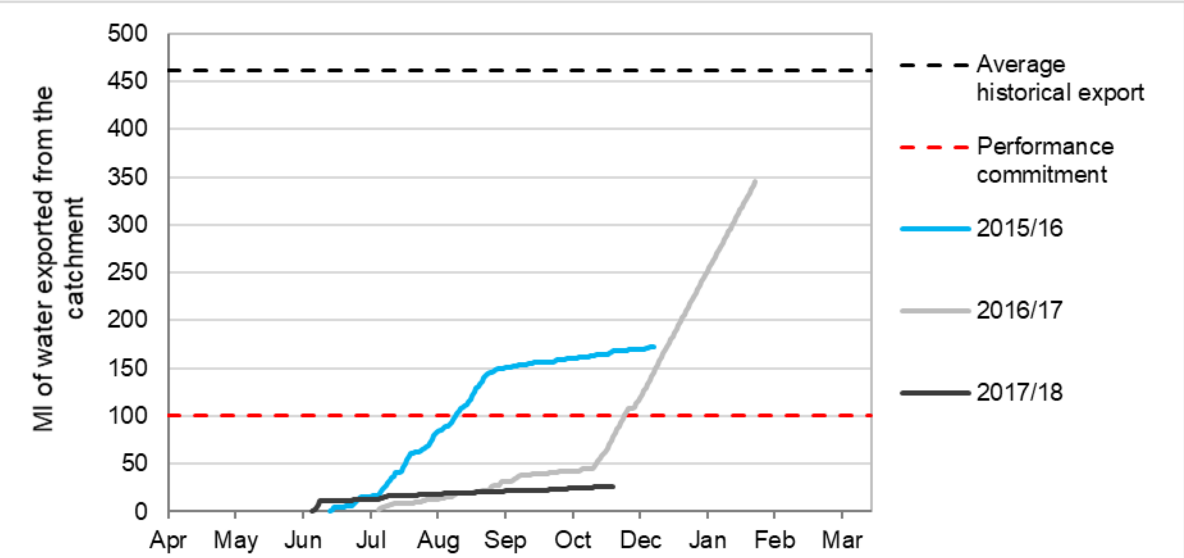


Table 4-5: Exports from Mere during the AIM period compared to the historical average export

Reporting year	Abstraction during AIM period (Ml)	Percentage of historical average*
2015/16	172	37 %
2016/17	341	74 %
2017/18	**30**	**7** %

*Based on the 5-year average prior to AIM starting which was 462 Ml.

AIM site – Stubhampton

Our Stubhampton groundwater source is located in the upper reach of the River Tarrant Valley. The source draws water from the underlying chalk aquifer, which is drained by the River Tarrant, a tributary of the River Stour. The Stubhampton source has been used since the 1950s and in the last 20 years abstraction has been close to 85% of full licence (2.18 Ml/d) all the time. The River Tarrant is a winterbourne stream and the whole river can dry during extended dry weather (as experienced in 1976).

The magnitude of flow, or more precisely the periods of no flow, in the River Tarrant has been the subject of residents' concerns for several years. Concerned parties have formed the River Tarrant Protection Society (RTPS) and have lobbied the EA and ourselves that abstraction is adversely impacting the flow and hence ecology of the River Tarrant.

In the 2015 to 2020 period we completed an investigation of the impact of public water supply abstractions upon the River Tarrant under a Water Framework Directive 'no deterioration' driver. The results show that our groundwater abstractions from neighbouring catchments do not impact flows along the River Tarrant. Therefore, any river flow change is due to the abstraction at Stubhampton. Hydrological modelling outputs suggest that on average between 1970 and 2016, the use of Stubhampton caused 14 days per year of extra drying (along the winterbourne reach from Gunville to Luton) compared to natural conditions, and 16 days per year if we were to abstract at the full licence. Conclusions from the ecological assessment indicate that the modelled scale of hydrological impact will not adversely impact the ecology of the River Tarrant.

Although the investigation shows that the impact of abstraction is not environmentally significant the concern of the local community remains. We have therefore proposed to implement an Abstraction Incentive Mechanism approach at Stubhampton to manage abstraction during low flow periods. In the development of our Business Plan we discussed this proposal with the Environment Agency and they are supportive of this approach for the 2020 to 2025 period.

The stretching target we are setting for the AIM at this source is to reduce abstraction during the AIM window (the period during which groundwater levels at Ivy Cottage[18] are below 78m AOD Ml/d) to 1.09 Ml/d. This is significantly lower than our recent (baseline) abstraction from the source during the AIM window which is 1.81 Ml/d, and half the licensed volume of

[18] Ivy Cottage is a privately-owned borehole that we have monitored during AMP6 with permission of the owner. We have assumed that we will be able to continue to access this site. In the event that this is not possible, an alternative location with an equivalent groundwater trigger level will be agreed in discussion with the EA and RTPS.

2.18 Ml/d. We estimate that this will result in abstraction being reduced for around 70% of the time, and an average reduction in abstraction of 192 Ml per annum (see Table 4-6).

Table 4-6: Historical use of Stubhampton and length of AIM window

	Historical PWS use in AIM Window (Ml/a)	AIM window (days)	Average historic use in AIM window (Ml/d)	Difference between Actual use and if AIM had been active (i.e. what would not have been abstracted) (Ml/a)
2011/12	673.4	366	1.84	274.4
2012/13	223.5	129	1.73	82.9
2013/14	505.4	262	1.93	219.8
2014/15	435.1	236	1.84	177.9
2015/16	445.4	249	1.79	173.9
2016/17	583.9	321	1.82	234.0
2017/18	493.0	288	1.71	179.1
Average	479.9	264	1.81	191.7

The AIM baseline for Stubhampton is 1.81 Ml/d abstracted over the AIM period (average abstraction of 479.9 Ml for an average of 264 days). This is based on our abstraction from this source between April 2011 and March 2018. This period has been used because it is representative of our abstraction for the period prior to AIM and includes the drier than average weather experienced in 2011/12 and 2016/17.

As with the Mere AIM, abstraction above the AIM level (1.09 Ml/d) is permitted without incurring an under-performance payment, provide the total use above 1.08 Ml/d does not exceed 45 Ml, during the AIM window. This value has been agreed with the EA and is broadly equivalent to 25% of the difference between the volume that we have historically abstracted during the AIM period (1.81 Ml/d) and the 1.09 Ml/d that we will be allowed to abstract under the AIM (difference: 0.72 Ml/d), multiplied by the average length of the AIM window (264 days). In addition, to protect spring heads on the river at the most sensitive time, during the first 60 days that the AIM window is open we will not abstract more than 11.25 Ml of the 45 Ml allowance (25% of 45 Ml).

4.4.5 Time limited licences

We hold just one time limited licence relating to the annual permitted abstraction volume from Wimbleball Reservoir. In 2011/12 the Environment Agency granted a variation to our Wimbleball licence to increase the annual limit from 11,615 Ml/a to 14,917 Ml/a. This change was related to the 2000-2010 (AMP3 and AMP4) Statement of Intent review of licences and helped make possible (by network displacement) the significant reduction in the annual volume abstracted at our Chitterne source.

The additional 3,302 Ml of annual licence for Wimbleball is time limited until 31 March 2023 (the base licence of 11,615 Ml/a has no time constraints). We anticipate applying to extend the variation by demonstrating need, efficiency and sustainability, and that the licence supports the achievement of the environmental objectives in the 2015 South West River Basin Management Plan. We look forward to discussions with the Environment Agency on this issue.

To account for the risk of non-renewal of the additional licence volume we have included an allowance in our headroom modelling – see Section 6.

4.4.6 Invasive and non-native species and eels regulations

Wessex Water has recently undertaken a National Environment Programme (NEP) investigation into invasive non-native species (INNS). The investigation consisted of:

- A review of INNS presence on land holdings
- Surveys where insufficient information was available
- Completion of a risk assessment of land, assets and operations
- Prioritisation of control/eradication opportunities and development of a programme of works for 2020-2025.

This investigation was completed and signed off by the Environment Agency in April 2017. The risk assessment element of this work included developing a risk matrix that focussed on the pathways by which INNS can be spread. The 25 highest risk sites identified in the assessment will be included in our next business plan (2020-25) as requiring biosecurity ranging from wash-down facilities at surface reservoirs with recreational sailing and angling to installing boot scrapers and awareness signage at sites accessed by public footpaths. In April 2017, a list of eight raw water transfers was compiled and sent to the Environment Agency. These have been included as investigations to be undertaken between 2020-25 following guidelines provided by the Environment Agency. This work reflects the Environment Agency's INNS February 2017 position statement and its principles.

We have no new proposed supply-side schemes as preferred options for this plan, and so have not considered INNS mitigation measures for new schemes.

Wessex Water is required to ensure that its operations are compliant with the Eels Regulations (England and Wales) 2009. We have undertaken investigations at ten of our water supply sites to assess the risk that they pose to eel entrainment and act as barriers to eel migration. Through this work we have identified sites where improvements to screening and upstream and downstream eel passes may be required, subject to the outcome of a cost benefit assessment (CBA) prescribed by the Environment Agency.

The CBA is not yet complete; however, the WINEP currently identifies the need to improve screening at the Albert Street intake on the Bridgwater and Taunton Canal. The requirement for screening improvements at a further seven sites will be determined by the CBA and discussion with the Environment Agency. There are no sites identified for eel passage improvements in the WINEP. It is our understanding that this is the case for all water companies, and we await further guidance from the Environment Agency's national fisheries team about these measures.

None of these measures will impact on our supply forecasts.

4.5 Accounting for water quality issues

The Water Supply (Water Quality) Regulations include mandatory standards for the quality of drinking water and the management of risk, in order to protect public health. Thus it is essential that our drinking water quality obligations are fully taken into account in the long-term planning of water resources. In September 2017 the Drinking Water Inspectorate (DWI) issued their guidance on the long term planning of drinking water quality[19]. The accompanying information letter issued by the DWI[20] highlights that there are no new policy initiatives and no new legal obligations, and that our focus should be on delivery of existing obligations using current good practice, within a long term planning context.

We confirm that this Plan is integrated with our drinking water quality programme and our maintenance programme, in order to ensure consistency across all areas for both business planning and delivery.

This section describes our strategy for managing drinking water quality, including catchment management, our maintenance programme, and the approach we have taken to incorporate water quality risks into this water resources management plan.

This Plan demonstrates that we have a robust water resources position with a supply demand balance surplus throughout the planning period (Sections 7 and 11). This surplus has been achieved by reducing demand (Section 5.1) and developing our integrated Grid to connect areas with surplus with areas with less resource (Section 3.1.1), rather than developing new resources. The Grid has also enabled us to maximise the opportunities from catchment management to deal with rising nitrates.

4.5.1 Outcome – Excellent drinking water quality

Our long-term priorities are described in our Strategic Direction Statement, published in July 2017, which reconfirmed a commitment to providing the highest quality drinking water.

The Strategic Direction Statement informs and supports both our water resources management plan and business plan proposals. The drinking water quality outcome and actions points (reproduced below) include use of source-to-tap drinking water safety plans, continued use of catchment management and proactive maintenance of our sources and water treatment works.

[19] http://dwi.defra.gov.uk/stakeholders/guidance-and-codes-of-practice/ltpg.pdf
[20] http://dwi.defra.gov.uk/stakeholders/information-letters/2017/03-2017.pdf

Excellent quality drinking water

Action points:

We will proactively maintain our water treatment works and distribution system using the latest technology in order to maintain excellent quality drinking water.

We will use catchment management to protect sources of raw water from contamination wherever feasible.

In addition to ensuring high levels of compliance we will manage risks to water quality by using source-to-tap drinking water safety plans.

We will continue to work closely with WRAS, the water fittings agency, on customers' plumbing and promoting WaterSafe (the industry approved plumber scheme). The use of appropriate materials will be a key focus as a significant proportion of water quality failures can be attributed to domestic plumbing and service pipe issues such as lead pipes, copper plumbing and nickel in taps.

We will continue to replace lead pipes in combination with phosphate dosing, a process that safely coats the inside of lead pipes.

We will continue to reduce customers' concerns about the appearance, taste and odour of their water through a combination of targeted rehabilitation of water mains and improved availability of information for customers who experience problems.

Outcome:

Safe, wholesome and pleasant drinking water which complies with mandatory standards and supports the wellbeing of our customers and communities.

4.5.2 Drinking water quality management

Seventy-five per cent of the water we abstract comes from groundwater sources and the majority of this is of good quality requiring minimal treatment other than disinfection before being suitable for supply to customers. The remaining 25% is provided by impounding reservoirs in Somerset. The raw water from these sources requires multiple complex treatment processes, as well as disinfection.

The Water Supply (Water Quality) Regulations 2016 include mandatory standards for drinking water, including nitrates and pesticides, to protect public health. These standards are enforced by the Drinking Water Inspectorate (DWI). We aim to uphold these standards at all times. In 2016 we carried out over 33,000 tests on water samples to monitor the quality of water we supply to customers. Over the past five years our mean zonal compliance with the drinking water standards has averaged 99.97%.

Our approach to long term planning and identifying proposals for drinking water quality improvements involves a combination of the following methodologies:

- Drinking water safety plans – further details provided below
- Review of compliance and operational performance, including customer contacts
- Horizon scanning of future obligations, include DWI's guidance note on long term planning.

Drinking water safety plans

Drinking Water Safety Plans (DWSP) enable us to understand risk to water quality from source to tap. The plans, or risk assessments, have transformed the way we think and act about drinking water safety.

The Drinking Water Safety Plans comprise a detailed site-by-site risk assessment. For each of our sources, water treatment works, distribution sites and water quality zones they comprise:

- Four stages from source to tap: catchment, treatment, distribution and customer
- Three categories: public health, compliance and serviceability
- Risk scoring of hazards based on consequence and likelihood in a 5 x 5 matrix
- Mitigation actions for each hazard/hazardous event.

The DWSP process is reliant on the compilation and continual assessment of data, knowledge and information by catchment specialists, process scientists, production and network operatives and customer services staff. The accompanying DWSP methodology is a 'live' document kept under continuous review to ensure further changes and improvements can be captured as plans continue to develop. We have a DWSP scientist to ensure that risks are scored consistently, which is then verified by a monthly meeting to further ensure consistency.

The DWSP process generates a large database of actions and risk scores, which are then used to prioritise investment and inform a rolling programme of capital maintenance.

Particular strategies arising from our DWSP reviews are described in the following sections, including:

- catchment management to mitigate rising nitrates and pesticides
- cryptosporidium risk reduction
- strategic maintenance.

4.5.3 Raw water quality and catchment management – nitrates and pesticides

With a large number of sources abstracting water from unconfined chalk aquifers, maintaining drinking water quality compliance in the face of rising nitrates is a major challenge. In addition, our surface water sources (and one groundwater source) are at risk from elevated pesticides.

The traditional approach to achieving compliance is by building treatment works, and in some cases we have had to do this. But treatment works are expensive to build, expensive to operate, high carbon, inflexible (nitrate treatment does nothing for pesticides and vice versa), and in the case of metaldehyde only partially effective.

Therefore, for the last 12 years we have been taking a catchment management approach. This involves working very closely with farmers in the areas around our reservoirs and boreholes – collecting detailed information on nitrate and pesticide concentrations and providing this to farmers to help them optimise their applications. In the direct catchment to

Durleigh reservoir we have successfully reduced metaldehyde by subsiding farmers to use of an alternative slug control product that does not include metaldehyde.

Whilst this is clearly the right approach in most circumstances – and it has been strongly supported by the Government – it does involve the water company taking more risk. We have sought to mitigate the risk by interconnecting our sources as far as possible, particularly with our integrated grid developments (Section 3.1) but monitoring nitrate concentrations and active catchment management remains a key activity to maintain a robust supply position.

Table 4-6 lists the sources where we are currently or intend to start implementing a catchment management programme. The average and peak deployable outputs are specified to indicate the scale of the issue to us. Sources where catchment management is planned to be started in 2020 will be included in our next Business Plan for review with Ofwat, the Drinking Water Inspectorate and the Environment Agency. Further details are given in the following sections.

Table 4-7: Sources with current or planned catchment management programmes

<table>
<tr><th>Source</th><th>Average deployable output (Ml/d)</th><th>Peak deployable output (Ml/d)</th><th>Risk</th><th>Start of catchment management</th></tr>
<tr><td>Deans Farm</td><td>10.12</td><td>12.00</td><td rowspan="3">Nitrate</td><td rowspan="7">2005</td></tr>
<tr><td>Eagle Lodge</td><td>7.00</td><td>8.20</td></tr>
<tr><td>Empool</td><td>12.63</td><td>24.00</td></tr>
<tr><td>Friar Waddon</td><td>8.24</td><td>7.84</td><td rowspan="4">Pesticides</td></tr>
<tr><td>Ulwell</td><td>0.73</td><td>0.45</td></tr>
<tr><td>Sutton Bingham</td><td>6.28</td><td>18.00</td></tr>
<tr><td>Durleigh</td><td>11.83</td><td>28.00</td></tr>
<tr><td>Bulbridge</td><td>0.76</td><td>0.76</td><td rowspan="5">Nitrate</td><td rowspan="5">2010</td></tr>
<tr><td>Fonthill Bishop</td><td>5.56</td><td>5.50</td></tr>
<tr><td>Hooke</td><td>2.42</td><td>1.49</td></tr>
<tr><td>Shapwick</td><td>5.60</td><td>7.09</td></tr>
<tr><td>Sturminster Marshall</td><td>15.95</td><td>15.95</td></tr>
<tr><td>Alton Pancras</td><td>2.44</td><td>3.51</td><td rowspan="6">Nitrate</td><td rowspan="7">2015</td></tr>
<tr><td>Belhuish</td><td>4.40</td><td>7.22</td></tr>
<tr><td>Friar Waddon</td><td>8.24</td><td>7.84</td></tr>
<tr><td>Milborne St Andrew</td><td>3.98</td><td>6.57</td></tr>
<tr><td>Sutton Poyntz</td><td>8.74</td><td>5.60</td></tr>
<tr><td>Forston</td><td>2.48</td><td>1.79</td></tr>
<tr><td>Ashford</td><td>7.87</td><td>14.00</td><td>Pesticides</td></tr>
<tr><td>Briantspuddle</td><td>12.32</td><td>9.00</td><td>Nitrate</td><td>2020</td></tr>
</table>

Source	Average deployable output (Ml/d)	Peak deployable output (Ml/d)	Risk	Start of catchment management
Cherhill	1.11	0.91	Nitrate	2020
Goodshill	0.46	0.29	Nitrate	2020
Litton Cheney	3.07	3.40	Nitrate	2020
Divers Bridge	4.31	3.94	Nitrate	2020
Shepherds Shore	1.50	0.54	Nitrate	2020
Albert Street (Bridgwater & Taunton Canal / River Tone)	N/A (Inc. in DO for Durleigh)	N/A (Inc. in DO for Durleigh)	Pesticides	2020
Total	**148.04**	**193.89**	-	-

Nitrates

Detailed analysis of the trends in nitrate concentrations has identified six sources where the concentration of nitrates may breach the standard before 2030. A ten year planning horizon is selected in order to give adequate time for catchment management activities to take effect.

Catchment management at these sites is supported by the Environment Agency through the Water Industry National Environment Programme (WINEP), under a drinking water protected area driver.

However at three sites, despite working with farmers for ten years, we have not seen any reduction in the concentration of nitrates, which now threatens to breach the standard in drinking water. The three sites are:

- Sturminster Marshall/Shapwick. These two sources combine at Sturminster Marshall water treatment works
- Fonthill Bishop
- Deans Farm.

Although the Grid project has provided a facility to back up each of these sources, the basis of design agreed in 2010 was that nitrate exceedances would be short term and only during the winter when demand was low. The recent data and the specialist trend analysis shows that elevated nitrates can occur at any time of year and for much longer durations. An alternative strategy is therefore required to ensure compliance.

Our options analysis concluded that the most cost-effective solution is to blend the high nitrate water with low nitrate water from a neighbouring source. Blending facilities are already is in place at Deans Farm. For the other two sites (Fonthill Bishop and Sturminster Marshall), we included blending proposals in our PR19 water quality submission to the DWI in December 2017. We subsequently received two letters of support for these schemes from the DWI, and have included the proposals in our September 2018 business plan submission[21]. The implications of blending on the utilisation of the sources and thus their deployable output is allowed for in our Miser modelling. Background catchment management will continue to minimise the risk of gross exceedances.

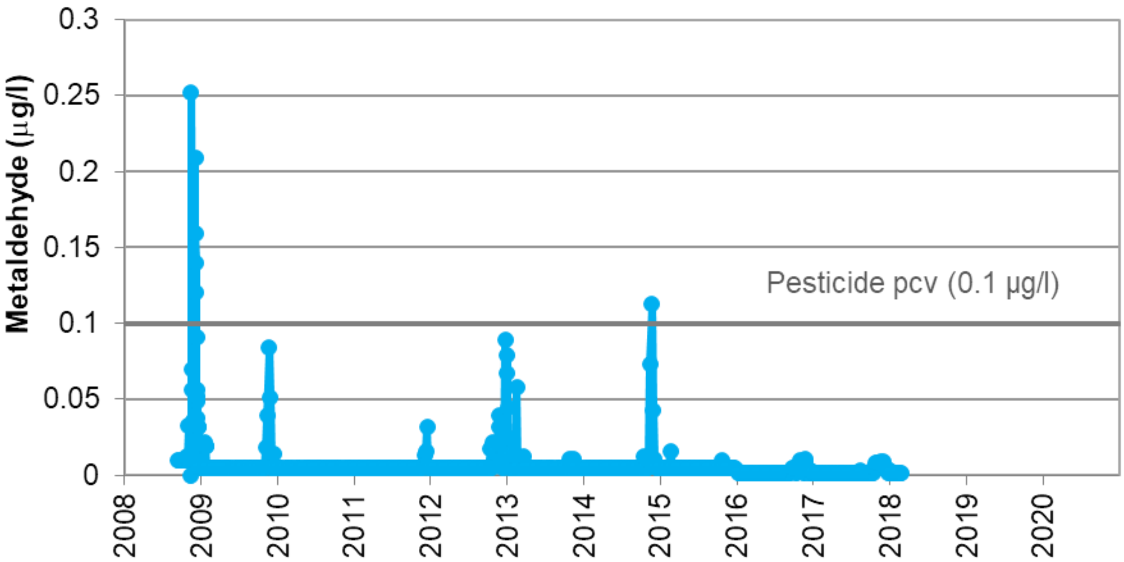
We do not see the change in approach for these three sites as a failure of our overall catchment-based approach, but rather the result of trying an innovative approach. The Grid has enabled us to try catchment management as a means of mitigating rising nitrates and to defer investment in an asset-based solution for 10 years.

Pesticides

We have treatment at all our surface water treatment works for the removal of pesticides. However, Metaldehyde, which is the active ingredient of the most common forms of slug pellets, is not readily removed by conventional water treatment processes.

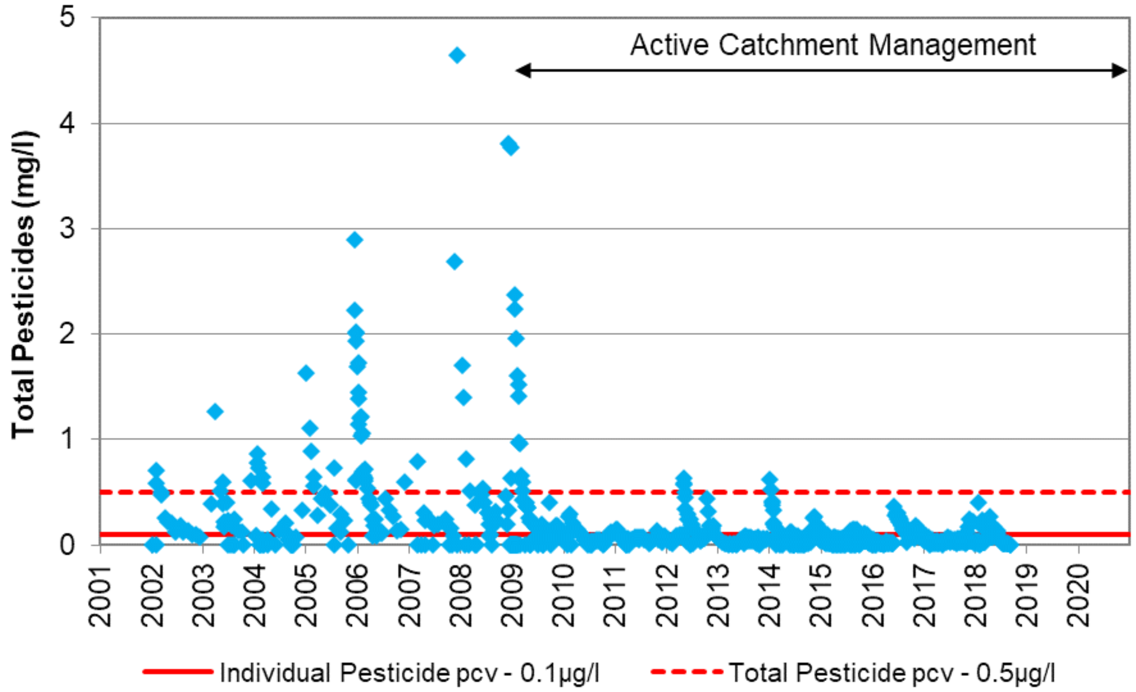
Catchment management and product substitution, whereby we subsidise farmers to use other products that do not contain Metaldehyde, has been successful in reducing Metaldehyde in the direct catchment of four at-risk catchments (Durleigh, Sutton Bingham, Ashford, Leigh/Luxhay). Figure 4-13 and Figure 4-14 show changes in Metaldehyde and Total Pesticides for Ashford and Durleigh Reservoirs, respectively.

Figure 4-13: Metaldehyde concentration at Ashford Reservoir



21 Further details about the proposed blending schemes and nitrate trends can be found in PR19 DWI water quality submission – Annex 1 and 2 Nitrate schemes.pdf, which is an annex for nitrates that accompanied our PR19 water quality submission to the DWI in December.

Figure 4-14: Total pesticide concentration for Durleigh Reservoir



Durleigh reservoir is also augmented by pumping for the Bridgwater & Taunton canal, which in turn is supplied from the River Tone in Taunton. To mitigate the risk of Metaldehyde contamination in this input to the reservoir we are currently trialling EnTrade, a market-based tool to incentivise changes in farming practice, in a smaller catchment, with a view to applying this approach in the Tone catchment in the 2020-25 period. This work in the Tone catchment is supported by the Environment Agency through the Water Industry National Environment Programme, under a drinking water protected area driver.

4.5.4 Cryptosporidium risk reduction

In 2014 we carried out a detailed review of sites that were at risk of cryptosporidium contamination. We assessed the full range of options to mitigate the risk (e.g. mothballing vs. treatment) and concluded that mothballing or decommissioning the sources was the most cost effective solution. The schemes were subject to notices agreed with the DWI.

Ten sites, predominantly small spring sources, have been mothballed as listed in Section 4.7.

4.5.5 Strategic maintenance

The main planning objectives used to prioritise our rolling programme of maintenance for our sources and water treatment works are:

- to maintain drinking water quality
- to maintain capacity
- to maintain stable serviceability.

In the past five years we have completed major maintenance schemes at Sutton Bingham, Ashford, Black Lane and Codford. Reconstruction of Durleigh WTW will commence on site in 2019. Going forwards the next highest priority sites are Fulwood, Lake and Rodbourne.

4.5.6 Incorporating raw water quality risks in our resource forecasts

The catchment management approach, described above, indicates that our supply forecast needs to take into account the risks we face with regard to deteriorating raw water quality. This is addressed in three ways:

Deployable output modelling

For sources where historical water quality data tells us that we should expect the source to be unavailable at particular times of the year we have incorporated this into our assessment of the deployable output of the source. Our Belhuish and Milbourne St Andrew sources for example are typically unavailable in the winter owing to high concentrations of nitrate and so this constraint was built in to the deployable output modelling undertaken with Miser – see Section 4.8 and Annex E.

Outage allowance

Historical data on water quality related outages are used to derive an appropriate allowance for future outages – see Section 4.10 for details.

For example our import from Bristol Water at Newton Meadows, near Bath, occasionally suffers from high concentrations of Metaldehyde. The source of the water is Bristol Water's Purton WTW, which receives raw water for the Sharpness canal and the River Severn. There is an agreed water quality management protocol between the two companies, which includes a provision for Bristol Water to warn us immediately when high Metaldehyde is detected at Purton WTW, subject to the limitation of turnaround times for the analysis. As there is a travel time to Newton Meadows of several days, we are then able to shut off the import and thereby protect our customers from a deterioration in water quality. The resulting outages are recorded and allowed for in our forecast of future outages.

Headroom

To account for the risk posed by sources that have deteriorating water quality but which may not be reflected in the historical outage record an allowance is made in our headroom assessment – see Section 6 for details. A lower magnitude of loss is assumed for sources such as Belhuish and Milbourne St Andrew than other sources to avoid 'double counting' the risk.

4.6 Bulk supply imports and exports

Our water supply system is not entirely isolated from the supply networks operated by neighbouring companies. Boundaries between water company supply areas often however occur in rural areas where infrastructure connections are small and therefore the volumes of water transferred between companies are small.

4.6.1 Existing water trading

We currently have bulk supply import and export arrangements as listed in Tables 4-7 and 4-8, the values shown here are consistent with Table WRP1. The volumes stated are within the existing physical and operational transfer capacities and consistent with contractual volumes. All existing transfers are one-way and for treated water meaning the potential environmental risks that can be associated with raw water transfers are not relevant. The reported volumes have been agreed between companies, and as with our deployable output calculations, agreed based on licenced volumes and transfer capacities.

Table 4-8: Bulk supply imports

Company	Name	Annual average (Ml/d)	Peak (Ml/d)
Bristol Water	Bath	11.37 / 4.40*	11.37 / 4.40*
	Marshfield	0.04	0.05
	Ashcott	0.29	0.36
Thames Water	Malmesbury	0.01	0.06
South West Water	Lyme Regis	0.04	0.05
	Stubhampton	1.27	1.27
Veolia Water Projects	Tidworth	0.18	0.22
	Leckford	2.74	3.00
Southern Water	Biddesden	0.04	0.04
	Ludgershall	0.29	0.36
Total		**16.27 / 9.30**	**16.78 / 9.81**

* Import from Bristol Water to Bath is expected to be reduced to 4.40 Ml/d for the annual average and critical period (peak) scenarios from 2025/26.

Table 4-9: Bulk supply exports

Company	Name	Annual average (Ml/d)	Peak (Ml/d)
Bristol Water	Chapmanslade	0.13	0.16
	Corsley	0.09	0.11
	Standerwick	0.05	0.07
	Lydford	0.01	0.01
	Compton Dundon	0.85	1.07
Scottish and Southern Electric	Salisbury	0.35	0.35
Total		**1.48**	**1.77**

We also have an agreement with Scottish and Southern Electric for a 30 Ml per year export to them for a domestic development near Dorchester (0.08Ml/d annual average). We have currently accounted for this small volume export within our overall demand forecast (i.e. we have not adjusted our population and property numbers explicitly to explicitly account for it), it is therefore not listed as an export in WRP1.

The values reported in Tables 4-7 and 4-8 are the same as we reported in our last Plan. It is assumed that these will be available at current agreed average and peak rates throughout the planning period, and we have verified the figures with neighbouring companies.

Uncertainties associated with agreements are accounted for in our headroom modelling (see Section 6). The management of bulk supplies during a drought is covered by our Drought Plan (2017).

<u>Bournemouth resilience transfer</u>

We have a bi-directional ‘resilience transfer’ with Bournemouth Water. As a best endeavours supply, the transfer has no guaranteed availability in a drought and as such has a capacity of zero under dry year annual average and peak (critical period) planning terms. This transfer is discussed in more detail in Section 8.3).

<u>Bi-directional transfer potential</u>

All existing transfers are one way, typically occurring at our boundaries with other companies in rural areas where infrastructure connections are small and therefore the volumes of water transferred between companies are small.

Our import from Bristol Water in to Bath, however, is of a more significant volume, and could have the potential to become bi-directional and provide improved regional resilience. The benefits of making this transfer bi-directional for outage and drought resilience will be explored further during negotiations with Bristol Water (Section 4.6.2) and as part our regional modelling work, as part of the West Country Water Resources group.

<u>Veolia Water</u>

Our contractual agreement with Veolia Water Projects (VWP) states that their export to us can be reduced below 3 Ml/d peak demand if the demand within the VWP service area exceeds 5.4 Ml/d, on a litre by litre basis. We have held discussions with VWP on this issue and for the following reasons it is unlikely that such reductions will occur during a peak period for Wessex Water:

- Wessex Water’s critical period demand is forecast to occur during peak summer periods, as a dry weather related demand uplift. A significant proportion (50%) of VWP demand is from a military base, which does not have a typical domestic driven demand profile, and peak periods are unlikely to occur at the same time as peak demand from Wessex Water due to summer leave for military staff.
- VWP has internal reservoir storage in the system of 12 Ml, which relative to total demand provides resilience to meet additional peak period demand for several consecutive days.

- VWP drought plan details demand reduction strategies – refer to their Drought Management Plan for more information.

4.6.2 Potential future new trades

WaterUK's recent Long-Term Planning Framework study (2016) identified that drought resilience, growing demands and the need to reduce abstraction in areas of environmental sensitivity makes a growing case for companies to explore new water trading opportunities.

Our integrated water supply grid and surplus situation gives us the opportunity to propose transfers of water into neighbouring areas where water is scarcer. We have responded positively to companies who have sought to understand the prospect for trades to help meet their supply and resilience needs related to growing demands and the need to reduce

We also participating in the recently formed West Country Water Resources Group comprising water companies and the Environment Agency. The group was formed in 2017 to discuss common water resource issues and explore future opportunities to ensure the best use of resources both within our region and out of region by transfer to other companies.

During the pre-consultation period we have had discussions with Bristol Water, Southern Water and Thames Water. See Section 10.2.4 which examines the sensitivity of our supply demand balance to potential new trading arrangements.

Contractual terms are currently under discussion with **Bristol Water** regarding the import to Bath. For this plan we have included the existing contracted volume of 11.37 Ml/d up to 2024/25, and from 2025/26 report 4.4 Ml/d for both dry year annual average and dry year critical period scenarios.

Pre-consultation discussions with **Southern Water** identified they are expecting deficits to address as a result of changes to key abstraction licences in their Hampshire water resources zone. We indicated a potential surplus volume for trading of between 10 and 15 Ml/d from Poole region of our network. We have held further discussions with Southern Water and South West Water/Bournemouth Water following the publication of draft plans to better understand the details and costs involved relating to the transfer routes. We provided further details to Southern Water regarding potential volumes and costs for a scheme involving both South West Water and Wessex Water in the Poole-Bournemouth region to feed into their draft final plan. Further design work will be required to provide detailed cost and volume estimates, and additional modelling is required to provide an assessment of reliability under drought scenarios (see Section 12.1). We have also identified potential effluent re-use schemes in the Poole area, and will be undertaking further work to understand their feasibility in helping to offset potable water demand to support a transfer. This work is being undertaken with the West Country Water Resources Group as we collectively seek to make the best use of water resources in our region and beyond.

During pre-consultation, we discussed with **Thames Water** an option for a 2.9 Ml/d transfer from the north of our zone in the Malmesbury area into Thames Water's SWOX (Swindon and Oxfordshire) water resources zone. In the modelling for their draft WRMP the option was selected as part of Thames Water's preferred plan with a start date of 2071. In their revised modelling for the final WRMP the transfer no longer gets selected for their preferred plan although it is selected in some of the stress test scenario runs. The availability and need for this transfer will be kept under review with Thames Water in future water resource planning cycles.

4.7 Source infrastructure constraints and decommissioning

4.7.1 Source infrastructure constraints

Miser contains information on infrastructure constraints that are relevant to source outputs for every source. Where appropriate the maximum capacity of borehole pumps, re-lift pumps, transmission mains and treatment works are specified to ensure that these constraints are accounted for in all model runs.

4.7.2 Source mothballing and decommissioning

We operate and maintain over 80 sources. In developing this Plan we have identified the opportunity to rationalise some of these assets to address water quality issues and improve efficiency. We plan to decommission or mothball the sources listed in Table 4-10.

Table 4-10: Source to be mothballed or decommissioned

Source	Average DO† (Ml/d)	Peak DO† (Ml/d)	Design capacity (Ml/d)	Assumption and comment*
Boyne Hollow	1.32	0.92		Mothball - Cryptosporidium risk site.
Broadwood	0.54	0.39	0.6	Mothball - Cryptosporidium risk site.
Calstone	1.62	1.40	2.0	Mothball - Cryptosporidium risk site.
Corscombe Spring	0.25	0.18	0.4	Mothball - Cryptosporidium risk site.
Devizes Rd	0.37	3.0	3.0	Mothball - Impacted by pesticides and high background levels of nitrate.
Okeford Fitzpaine	0.74	0.72	1.3	Mothball – Cryptosporidium risk site
Pitcombe	0.45	0.37	0.5	Mothball – Cryptosporidium risk site.
Wellhead	1.27	0.93	1.8	Mothball – Cryptosporidium risk site.
West Lulworth Spring	0.50	0.35		Mothball – Cryptosporidium risk site.
Winterbourne Abbas	1.47	2.77	4.5	Mothball - Cryptosporidium risk site and impacted by high background levels of nitrates.

† Average and peak deployable outputs quoted are those specified in our last Plan.
* Decommission = permanent cessation of use and licence revocation; Mothball = assets retained and licence kept

In February 2018 we revoked the abstraction licences for Bradley Head and Milbourne Wick sources. These sites had been mothballed since 2012 and 2014 respectively owing to poor water quality associated with cryptosporidium risk. These sources were identified as being located in ’over licenced catchments’ (as determined by the WINEP) – and so revoking the licences helped to improve the environmental status of these catchments.

Where there are no environmental concerns relating to the source or others in the catchment we propose to retain the licence and the source in a mothballed condition at the present time. This will ensure that the future use of the source to support resource sharing with regions facing significant supply demand balance issues can be explored.

4.8 Miser modelling

4.8.1 Background to Miser

We have been using Miser modelling software to help manage water resources since 1997. The model represents every source, distribution main, service reservoir, connections with neighbouring companies and demand centre within an integrated model. Annex E contains some extracts from the model to illustrate how sources, the distribution network and demand nodes are represented.

We use the same base model for strategic planning for the water resources management plan and business plan that we do for monthly operational planning of source utilisation, i.e. selection of sources and outputs to ensure prudent operation in droughts and cost effective operation at other times.

For each source, the model includes data on licence conditions, hydrological flow sequences for reservoirs and rivers, relationships between maximum available source outputs and regional groundwater levels and infrastructure constraints. We update the model regularly to ensure it accurately reflects any changes in the network. The model used for the assessment of deployable outputs for this WRMP includes all the new infrastructure connections that are complete or under construction for our integrated grid project.

The strength of Miser over traditional approaches to resource planning is that it allows for the following to be taken into account in assessing the supply demand balance:

- We have 122 demand nodes spread across 33 water into supply (WIS) zones, with an average demand in each of just over 2.7 Ml/d. In effect the Miser model gives a supply demand balance calculation at sub WIS zone level.
- the relationship between regional groundwater levels and source outputs
- the relationship between groundwater abstractions and storage in aquifers
- the conjunctive use of sources, not just groundwater and surface water as separate entities but between all elements of all sources including stream support requirements and the availability of pumped storage
- simulation of peak demand and average demand within the same model run.

4.8.2 Application of demand forecasts to the Miser model

The observed regional demand profile from 1995 is scaled to meet the annual average distribution input of 346 Ml/d and critical period uplifted to 415 Ml/d - our base year dry weather regional forecast demand detailed in Section 5. The observed five year annual average demand for each of the 122 demand nodes was then, in turn scaled to meet based on this regional profile. This allows the sub regional spatial and seasonal variations in demand to still be represented in the model.

4.8.3 Deployable output modelling assumptions, review and adjustments

Average and peak deployable outputs for each source are derived from running the Miser model with the following assumptions:

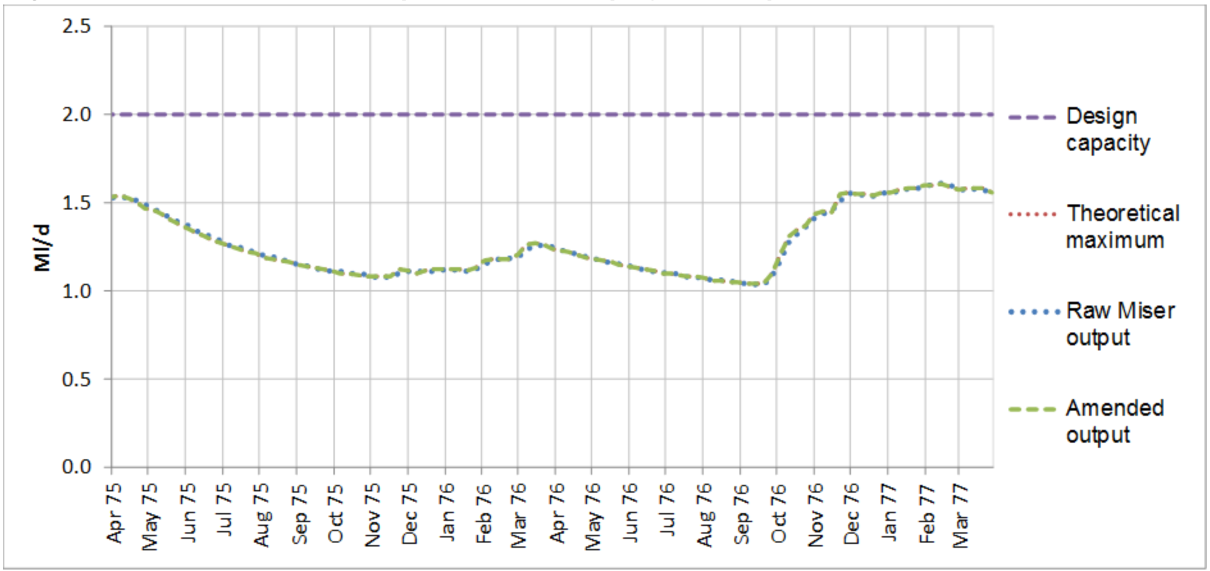
- 24-month optimisation period; reservoir inflows and groundwater sequences set for the critical identified period (April 1975 to March 1977).

Peak deployable output for each source is defined by the output in August 1976. Average deployable output for each source is defined by the average output over the full 24-month optimisation period.

The raw source outputs from Miser are reviewed and compared to their relevant constraining factors – i.e. licence conditions, the design capacity of related infrastructure and/or hydrological constraints.

Figure 4-19 below illustrates the monthly raw Miser outputs for Arn Hill source. It shows that the model 'maximises' the source during the critical period (May – August 1976) of the optimisation so that the raw outputs exactly match the theoretical maximum outputs (as defined by the groundwater output relationship equations outlined in Section 4.1) whilst respecting the source's infrastructure design capacity constraint. Model outputs like this require no post-modelling adjustments to define deployable output values; 21 of our sources (28%) are of this nature.

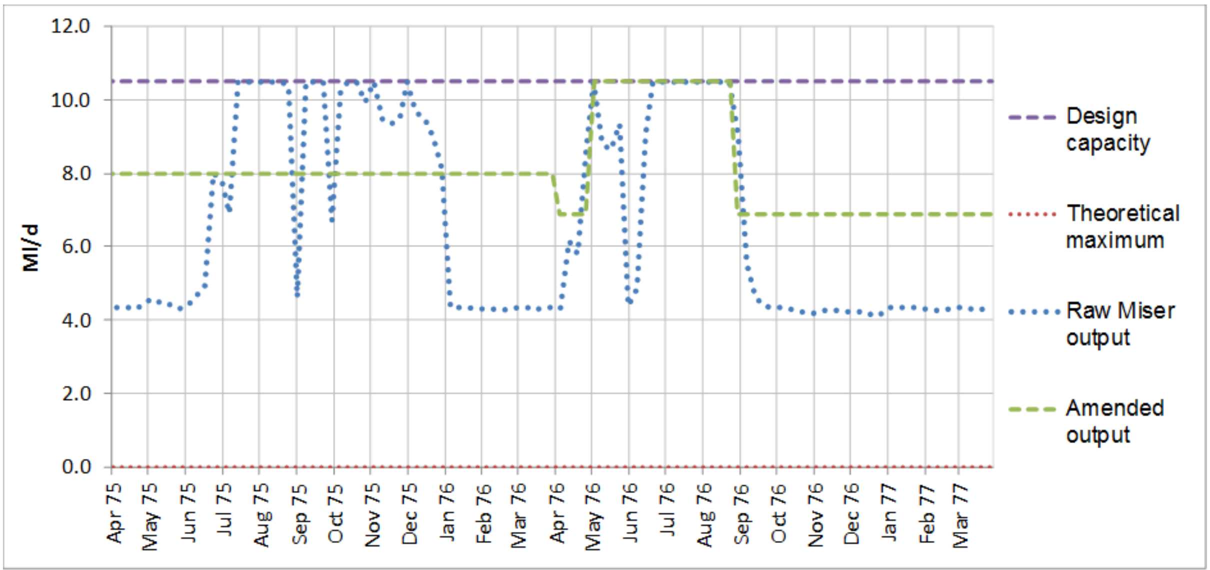
Figure 4-15: Arn HIll source outputs from the deployable output Miser run



The raw outputs of some sources reveal that they are not 'maximised' by Miser during the critical period of the deployable output run. This is usually because the particular demand scenario applied to the optimisation can be met without the source being fully utilised. Deployable output however should not be constrained by the demands that are applied to a conjunctive use model; it should represent the volume of water that could go into supply to meet demand whilst accounting for true constraints such as licence conditions and infrastructure.

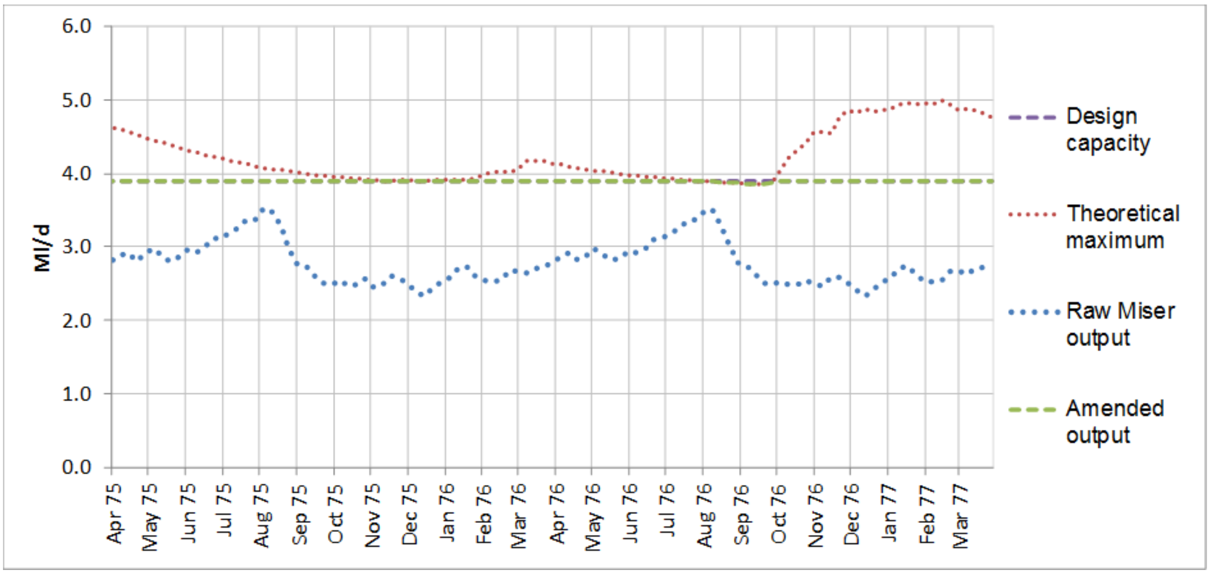
Figure 4-15 illustrates the monthly raw Miser outputs for Black Lane source, which is constrained by its licence and infrastructure design capacity and not hydrology. It shows that the source is not 'maximised' by the model run and so an amendment is made to uplift the outputs during the critical period (May-August 1976) to reflect design capacity. Similarly the source has not fully utilised its available annual licence. As such the output was increased to the annual licence limit (defined as a daily volume) whilst ensuring the year in which the critical period was applied the output was factored down accordingly. The resulting profile of amended source outputs used to calculate average deployable output for Black Lane source is shown below.

Figure 4-16: Black Lane source outputs from Miser and the amended values used for defining deployable output



Similar adjustments are also made to sources that are hydrologically constrained but not maximised; the example of Dunkerton is presented in Figure 4.16.

Figure 4-17: Dunkerton source outputs from Miser and the amended values used for defining deployable output



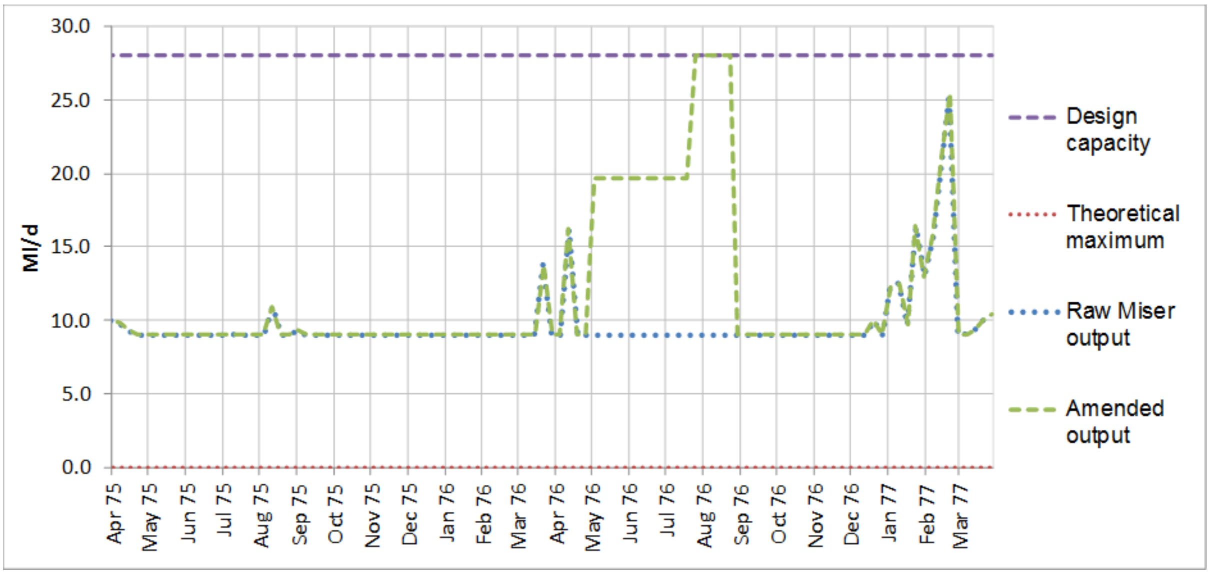
Forty nine of our sources (65%) require post-modelling adjustments of this nature to define their deployable output values.

To define the deployable output of the reservoir sources it is necessary to review whether their drawdown during the Miser optimisation reached their minimum allowable storage level. If they did not reach their minimum allowable storage it means there is spare water that was not used (i.e. reservoir output was constrained by demand). An adjustment is therefore required to account for this water in the deployable output calculation.

If the reservoir's output during the critical period (August 1976) is below the design capacity, it is appropriate to uplift the output that month to represent the true available peak deployable output (as constrained by design capacity and/or licence). A downward adjustment is then made to the other critical period months so that overall abstraction during the critical period remains the same. Additionally, the overall volume of spare water (i.e. the difference between actual minimum and the allowable minimum storage[22]) is divided by the number of months in the critical period (which for a reservoir is the number of months between going off full and reaching minimum drawdown whilst excluding the peak demand month as a separate adjustment is made to this month). The volume of additional water available is factored to account for the higher demand that would be associated with the critical period and the resultant value is subtracted from each month of the optimisation period. Figure 4.17 shows how these adjustment have been applied to Durleigh Reservoir.

[22] Which is applied as a constraint within Miser.

Figure 4-18: Durleigh source outputs from Miser and the amended values used for defining deployable output



Annex E contains a graph for every source and a summary table illustrating the amendments made to the raw Miser outputs to derive deployable output.

4.8.4 Baseline deployable output

Following the review and adjustment of the Miser outputs, as described above, overall regional deployable output is summarised in Table 4-11.

Table 4-11: Planned level of service baseline deployable output with and without sustainability reductions

Scenario		Deployable output
Dry year annual average	Without sustainability reductions	419.50 Ml/d
	With sustainability reductions	402.79 Ml/d
Peak week critical period	Without sustainability reductions	514.17 Ml/d
	With sustainability reductions	487.97 Ml/d

Peak and average deployable outputs for individual sources are reported in Table WRP1 BL Licences.

Deployable output for our last Water Resources Management Plan, using the same design event, was 426.48 and 514.34 Ml/d for the average and peak scenarios, respectively. The small changes reflect the balance of the additional sustainability reduction at Stubhampton (Section 4.4.3), and changes to the model inflow sequences to Miser as a result of new analysis and modelling (Section 4.2.2).

4.8.5 Deployable output and levels of service

The deployable output of a water supply system is related to the planned level of service (i.e. frequency of customer restrictions) against which it is modelled (UKWIR, 2012). Our drought analysis (Section 10.1) suggests our services are resilient to a repeat of any weather events observed in the last 100 years without the need to restrict customers' use. Our deployable output calculations suggest our design event, 1975/76 is the worst drought event within the ~100 year historical record.

The deployable output calculated for our planned level of service is based on modelling source yields conjunctively using our Miser model so that source outputs are maximised within appropriate licence and infrastructure constraints given the hydrological constraints experienced during the 24-month period of April 1975 to March 1977 (see Section 4.9). The approach means that the level of service is 'just met' (i.e. no restrictions under these conditions) and assumes that reservoirs are drawn down to their lowest operating level.

In accordance with the Water Resources Planning Guidelines, we have assessed baseline deployable output (without climate change) for the following levels of service scenarios:

- Planned levels of service
- 1 in 200 reference levels of service

Table 4-12: Deployable output under design events (Ml/d)

Design event	DYAA		DYCP	
	without reduction	with reductions	without reductions	with reductions
1975/76	419.50	402.79	514.17	487.97
1 in 200	411.05	394.34	500.74	474.54

4.9 Climate change

As a water supply and waste-water treatment business our day-to-day services and operations are affected by weather patterns and so it is important that we account for changes that might be expected to occur to these in our long term planning. We are a long term business and adapting to a changing climate is integral to our long term vision and business plan.

Specific risks to our business and our adaptation, mitigation and management strategies were outlined in our 2015 report to Defra under the Climate Change Adaptation Reporting Duty[23].

Within the context of water resources planning it is particularly important that we consider the impact of changing rainfall, evaporation and temperature patterns and the impact that these may have on river flows, reservoirs, groundwater recharge and ultimately on deployable output. The impact that climate change might have on the demand for water also requires consideration and this is covered in Section 5.5.6 of this Plan.

The most recent information available to water resources planning is the UK Climate Projections outputs from 2009 (UKCP09). The projections incorporate:

- Three different emissions scenarios (low, medium, high)
- Three time periods of the 21st century (2020s, 2050s and 2080s)
- Varying probability, based on evidence for different levels of future climate change.

The projections suggest that compared to the baseline period of 1961-1990 the future climate in south-west England is likely to be characterised by drier and warmer summers, milder and wetter winters, and for extreme events to happen with greater frequency.

Table 4-12 shows the most likely 'central case' projections for our region across all three emissions scenarios and three time horizons, which overall suggests a small increase in overall precipitation, with an increase in winter precipitation, and a reduction in summer precipitation. Temperatures are forecast to increase both on an annual average basis, and also during the summer period.

[23] Wessex Water (August 2015). *Wessex Water's second report to Defra under the Climate Change Adaptation Reporting Power.*

Table 4-13: Overview of UKCP09 projections relative to the 1961-1990 baseline period. Source: Wessex Water (August 2015)

Climate factor/indicator	2020s	2050s	2080s*
Annual mean precipitation	0 to +1%	0	+1 to +2%
Summer (Jun-Aug) precipitation	-5 to -8%	-14% to -20%	-16% to -30%
Winter (Dec-Feb) precipitation	+6 to +7%	+12 to +17%	+17% to +27%
Spring and autumn precipitation	0 to +10%	0 to +10%	0 to +10%
Annual average temperature	+1.4ºc to +1.5ºc	+2.2ºc to +2.8ºc	+2.8ºc to +4.4ºc
Summer mean temperature	+1.5ºc to +1.7ºc	+2.0ºc to +4.0ºc	+3.0ºc to +5.1ºc
Summer mean maximum temperature	+2.0ºc to +2.1 ºc	+3.3ºc to +4.2ºc	+3.9ºc to +6.7ºc

The values shown are those that occur most frequently in our region (i.e. the mode) in the UKCP09 projections. The ranges represent the low and high emissions scenarios.

We have followed the guidance set out in the WRMP19 supplementary information[24] in assessing the impact of climate change on deployable output. Our general approach to the assessment of the impact of climate change on our water resources follows the framework proposed by the joint UKWIR and Environment Agency project ‘Climate change approaches in water supply planning – overview of new methods’[25].

The approach involved a vulnerability assessment (to determine the type of analysis required in the more detailed analysis) followed by a three-stage analysis approach:

- Stage 1 – calculate river flows for a water resource zone in the 2080s
- Stage 2 – calculate deployable output for the 2080s
- Stage 3 – scale the impact determined for the 2080s through the planning period and consider uncertainty

The analysis undertaken in the vulnerability assessment and during each of the three stages is outlined in sections below.

4.9.1 Vulnerability assessment

The methods used to assess the effect of climate change on deployable output should be proportionate to the risks presented. In accordance with the Guidelines a vulnerability assessment was undertaken to review existing information from previous Water Resources Management Plans, Drought Plans and other relevant data sources to ascertain the level of risk faced and thereby determine a proportionate level of further analysis.

The vulnerability assessment is presented in Table 4-13 and Figure 4-18 and this information was discussed with the Environment Agency and Ofwat during the pre-consultation period.

[24] Environment Agency (2017) WRMP19 supplementary information: Estimating the impacts of climate change on water supply.
[25] Environment Agency (2012). *Climate change approaches in water supply planning – overview of new methods.*

Table 4-14: Climate change vulnerability assessment

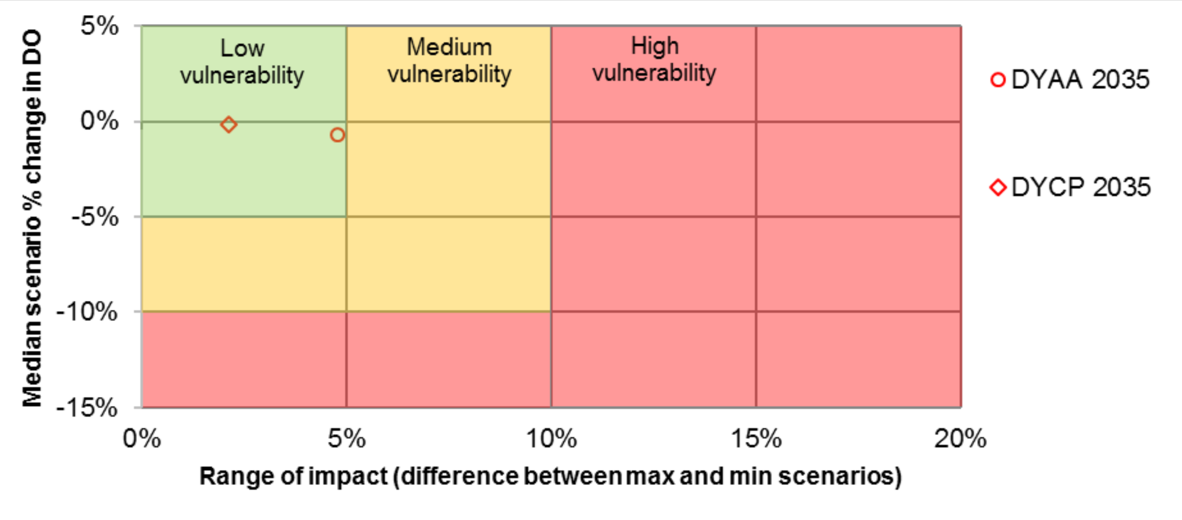
Assessment criteria	Comments	Information source
Critical drought years	1975/76, 1920/21, 1933/34 have been identified as key droughts in studies of historical rainfall records and the analysis of their impact on deployable output. These are the years that we identify the lowest drawdown levels in our single source reservoir model simulations and similarly the lowest simulated groundwater levels in our single point groundwater models.	Analysis of pre-1975 rainfall sequences. Wessex Water, June 2007. Impact of historical droughts on water resource availability. Wessex Water, August 2009. Water Resources Models Data Series Extension Report. Mott MacDonald, March 2009.
Period used for analysis (historic flow or groundwater level record)	The critical drought years were identified from rainfall records and reservoir and groundwater level simulations from the 1890s to 2006.	Same references as above plus:
Sources	We have over 80 sources. Approximately 75% of the water we supply comes from groundwater and 25% comes from surface water reservoirs. We also have some key imports of water from neighbouring companies which account for *c.*2% of our distribution input. The development of our integrated grid during AMP5 and AMP6 is connecting communities that are currently stand alone (i.e. can only be supplied by one source) to the wider distribution network thereby increasing their security of supply and making the system more resilient to the potential impacts of climate change.	WRP1 (Baseline Supply), WRP1a (Licences), WRP5 (Final Planning Supply). Water Resource Zone integrity assessment – see Annex B
Supply-demand balance in the base year	The annual review of the Water Resource Management Plan for 2016/17 (the base year) indicated a satisfactory resource position throughout the year. The security of supply index (SOSI) calculation for 2016/17 was 100%.	Annual review of the Water Resource Management Plan 2017
Security of water supply and/or water scarcity indicators	Our investment in a more integrated grid during AMP5 and AMP6 means that we are expecting to forecast supply-demand surpluses throughout the planning period.	Section 4.9

Assessment criteria	Comments	Information source
Critical climate variables (e.g. summer rain, winter recharge etc.)	Our supply system is generally most sensitive to multi-season droughts, i.e. the dry summer-dry winter-dry summer drought during 1975/76. Our Drought Plan measures water resource availability against reservoir storage and the use of key annual licences. We also monitor groundwater levels at Allington, Woodyates and Ashton Farm and use these in our monthly supply strategy modelling (using Miser) to optimise source outputs. In 1975/76 summer inflows and groundwater recharge were very low (effectively zero). Climate change therefore cannot make this significantly worse – unless summers become longer (but there is not yet any evidence or data on this from the UK Climate Impacts Programme). Therefore the impact on winter rainfall and infiltration is likely to be more significant, particularly on groundwater recharge (75% of water supplies from groundwater).	Drought Plan (Final Daft, October 2017)
Climate change deployable outputs (dry, mid, wet scenarios from 2013 water resources management plan's)	Overall therefore, the baseline impact of climate change in the 2030s is estimated to be -2.84 Ml/d on average (0.7% of deployable output) and -0.83 Ml/d for the peak scenario (0.2% of deployable output).	Water Resources Management Plan 2013.
Adaptive capacity (list of available sources and drought measures)	A list of all our available sources is provided in WRP1a. This table provides information on whether each source is licence, hydrologically or infrastructure constrained. Nearly half of our sources are hydrologically constrained making them particularly susceptible to the impacts of climate change. Appendix 8.3 of our Drought Plan (2017) screened each of our sources for 'adaptive capacity' in terms of whether they would be suitable for drought permit options. This process identified five options in the context of drought planning.	WRP1a (Licences). Appendix 8.3 of Drought Plan – Drought Permit Option Screening.

Assessment criteria	Comments	Information source
Sensitivity (Low medium or high)	Sources in the south of our area are particularly unaffected by drought as many of the sources are infrastructure or licence constrained (not hydrologically constrained). Reservoirs in the west of our area may be more susceptible to the impacts of climate change. They demonstrated greater variability in the impact on deployable output in climate change scenarios explored in our last Plan.	Water Resources Management Plan 2014
Vulnerability classification	The magnitude versus sensitivity plot (see Figure 4-18) suggests **our single resource zone is of low vulnerability to climate change.**	
Identify overall vulnerability and proposed climate change assessment approach	Given our low vulnerability status Tier 1 climate change assessment methods are adequate however, given that we have rainfall-runoff models available be have followed the Tier 2 approach. This method uses the 11 UKCP09 Spatially Coherent Projections to generate monthly climate change factors for precipitation and potential evapotranspiration in the 2080s, which have then been applied to rainfall-runoff model inputs to generate 11 sets of flow sequences and flow factors for each mode.	N/A

Figure 4-19 shows the magnitude-sensitivity plot of information from our previous Water Resources Management Plan – the change in deployable output for the median impact scenario is plotted against the uncertainty as represented by the range of change in deployable output (the difference between the maximum and minimum impact scenarios). The figure shows that the impact of the median impact climate change scenario on deployable output was low for both the dry year annual average and dry year critical period scenarios (<1% by 2035). It also shows that the uncertainty associated with this projection was less than 5% for both scenarios. The plot indicates that our single water resource zone is assessed as low vulnerability to climate change category.

Figure 4-19: Magnitude-sensitivity plot of deployable output to climate change (dry year annual average- DYAA and dry year critical period-DYCP)



Given the evidence presented in Table 4-13 and Figure 4-19 the conclusion of our vulnerability assessment is that the Wessex Water region is at low risk from climate change.

4.9.2 Impact of climate change on river flows and groundwater levels

This section covers the assessment of the impacts of climate change on groundwater levels and river flows. Figure 4-32 shows how the analysis undertaken in this stage aligns with the subsequent stage of assessing impacts on deployable output. The impact of climate change is only assessed for sources that are hydrologically constrained; sources that are constrained by licence conditions or infrastructure are not subject to climate change analysis.

The supplementary guidance[26] states that there are three tiers of analysis in order to calculate river flows to input into a water resources model, that may be adopted as a minimum:

- Tier 1 – if the vulnerability is low and there are no rainfall-runoff models
- Tier 2 – if the vulnerability is medium or there are available rainfall-runoff models
- Tier 3 – if there is high vulnerability

Whilst our vulnerability assessment suggests low vulnerability, we have adopted Tier 2, as we have rainfall-runoff models that were devleoped for inflow sequence calculation (Section 4.2.4). In this tier of analysis, we have used the 11 UKCP09 Spatially Coherent Projections (SCPs) to generate monthly climate change factors for precipitation and PET (potential evapotranspiration) in the 2080s, which have then been applied to rainfall-runoff model inputs to generate 11 sets of flow sequences and flow factors for each model.

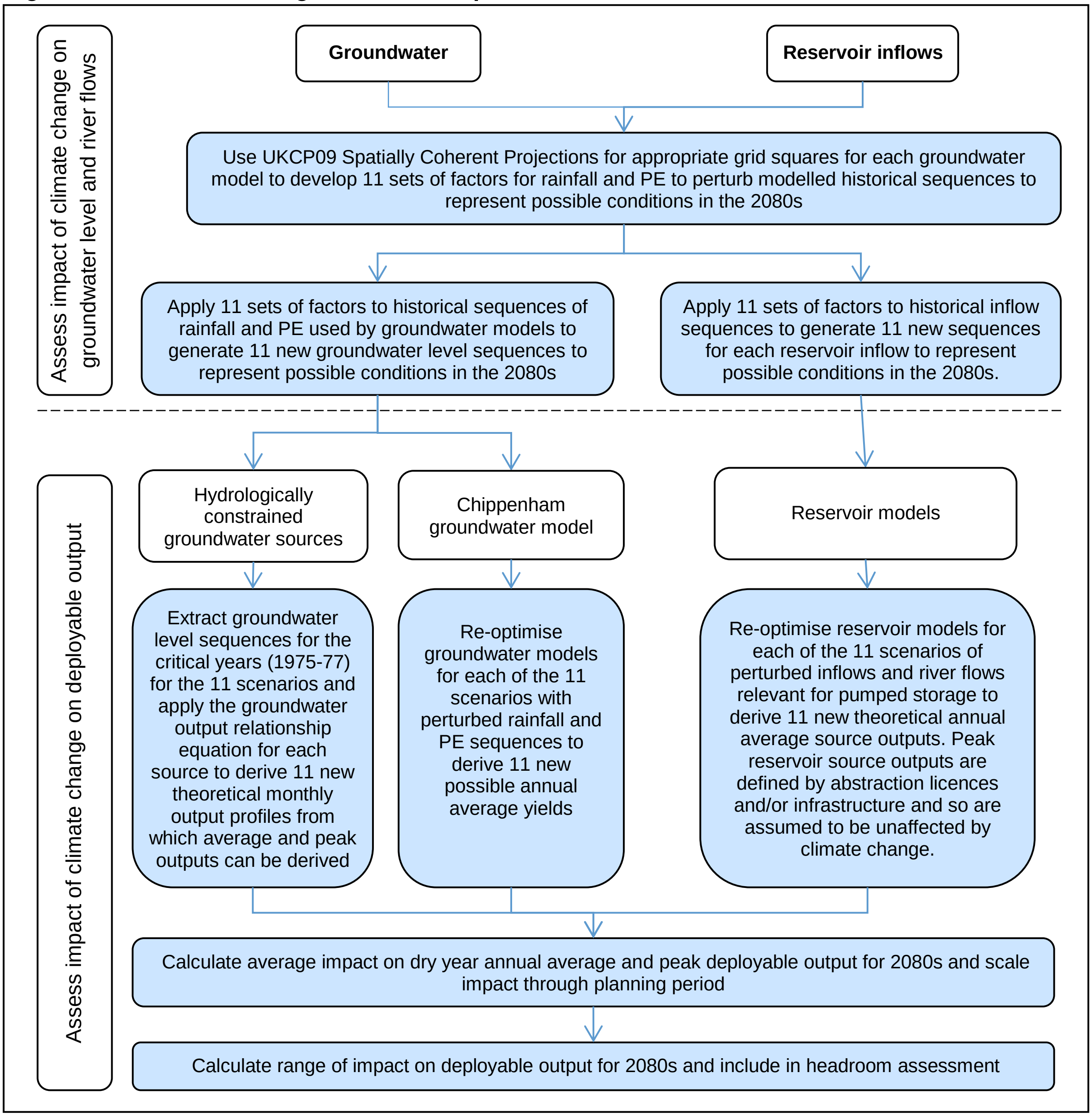
The ensemble of 11 data sets are all equally likely; they therefore enable us to investigate a range of potential future climates and their possible impact on water resources. The

[26] Environment Agency (revised April 2017). WRMP19 supplementary information – Estimating the impacts of climate change on water supply

uncertainty associated with future projections can be considered by evaluating the impacts of all ensemble members.

We believe that taking the Tier 2 approach is proportionate for the risks from climate change faced by our supply area. We discussed our vulnerability assessment and proposed analysis methods with the Environment Agency during pre-consultation. This process is set out in Figure 4-19 below.

Figure 4-20: Climate change assessment process

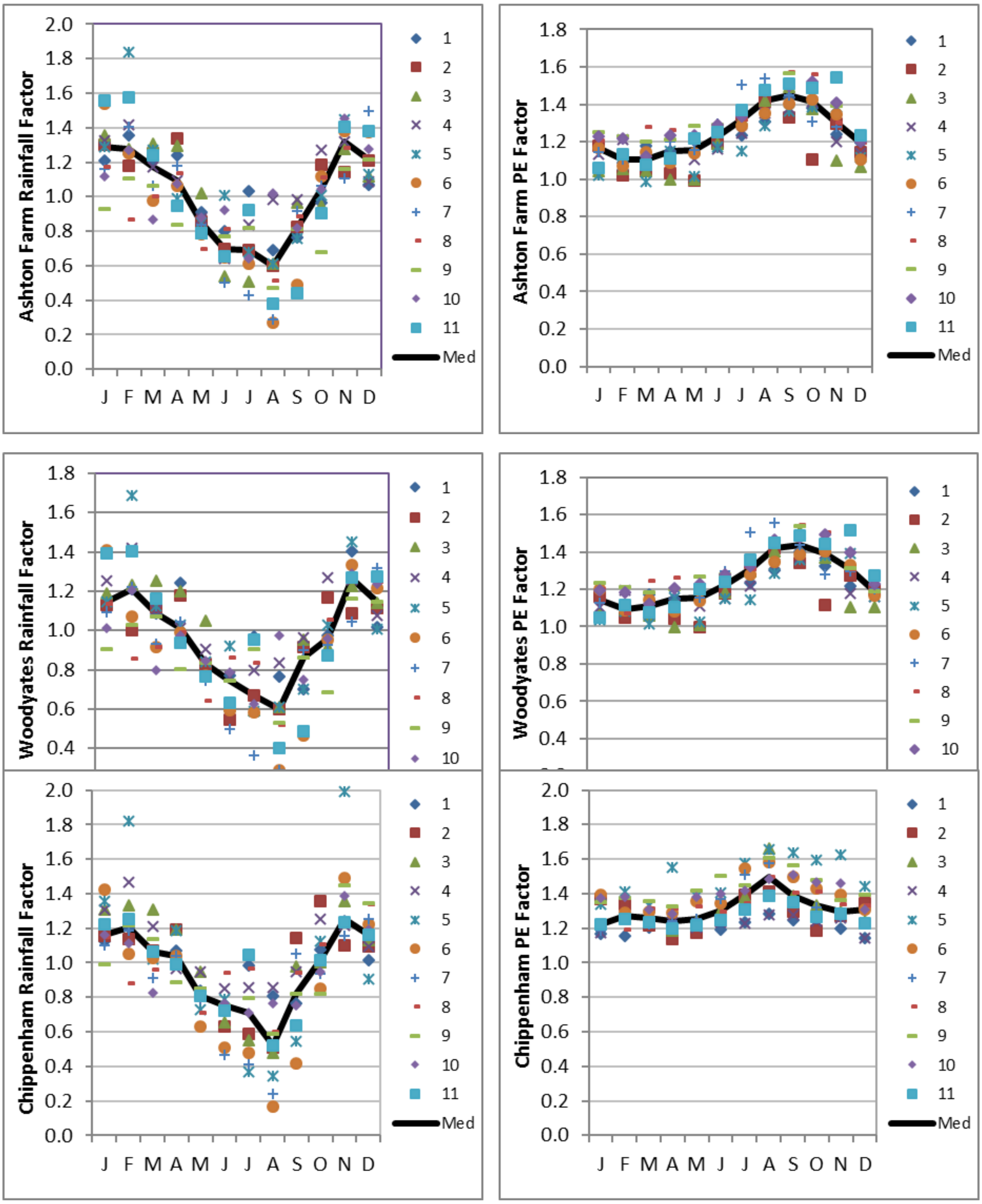


Groundwater analysis

In this tier of analysis, we have used the 11 UKCP09 Spatially Coherent Projections (SCPs) to generate monthly climate change factors for precipitation and PET (potential evapotranspiration) in the 2080s. For each groundwater model and catchment model, the appropriate time-series of factors for precipitation and PET for the relevant grid cell(s) were selected from the SCPs and used to perturb model inputs, which were then run to evaluate the impact of climate change on groundwater levels and catchment discharge. Based on data provided in the SCPs, we applied the Hamon equation to derive PET.

The rainfall and PET factors for Woodyates, Ashton Farm and Chippenham are shown in Figure 4-20 they indicate that in general (i.e. looking at the median values) the changes in rainfall PE are consistent with the expected warmer drier summers and milder wetter winters.

Figure 4-21: Rainfall and potential evapotranspiration factors for Woodyates, Ashton Farm and Chippenham groundwater models for 11 climate change scenarios



The 11 new groundwater level sequences for the 1975-77 critical period for Woodyates and Ashton Farm are shown in Figure 4-22 and Figure 4-23.

The full historical record of groundwater level changes at Woodyates and Ashton Farm suggest that the levels in these locations vary between 67 and 105 mAOD (range of 37 m) and 63 and 72 mAOD (range of 8 m) respectively. The figures below show that the climate change scenarios suggest the impact on maximum groundwater level in January 1976 may be of the order of magnitude -1 to -5 m for Woodyates (up to 13.5% of the maximum range) and up to -1 m for Ashton Farm (12.5% of the maximum range). There is less variability in the impact of the scenarios on groundwater levels around the critical period (August 1976) and the lowest drawdown point (September/October 1976).

Figure 4-22: Woodyates groundwater levels modelled for 11 climate change scenarios

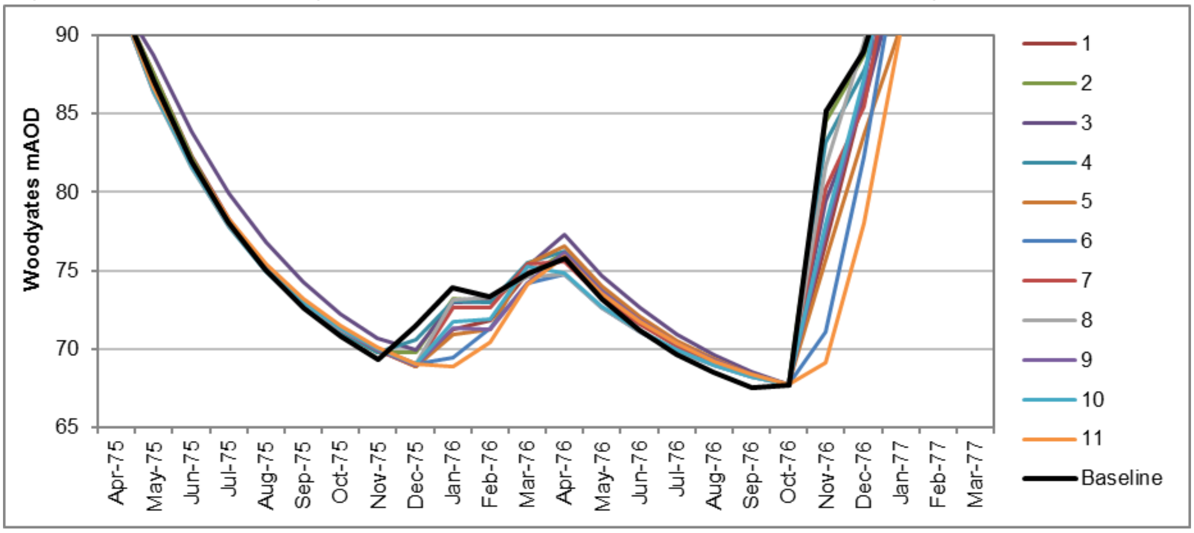
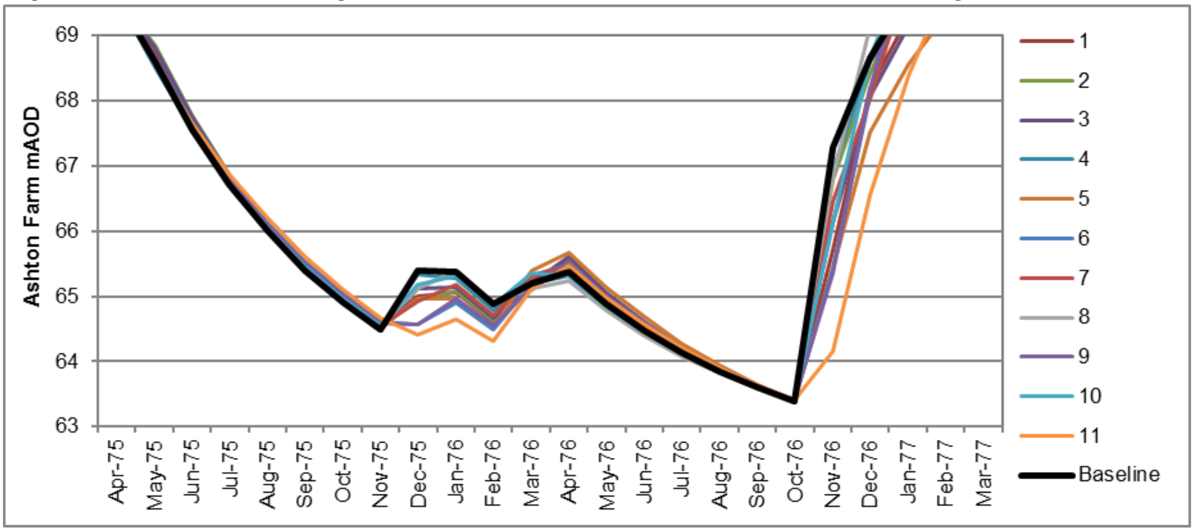


Figure 4-23: Ashton Farm groundwater levels modelled for 11 climate change scenarios

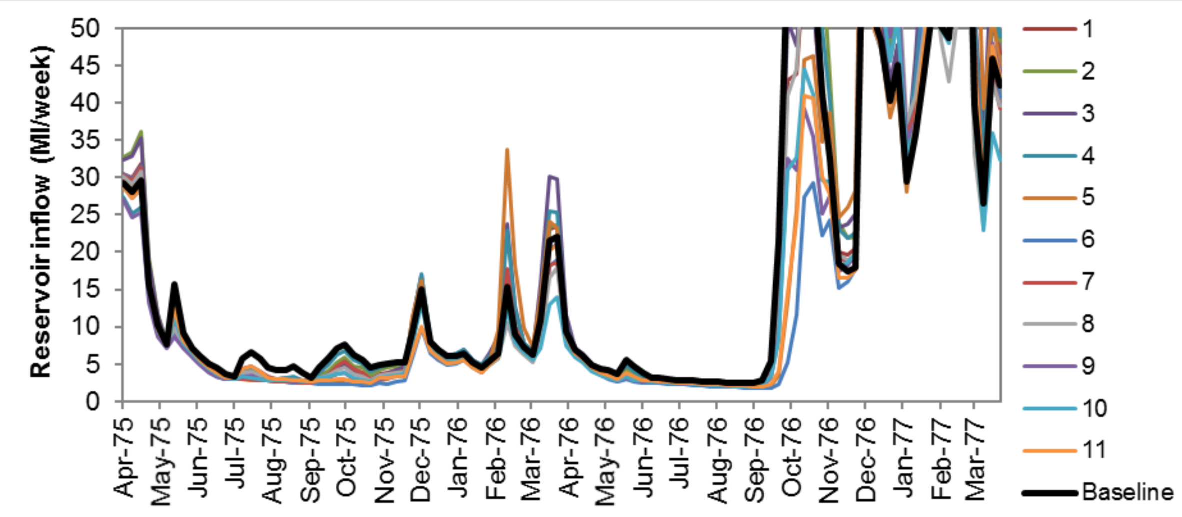


Reservoir inflow analysis

The method for obtaining river flows was the same as that applied as described in groundwater analysis, above.

Figure 4-18 below shows the impact of the climate change scenarios on inflows to Durleigh Reservoir during the critical period of 1975-19176.

Figure 4-24: Inflows for Durleigh Reservoir under climate change scenarios



4.9.3 Impact of climate change on deployable output

This element of the climate change analysis uses the outputs of the assessment of impacts on groundwater levels and river flows to examine the potential impacts on the deployable output of the hydrologically constrained sources under the eleven scenarios. The analyses are undertaken as sensitivity tests against a baseline scenario of 'no climate change'. Baseline deployable outputs are based upon yields available during 1975/76 (see Section 4).

As shown in Figure 4-24, the overall impact of climate change on average and peak deployable outputs are calculated from the combined outputs of three parallel analysis methods, which are applied depending on source type. The three methods are described below:

Hydrologically constrained groundwater sources

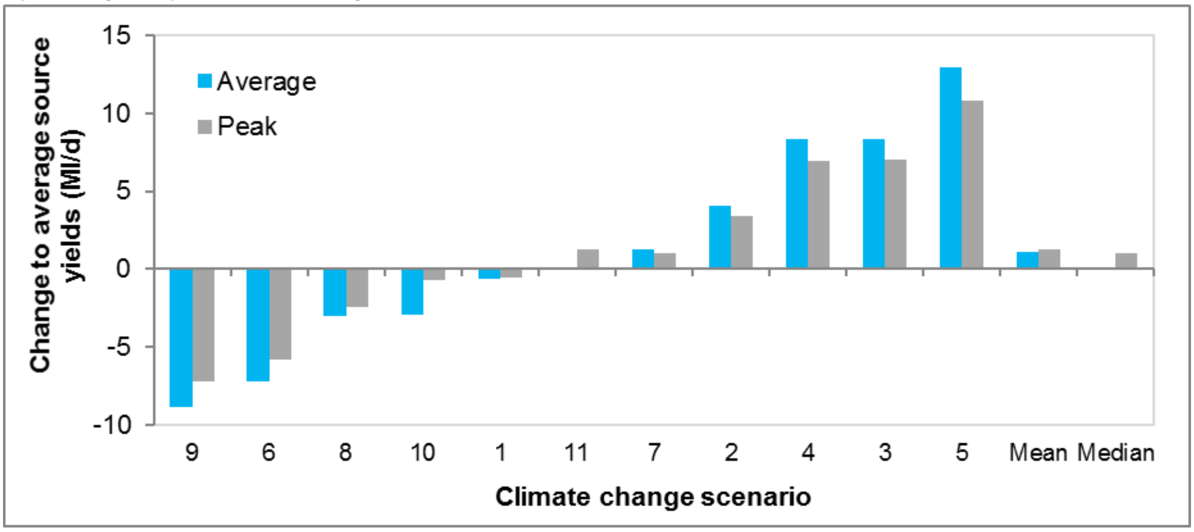
As outlined earlier in this chapter, 37 of our groundwater sources are hydrologically constrained (accounting for nearly 120 Ml/d and 30% of average deployable output) and their available output can be modelled using their output relationship equation against Woodyates or Ashton Farm (see Section 4.2.3). To assess the impact of climate change on the deployable output of these sources the 11 climate change perturbed groundwater sequences for Woodyates and Ashton Farm were used to calculate average and peak potential yields for the 1975/76 period for each source for comparison against their respective baseline. The 'peak' potential yield is that which would have been theoretically possible in August 1976 and the ‘average’ potential yield is the mean theoretically possible yield during the critical summer period (May-August 1976).

Figure 4-25 shows the overall impact on the hydrologically constrained groundwater source yields relative to the baseline condition for each of the 11 scenarios (ranked in order of impact), the mean and median impact.

The magnitude of the impact varies from -8.8 Ml/d to +12.9 Ml/d for average (approximately -6% to +11% of the potential yield) and from -7.2 Ml/d to +10.9 Ml/d peak (approximately - 6% to + 9% of the potential yield).

The mean impact of the 11 scenarios is a change in total average deployable output of +1.1 Ml/d and a change in total peak deployable output of +1.3 Ml/d. However, as the impact of the 11 scenarios is not normally distributed, a more representative measure of the most likely impact is given by the median value, which indicates a change in total average deployable output of -0.02 Ml/d and a change in total peak deployable output of -1.07 Ml/d by the 2080s.

Figure 4-25: Summary of impact of climate change scenarios on average and peak yields hydrologically constrained groundwater sources*



*note the median change in Average is -0.02 Ml/d, so does not show on the figure

Chippenham groundwater model

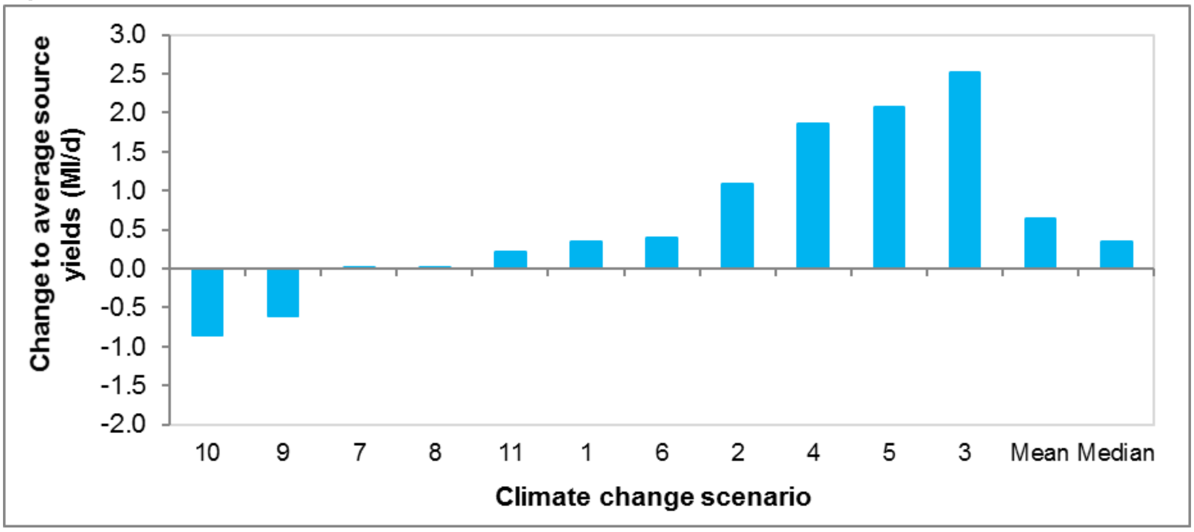
Chippenham

Unlike most of our groundwater sources, our abstractions from the Chippenham aquifer can impact on the volume of storage in the aquifer. To model this effect we have a single point groundwater model, which we have used to model the effect of the 11 climate change scenarios relative to the baseline.

Like other 'reservoir' type sources we have assumed that climate change will not impact upon the peak deployable output; it is assumed that we would manage abstraction from the aquifer so that peak outputs in the future are maintained at the current level.

Figure 4-26 shows a summary of the modelling results of the impact on average yields for the 11 climate change scenarios relative to the baseline. It shows that two of the 11 scenarios suggest that the average yield will decline and the other nine scenarios all indicate a net increase in yield which implies the wetter winters will outweigh the effect of drier summers for this aquifer. Overall, the impact varies from -0.9 Ml/d to +2.5 Ml/d, with a mean of +0.60 Ml/d and a median value of +0.3 Ml/d.

Figure 4-26: Impact of climate change scenarios on the average yield of the Chippenham aquifer sources

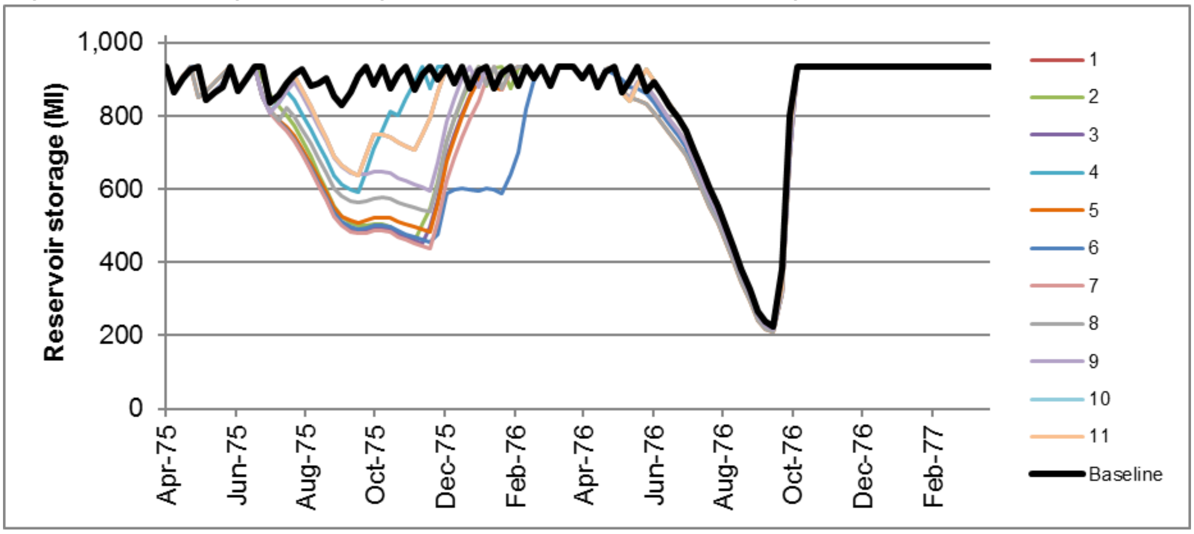


Reservoirs

Climate change is assumed to impact only on the average yield of a reservoir source; the peak output of these sources is defined by licence and/or infrastructure constraints which are assumed to remain constant and we would expect to manage abstraction through the year to ensure the peak output would be hydrologically possible.

To calculate the impact of the climate change perturbed inflows on the average yield of our reservoirs we re-optimised each reservoir model for each climate change scenario. The annual average yield is determined against a fixed condition relating to the maximum permitted drawdown (30 days of average yield/abstraction plus compensation flow). The drawdown profile for Durleigh Reservoir is shown in Figure 4-27.

Figure 4-27: Storage in Durleigh Reservoir under climate change scenarios



Figures 4-27, 4-28 and 4-29 show that under all scenarios and for all reservoirs there is a bias towards a reduction in average yield relative to the baseline. Two reservoirs (Clatworthy and Durleigh) indicate potential increases in yield under some scenarios.

Clatworthy shows the largest absolute yield reduction of up to -3.5 Ml/d under scenario 6, which similarly leads to reductions of -3.0 and -2.7 at Sutton Bingham and Ashford-Hawkridge respectively. Durleigh and Fulwood reservoirs indicate lower absolute impacts and a smaller range.

Figure 4-28: Volumetric change in average yield relative to baseline by reservoir for 11 climate change scenarios

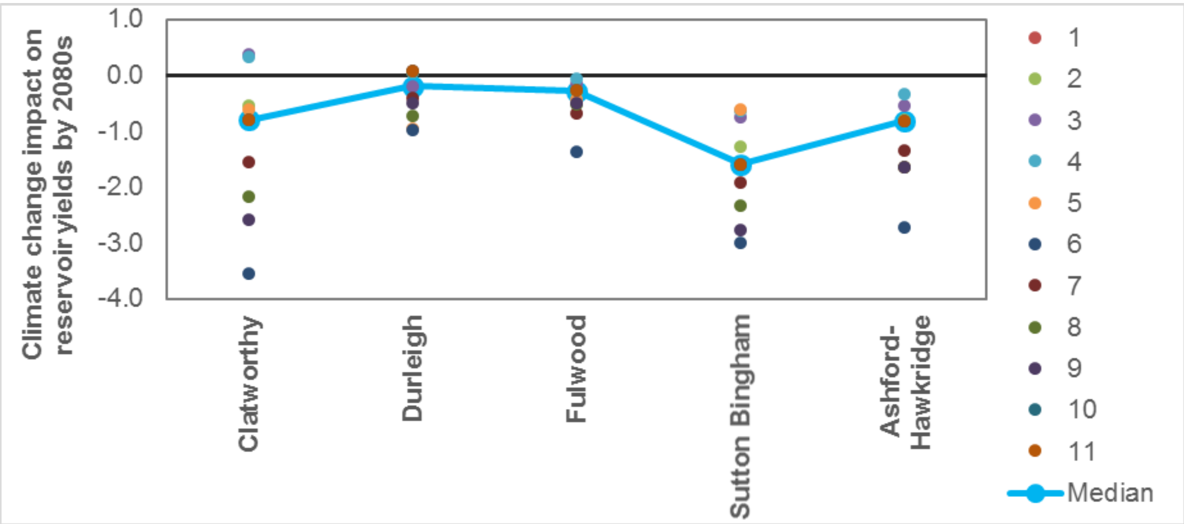


Figure 4-29: Percentage change in average yield relative to baseline by reservoir for 11 climate scenarios

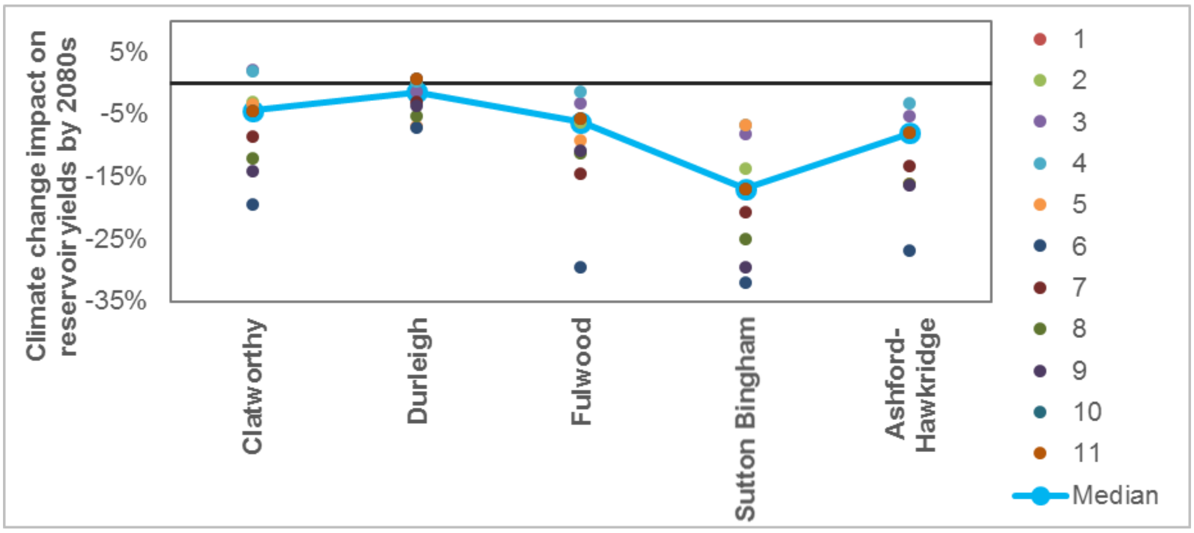
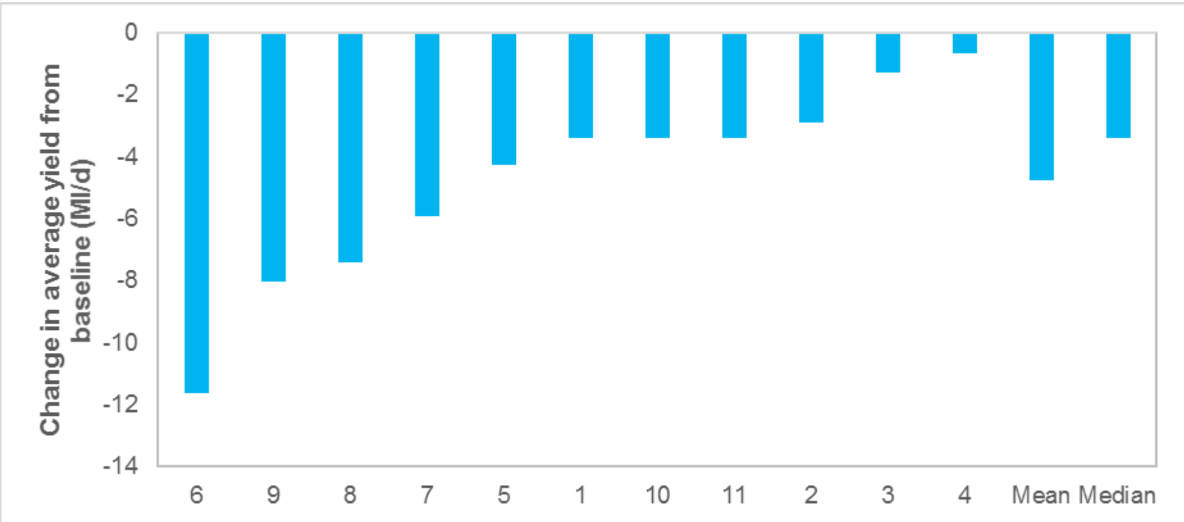


Figure 4-30: Combined change in average reservoir yields relative to baseline for 11 climate change scenarios



Summary of climate change impact on baseline deployable output

The impact of each climate change scenario on groundwater sources and reservoirs for average and peak conditions for the 2080s is shown in Table 4-15.

Table 4-15: Average and peak climate change impacts on deployable outputs for the 2080s

Scenario	Average				Peak
	Hydrologically constrained groundwater	Chippenham	Reservoirs	Total	Hydrologically constrained groundwater
1	-0.65	0.35	-3.39	**-3.69**	-0.53
2	4.10	1.08	-2.89	**2.29**	3.38
3	8.37	2.52	-1.27	**9.62**	7.02
4	8.33	1.86	-0.65	**9.54**	6.98
5	12.92	2.07	-4.26	**10.73**	10.78
6	-7.17	0.40	-11.64	**-18.41**	-5.81
7	1.29	0.01	-5.92	**-4.61**	1.07
8	-3.03	0.01	-7.40	**-10.41**	-2.46
9	-8.83	-0.60	-8.02	**-17.45**	-7.17
10	-2.95	-0.86	-3.39	**-7.20**	-0.70
11	-0.02	0.21	-3.39	**-3.20**	1.29
Mean	**1.12**	**0.64**	**-4.75**	**-2.98**	**1.26**
Min	**-8.83**	**-0.86**	**-11.64**	**-18.41**	**-7.17**
Max	**12.92**	**2.52**	**-0.65**	**10.73**	**10.78**
Median	**-0.02**	**0.35**	**-3.39**	**-3.69**	**1.07**

The 11 scenarios all have equal probability of occurrence. Given that the range of results are not normally distributed we have chosen to use the median impact of the 11 scenarios for the baseline supply forecast and the variability is accounted for within the headroom assessment.

Overall therefore, the baseline impact of climate change in the 2080s is estimated at -3.69 Ml/d on average (1% of base year deployable output) and +1.07 Ml/d for the peak scenario (0.2% of base year deployable output).

4.9.4 Scaling the impacts through the planning period

The change in deployable output calculated for the 2080s is scaled by generating a multiplier for each year of the planning period that assumes the impact of climate change in 2085 began from a base of no impact in 1975.

The scaled change in deployable output is included in Table WRP2 BL Supply, and summarised in Table 4-15.

Table 4-16: Central estimate of the impact of climate change on deployable output

	2016/17	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Dry Year Annual Average impact of climate change (Ml/d)	-1.41	-1.51	-1.68	-1.85	-2.01	-2.18	-2.35
Dry Year Critical Period impact of climate change (Ml/d)	0.41	0.44	0.49	0.53	0.58	0.63	0.68

4.9.5 Uncertainty and headroom

The variety in impact shown by the 11 scenarios illustrates that the future impacts of climate change remain uncertain. We have accounted for this uncertainty in our planning by incorporating the impact of all 11 scenarios in our headroom assessment – please see Section 6 for details.

4.10 Outage

At any one time actual achievable output from some of our sources will be less than the total deployable output owing to source outages. Outages are defined as a temporary loss of deployable output due to planned maintenance and capital work or unplanned events such as power failure, asset failure or water quality issues (including source pollution). It is important that sufficient allowance is made for such temporary reductions in deployable output when calculating overall supplies available.

4.10.1 Outage methodology

In developing the outage allowance for our plan, we have followed the EA WRMP planning guidelines, including the supplementary guidance WRMP19 methods: Outage allowance. In our last plan, we contacted consultants Mott MacDonald to develop an appropriate outage allowance, who developed an approach based on the methodology published by UKWIR in 1995, which was extended by not only considering the magnitude and duration of events, but also their frequency in deriving overall outage.

For this plan, as per the EA guidelines, we have followed the principles within the UKWIR report Outage allowances for water resources planning (UKWIR, 1995), and also the UKWIR risk -based planning guidelines, in developing an outage allowance for both the dry year annual average, and critical period planning scenarios.

As it is not appropriate to consider large outages in a stochastic approach (e.g. planned source outages greater than 90 days), the potential impact of large, key outage events is included in Scenario analysis and stress testing (Section 10).

<u>Outage record</u>

A single resource zone outage model was developed for this Plan. Data used to support the model came primarily from the company's Outage Database, which is an 11-year record, updated twice-weekly by the Water Resources Planning Team in conjunction with the abstraction data monitoring and verification process. The database was designed to capture outage information in a 'ready to analyse' format, which meets the needs of the 5-yearly Water Resources Management Plan, and the company's internal management reporting requirements. The database contains over 1,200 individual records of outage events at all sources since 2006/07; an example of the information recorded is shown in Table 4-16, and the outage record is included as an Appendix to this plan.

Table 4-17: Example extract from our outage database

Source	Design capacity (M/d)	Current max output (Ml/d)	Loss of output from design capacity (Ml/d)	Start date	End date	Duration (days)	Category	Issue	Magnitude of outage event (Ml)
Source A	4.5	0.0	4.5	01/04/11	08/04/11	7	D: Raw water quality	Turbidity	18.0
Source B	0.85	0.45	0.4	10/04/11	16/05/11	36	E: Operational	Pump failure	14.4

Outages are recorded against five categories:

- A: Long term – capital investment
- B: Planned – on programme
- C: Planned – outside programme
- D: Raw water quality
- E: Operational

Analysis methodology

We implemented the UKWIR 1995 methodology, and also followed the recommendations in applying the methodology made by consultants Mott McDonald in their report for our previous plan. The methodology was implemented as follows:

- Reviewed the historical outage record to assess the accuracy of recorded data, and the legitimacy of outage events. For example, we filtered out from the record some outage events relating to water quality, as these events occur annually, and are already accounted for in our Miser modelling, and therefore DO assessment. We also considered potential double counting of outage events at sources (e.g. where recorded as both water quality and turbidity), and removed events less than one day, and those longer than 90 days.
- Taking into account changes in the water supply system – relating to both network and treatment improvements. For example, at some sources, we now have UV plants in place, and so some water quality incidents in the outage record that occurred prior to UV plant installation, have now been removed, as they would no longer occur cause a reduction in deployable output.
- Represent the frequency magnitude and duration of each outage issue at each source by fitting a range of probability distributions to the magnitude, duration and frequencies of the outage event. In defining the magnitude of outage at each site we incorporated the outputs of deployable output assessment for each site (Section 4.8.5) alongside the historic outage record, to set appropriate outages for both the DYAA and DYCP.
- Select the most appropriate distributions for each outage type at each source, using expert judgement considering the validity of the historic record as representative of outages in the future, and also considering the quality of the underlying data in supporting a given model fit. In most cases, outage data were insufficient to justify particular model fits (which for statistical robustness ideally require 10s of samples), and so we used a triangular distribution, as recommended in the original 1995 methodology for most outages.
- Run the Monte Carlo sampling from each source and set of distributions to derive an overall outage allowance. The original 1995 methodology recommends 500 iterations, and in WRMP14 up to 10,000 were ran. We implemented the sampling in the R statistical software package[27], so we ran 100,000 samples to get as representative distribution as feasible, given lower computational constraints.

[27] R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

4.10.2 Outage results

Figure 4-31 shows the sampled dry year annual average outage distribution. The median of the DYAA outage distribution is 17.8 Ml/d, with a range from 13 Ml/d to 23 Ml/d, which equates to 3-5% of deployable output, depending on the chosen risk percentile. Figure 4-31 shows the equivalent distribution for the dry year critical period. The DYCP outage distribution median is 24.3Ml/d, and ranges from 17 Ml/d to 32 Ml/d, which is 3-6% of deployable output.

The UKWIR risk-based planning guidelines states that there has been no guidance as to the percentile to choose to derive the outage allowance, and suggests that although academic theory might suggest a lower percentile, practicalities associated with physical resource management and the management of drought risk indicate that a planning allowance in the range 75% to 90% should be used. In our previous plan, we adopted the 85th percentile for both the annual average and critical period planning scenarios.

We have selected to use the 85th percentile for outage throughout the planning period for both the DYAA and DYCP, which gives an outage allowance of 19.38 Ml/d (4.5% deployable output) and 26.59 Ml/d (5% of deployable output) for the DYAA and DYCP, respectively.

Figure 4-31: Sampled outage distribution for dry year annual average

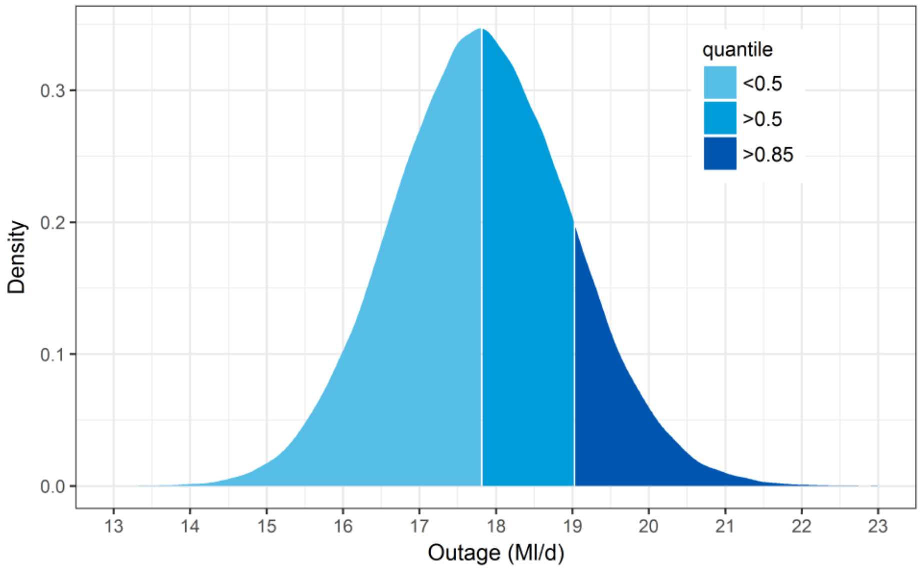


Figure 4-32: Sampled outage distribution for the dry year critical period

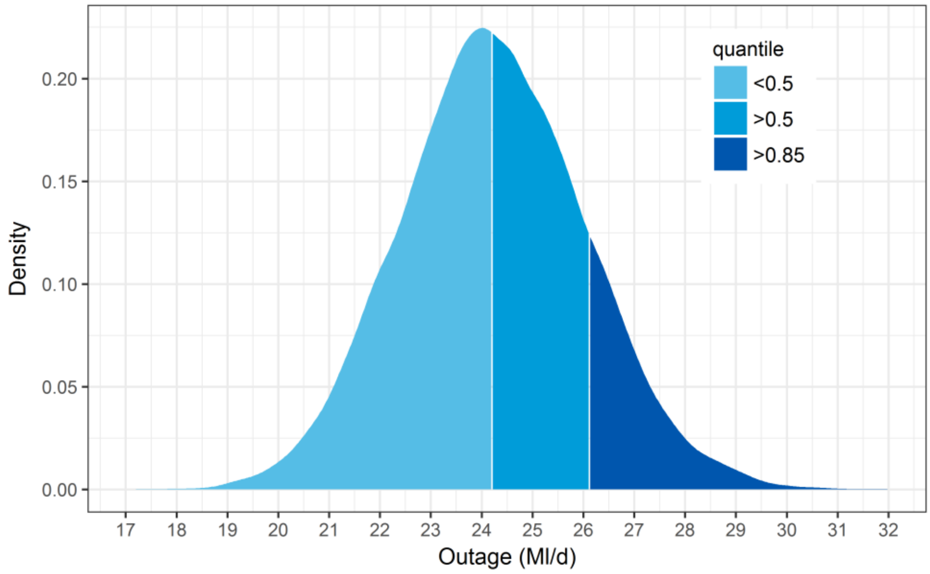
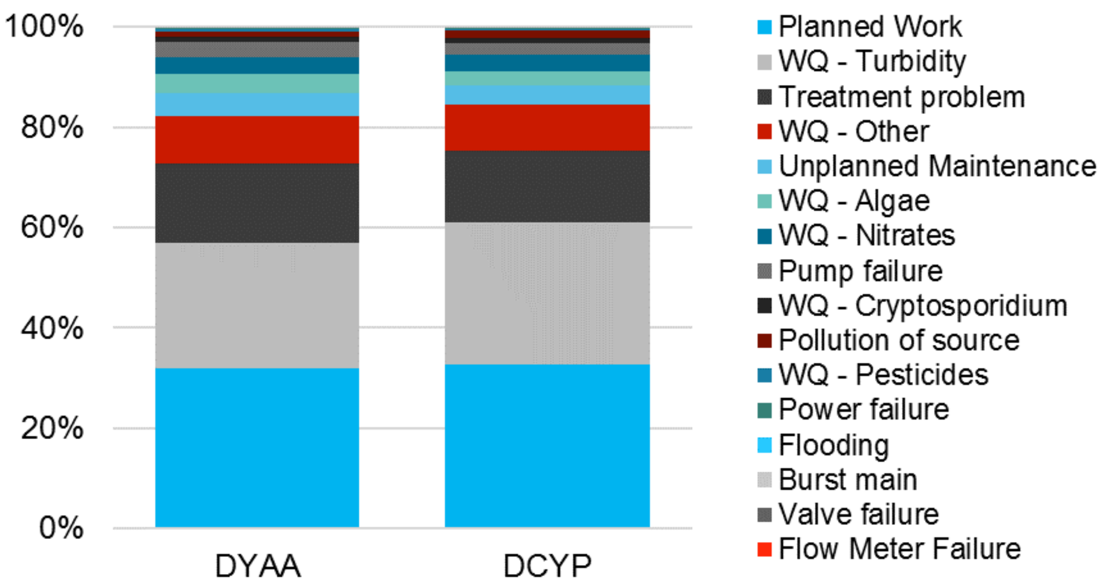


Figure 4-33 shows the contribution of outage type to overall outage at the 85th percentile for both the DYAA and DCYP planning scenarios. Overall planned work contributes the most to the outage allowances. Water quality issues combined, however, contribute 43% (DYAA) and 45% (DYCP), with turbidity issues being the main problem. Unplanned maintenance only contributes 4.8% (DYAA) and 3.9% (DYCP) to the overall outage allowance.

Figure 4-33: Contribution of outage type to overall outage (85th percentile) for dry year annual average and critical period scenarios



The outage allowance has not been reassessed across the planning period as following the completion of our integrated grid in 2017/18, no further significant changes to the supply system are planned. Outage has also been considered separately from target headroom; our analysis of headroom is covered in Section 6. Owing to our baseline supply demand balance surplus (Section 7) options to reduce outage have not been considered.

4.11 Overall supply forecast

Table 4-18 and Table 4-19 summarise the key elements of the baseline supply forecast that have been described throughout this chapter. The key variable that is input into the supply-demand balance is the Total Water Available For Use (TWAFU), which is calculated as follows:

TWAFU = Baseline Deployable Output + Imports – Exports – Reduction due climate change – sustainability reductions – Treatment works operational use – Outage allowance

Table 4-18: Summary of dry year annual average supply forecast (all values in Ml/d)

Component	2017/18	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Baseline deployable output	419.50	419.50	419.50	419.50	419.50	419.50	419.50
Imports	16.27	16.27	16.27	9.30	9.30	9.30	9.30
Exports	1.48	1.48	1.48	1.48	1.48	1.48	1.48
Reduction due to climate change	1.41	1.48	1.65	1.81	1.98	2.15	2.32
Sustainability reductions	0.00	-16.17	-16.71	16.71	16.71	16.71	16.71
Treatment works operational use	4.65	4.65	4.65	4.65	4.65	4.65	4.65
Outage	19.38	19.38	19.38	19.38	19.38	19.38	19.38
Total Water Available For Use (TWAFU)	**408.85**	**392.61**	**391.90**	**384.77**	**384.60**	**384.43**	**384.26**

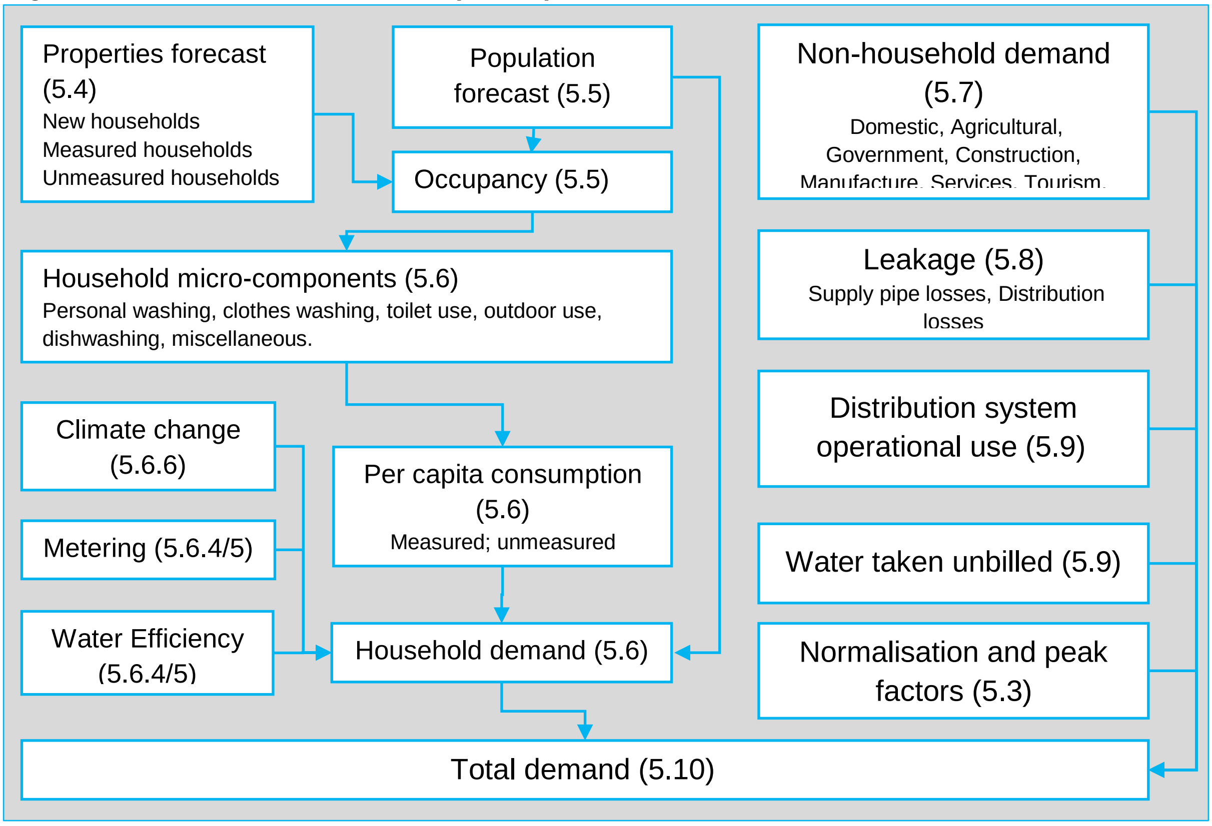
Table 4-19: Summary of dry year critical period supply forecast (all values in Ml/d)

Component	2017/18	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Baseline deployable output	514.17	514.17	514.17	514.17	514.17	514.17	514.17
Imports	16.78	16.78	16.78	9.81	9.81	9.81	9.81
Exports	1.77	1.77	3.27	3.27	3.27	3.27	3.27
Reduction due to climate change	-0.41	-0.43	-0.48	-0.52	-0.57	-0.62	-0.67
Sustainability reductions	0.00	25.00	26.20	26.20	26.20	26.20	26.20
Treatment works operational use	4.65	4.65	4.65	4.65	4.65	4.65	4.65
Outage	26.59	26.59	26.59	26.59	26.59	26.59	26.59
Total Water Available For Use (TWAFU)	**498.35**	**473.37**	**470.72**	**463.79**	**463.84**	**463.89**	**463.94**

5 Future water demands

This Section outlines the development of our forecast of future water demands. An overall projection of the average volume of water we will need to put into our distribution network each day (known as 'distribution input') is built up from component forecasts of population, property, household water use patterns, commercial usage, leakage and other minor elements (Figure 5-1). The forecast takes account of projections made by Local Authorities of expected housebuilding rates in our area, the impact that increased metering and water efficient behaviours by our customers will have and an allowance is made for the possible impact that climate change may have on water usage. The approach taken in developing our demand forecast approach is consistent with our problem characterisation assessment and supply-demand balance situation.

Figure 5-1: Demand forecast development process



A wide variety of data has been used to develop and underpin various elements of the forecasts using a mixture of national data sources, company specific information and bespoke research. Forecasting methods used are consistent with those recommended by the water resources planning guidelines and UKWIR reports.

Since the development of our last Plan the water industry has collaborated on several projects to better align the technical methods used by companies to assess leakage, supply interruptions and sewer flooding. In 2017 Water UK co-ordinated the development of new guidance[28] with the support of the Environment Agency, Ofwat, CCWater, Defra, Natural Resources Wales and the Welsh Government.

The UKWIR (2017) report provides a best practice methodology to estimate annual leakage volumes and as a result all water companies have made changes to the methods they have previously used to align with the new common approach. Using a standardised method better enables regulators and customers to compare company performance. Methodological changes have, for all companies, led to a revision in the estimate of total leakage. It is important to note that the recent change in reporting of leakage is purely a change in reporting: it does not affect the actual amount of water lost through leakage.

We have adopted the new methodology, to recalculate leakage for the 2017/18 base year and used this as the starting point for our forecasts, as recommended by the Environment Agency's supplementary guidance[29] to the water resources planning guidelines

We seek to continually improve our understanding of the water balance (i.e. how the component parts of the demand forecast impact on each other) and so in addition to the industry wide improvement projects noted above we have also recently completed a number of studies to improve our understanding of water demand across our region. These have included research and analyses on household occupancy and meter under registration allowances.

In combination, the new methodology to estimate leakage and the data analysis improvements have resulted in some changes to the base year values for leakage and per capita consumption relative to the figures reported in our 2017/18 Regulatory Return. These changes are detailed in Annex A to this Plan.

In the publication of the draft of this Plan we used 2016/17 as the base year for the plan forecasts. Since then, annual return data for 2017/18 has become available, and we have also made data improvements as we work to becoming fully consistent with the new leakage methodology. We have therefore re-based the plan and are using 2017/18 as the base year for our forecasts to account for these changes.

The structure of the rest of this chapter is as follows:

- Section 5.1 provides an overview of historical demand patterns
- Section 5.2 describes the base year normalisation and an explanation of the peak factors used
- Sections 5.3, 5.4 and 5.5 explains the development of the population, property and household water use forecasts – including the impact of schemes to enhance metering and water efficiency
- Section 5.6 outlines the non-household (commercial) demand forecast
- Section 5.7 summarises our current leakage position, the sustainable economic level of leakage and our future forecast of leakage reduction

[28] UKWIR (2017) Consistency in Reporting Performance Measures

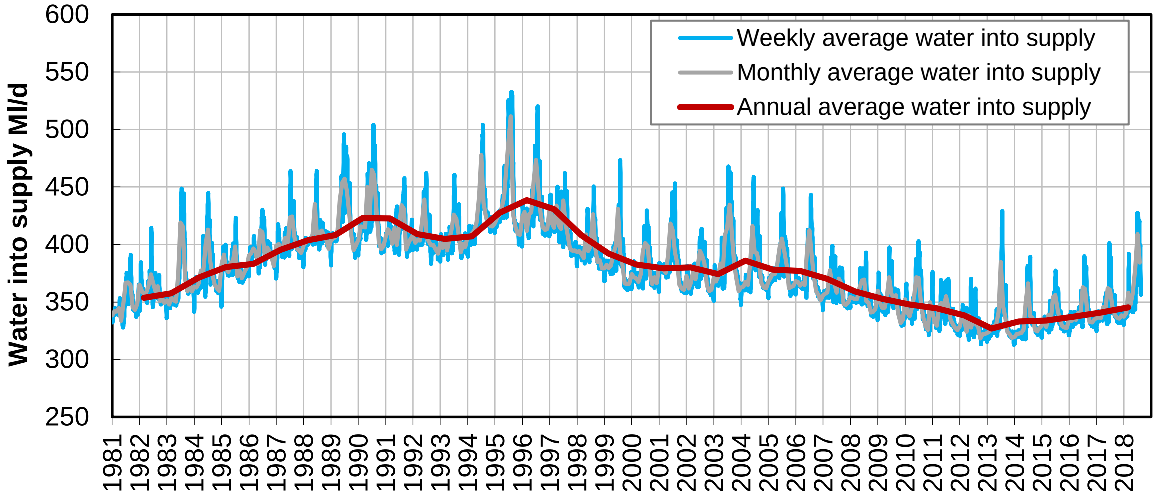
[29] Environment Agency (June 2017) Leakage in WRMPs

- Section 5.8 describes two minor elements of demand – distribution system operational use and unbilled water
- Section 5.9 then summarises the overall baseline and final planning demand forecasts and discusses some of its key sensitivities

5.1 Historical demand patterns

Until the mid-1990s the demand for water in the Wessex Water region was on a steadily rising trend. From then until around 2013 this trend was reversed and the demand for water and therefore the volume of water that we need to abstract from the environment reduced. In recent years we have seen a slight increase in baseline demand which is likely related to a complex pattern of in year weather patterns, societal and behavioural patterns. Figure 5-2 shows weekly, monthly and annual average 'water into supply' (WIS) since 1981. It shows that over the last 20 years peak week demands have fallen from approximately 525 Ml/d to around 400 Ml/d, and annual average demands have reduced from around 425 Ml/d to less than 350 Ml/d.

Figure 5-2: Weekly, monthly, and annual average water into supply (demand)



The general reduction in the demand for water has occurred despite an overall increase in the population in our area, which has risen from 1.1 million people in 1994/95 to 1.3 million in 2017/18. The reduction in demand has occurred due to:

- Leakage reduction – we have reduced leakage from the network by half.
- Customers switching to a metered supply – the proportion of metered households in our region has increased from less than 10% to more than 62% today.
- The more efficient use of water in homes and businesses by our domestic and commercial customers.
- Reduced non-household (commercial) demands due to the closure of some large user industrial sites in the chemical and food and drink sectors and increased water efficiency.

Figure 5-3: The reduction of water put into our network since 1995 relative to population growth and leakage reductions

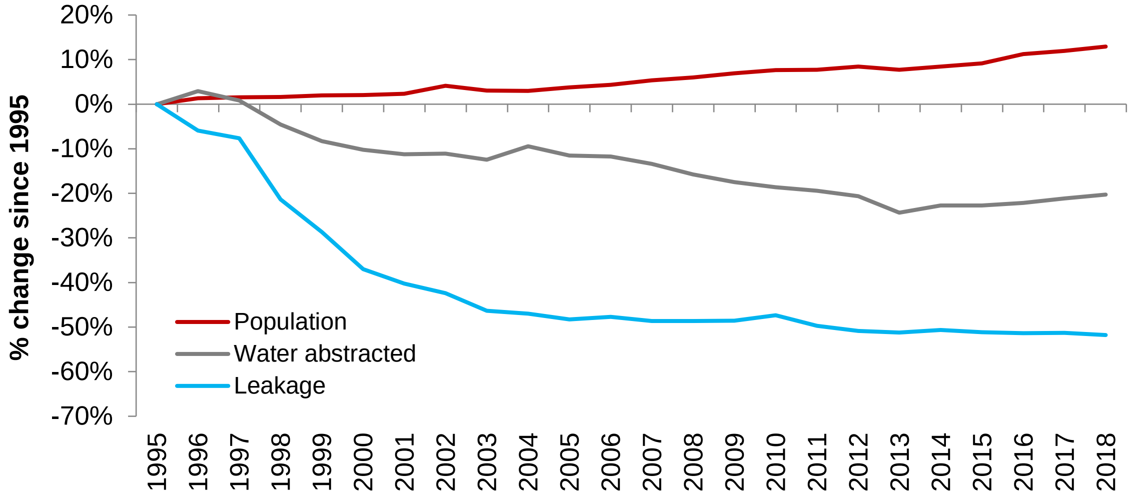
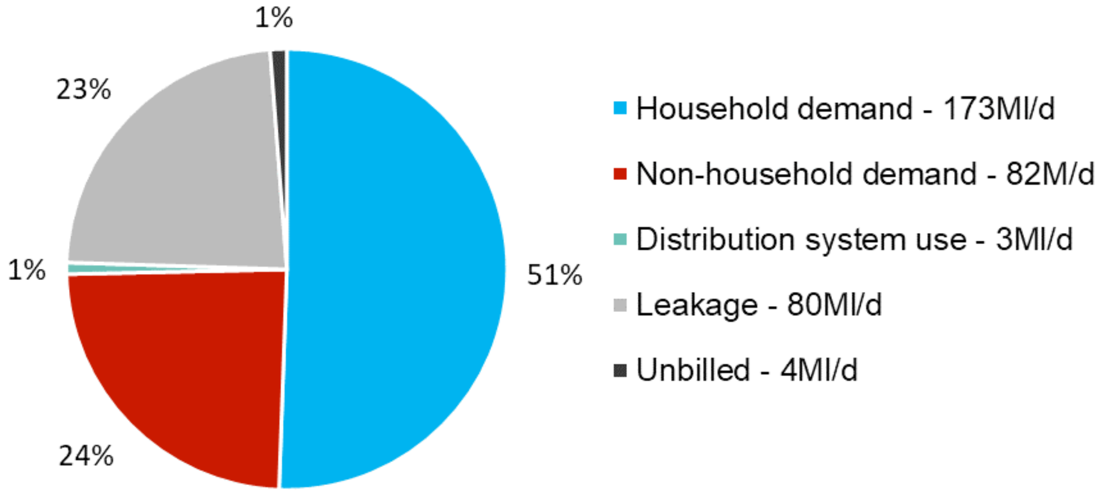


Figure 5-2 shows the in-year variability in the demand for water; during the summer the demand for water generally increases as our customers use more water in their gardens for plants and leisure, and also inside their homes for showering and clothes washing. Water use by businesses also increases in the summer months, particularly in areas popular for tourism and we also have a high proportion of agricultural volumes. Higher demands can also sometimes occur in winter as a result of short-term increases in leakage related to freeze-thaw weather conditions. This effect can be seen in the weekly average WIS trend, notably in the winters of 2009/10 and 2010/11, and most recently in March 2018, following the so-called “beast from the east” cold weather event. See section 8.10 for further details of our resilience to freeze-thaw events.

Figure 5-4 shows total reported water demand (338 Ml/d) in 2016/17, segmented into key categories. For this Plan, 2016/17 is used as the base year, from where we made a projection of future demands. It indicates that half of the water we supply is to households, and non-household (commercial) demand comprises just under a quarter of the total; leakage accounts for 25% of water we supply. Water used within the distribution system for operational purposes and water that is taken and unbilled both amount to around 2% of total demand.

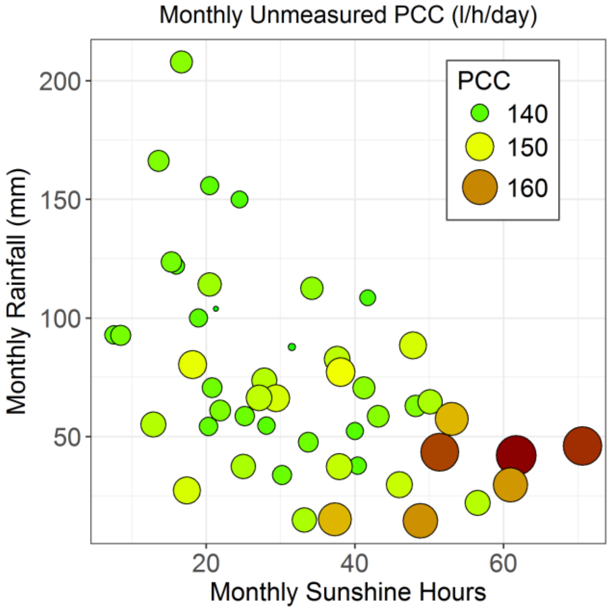
Figure 5-4: Segmentation of total water demand in the base year 2017/18



5.2 Base-year normalisation and peak factors

Demand varies season to season, and year to year depending on the weather conditions. As shown in Figure 5-4, demand (as represented by unmeasured per capita consumption) is highest during drier periods with lower rainfall, and also during sunnier (and typically warmer) periods.

Figure 5-5: Relationship between monthly per-capita consumption and key weather variables



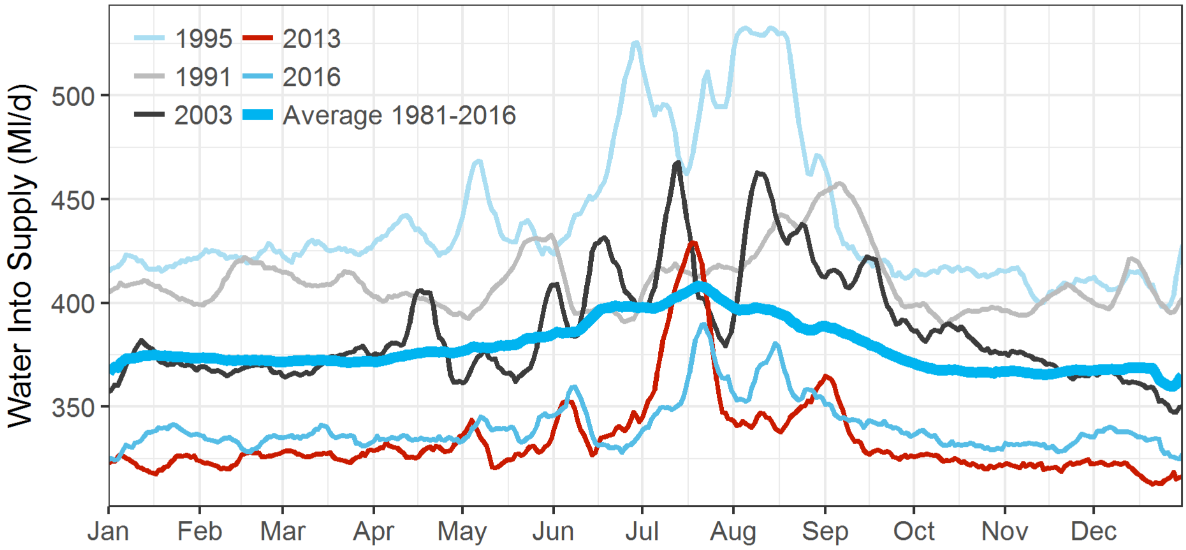
Warmer, sunnier and drier periods tend to occur during the summer, leading to higher (peak) demands relative to average conditions (Figure 5-6). Increased water use at this time typically reflects increases in garden usage for watering and leisure, and increased personal washing[30]. Depending on when in the year the drier conditions occur can influence what

[30] Tynemarch (2012), Wessex Water Tariff Trial Project Household Consumption Analysis (final report).

water use behaviours are driving the peak – e.g. spring bedding planting or school holidays and leisure (paddling pool) use.

In addition to annual weather conditions overall demand is also influenced by long-term trends in water consumption (Figure 5-2), relating to increased water efficiency, metering and long-term reductions in leakage.

Figure 5-6: Annual variability of water into supply for key historical years



In order to calculate demand for our dry year annual average (DYAA) and our dry year critical period (DYCP) planning scenarios, we evaluate how demand changes historically over time, and particularly during dry years in the historical record, which do not happen too often. It is necessary to isolate the effect of long-term trends from annual variability in weather conditions, to understand what demand would be today (reflecting current usage and leakage), under a low-rainfall year, and during a critical dry period. To achieve this, we first normalise base-year demand to remove the influence of the weather to derive the normal year annual average (NYAA) demand, and second uplift normalised demand using **peak factors** to derive demand under dry weather conditions for the DYAA and DYCP planning scenarios.

5.2.1 Base year normalisation

Of the various components of demand, two are affected by changes in the weather – water delivered to household customers and water delivered to non-household customers. Leakage, water taken unbilled, and distribution system operational use are assumed not to vary with the weather[31]. To normalise the base year demand for household and non-

[31] Leakage is recognised to vary with winter weather conditions as extreme freeze-thaw conditions can result in an increased leakage (winter breakout) – see Section 8.10. These events however are typically short-lived and are not critical in the development of DYAA and DYCP forecasts particularly as winter breakout occurs at a time when other demands tend to be low and supplies are not constrained by low groundwater levels as in the summer months.

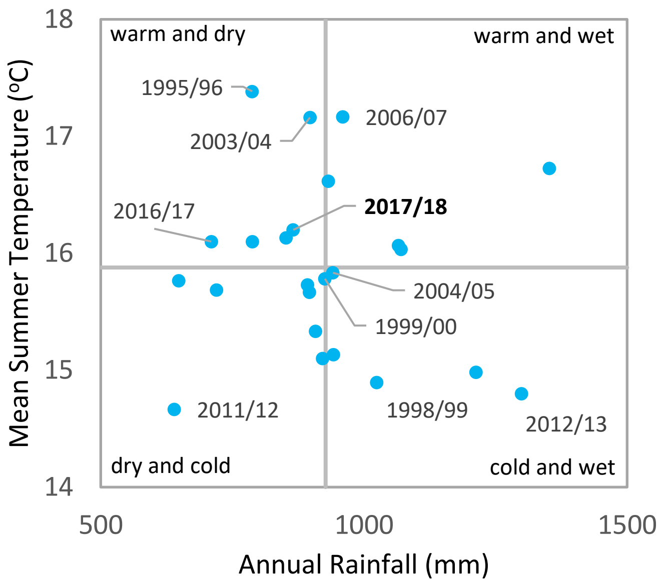
households, we followed the methodology set out in the UKWIR WRMP19 consumption forecasting guidance[32], and undertook a trend-based analysis of demand.

In overview, we applied the following four step methodology:

1. **Collate data**: Collated base-year water delivered for each demand category from regulatory returns, from 1995/96 to 2016/17 (the base year);
2. **Adjust data**: Calculate water consumption from water delivered (where relevant) by removing calculated leakage, to give component of demand that is weather related.
3. **Develop regression model**: develop regression model to account for underlying trend in the data. Regression models were developed for each demand component as a function of properties and population for each category to account for impact of changes in meter penetration and population, and also as a function of time to account for overall trends (e.g. as a result of increasing water efficient behaviours).
4. **Estimate NYAA adjustment factors** – adjustment factors to the base year demand were calculated by using the regression model prediction for the base year.

Figure 5-7 shows variability in weather conditions in recent years. The years 1999/00 and 2004/05 were the most average (i.e. normal) years at an annual level, whilst notable dry years occurred in 1995/96, 2003/04. The summer of 1995 in particular had the highest average summer temperatures of the last 22 years and led to water use restrictions in other parts of the country. The summers of the last two years were also both warmer and drier than average, with a notable dry period during the spring of 2017, leading into a warm dry spell that led to a peak in demand in June.

Figure 5-7: Weather variability from 1995/96 to the base year 2017/18



Note the horizontal and vertical lines show the mean summer temperature and mean annual rainfall, respectively.

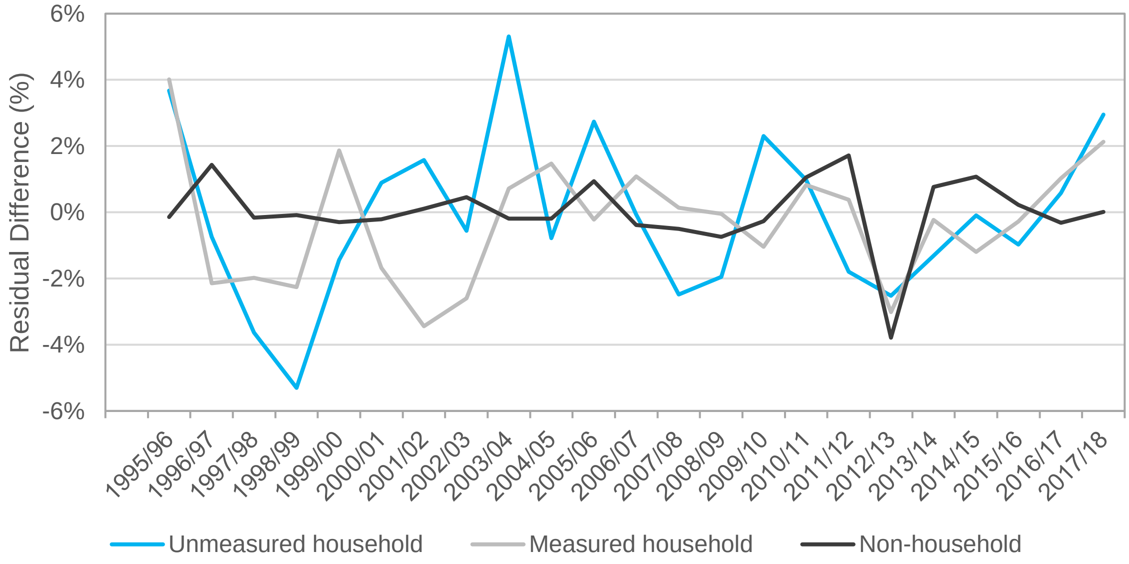
[32] UKWIR (2014-15) WRMP19 Methods – household consumption forecasting guidance manual, section 6 - Take account of year-to-year weather variation.

Figure 5-8 shows the residual percentage difference between observed consumption and modelled consumption for the three consumption regression models that were developed. Unmeasured households show the biggest variation in consumption, with the highest positive differences between observed and normalised demand occurring in 1995/96 and 2003/04, two of the driest and warmest years on record.

The highest measured household consumption compared to the normalised demand also occurred in 1995/96. Demand in all three categories was low in 2012/13, which was the coldest and wettest year in the record. Measured and unmeasured household consumption was also low in 1998/99, another cold and wet year.

Figure 5-8 suggests that consumption in the base year (2017/18) was average for non-household demand, and slightly higher than average (normal) for household demand, but not as high as under the driest years. This is consistent with our interpretation of weather for the base year, which was drier than normal, but mainly during the spring and early summer.

Figure 5-8: Residual difference between observed and predicted consumption (trend-based model)



To define the normal year base year demand we have adjusted the outturn data[33] to reflect predicted demand had the weather conditions been 'normal', by using the trend model prediction for the base-year as our normalised base-year consumption.

[33] Outturn data that has also already been adjusted for water balance improvements described at the start of this chapter and in Annex A.

Table 5-1: Outturn to normal year consumption adjustments

Demand component	Base year consumption (Ml/d)	Uplift (Ml/d)
Unmeasured household consumption	80.89	-1.96
Measured household consumption	92.07	-2.39
Measured non-household consumption	77.48	-0.01

5.2.2 Peak factors

Once normalised demand components have been produced (as described in the previous section, 5.2.1) 'peak factors' are used to uplift components of demand that are influenced by dry year conditions to derive dry year (DYAA) and critical period (DYCP) demands.

Our last Plan used peak factors that were developed by Tynemarch (now Servelec) through analysis of annual performance return data, weather data, detailed consumption information from our 2008-11 Tariff Trial project and high-resolution consumption data from summer 2013 peak demands. The full findings of the peak factor analyses are available as appendices[34].

In the intervening years since 2013, we have not experienced any significant, extended dry summer peak periods, or drought conditions[35]. As a result, we have taken a proportionate approach to maintain the same peak factors as applied in the last Plan, where uplifts are based on the weather conditions observed in 1995/96, which as shown in Figure 5-7 is the warmest and driest year in the recent record.

Table 5-3 presents the peak factors used for each component of demand for the base year (2017/18) and at the end of the planning period (2044/45). Distribution system operational use and leakage are not uplifted (i.e. they have factors of 1.0) as they are assumed not to vary between demand scenarios. Household and non-household factors are applied only to consumption; supply pipe losses (customer leakage) associated with each property are not factored up.

[34] Tynemarch (June 2012). Wessex Water Tariff Trial Project – dry year peak factors methodology (Final Report).
Tynemarch (October 2013). Dry Year household peak factors update.
[35] With the exception of summer 2018, during the preparation of the revised draft final plan. Please see end of Section 5.2.2.

Table 5-2: Uplift factors for normal to dry year annual average and dry year critical period demand

Component of demand	Normal year annual average : Dry year annual average		Normal year annual average : Dry year critical period	
	Base year	2044/45	Base year	2044/45
Measured household	1.041	1.045	1.196	1.236
Unmeasured household	1.065	1.066	1.481	1.513
Measured non-household billed monthly	1.04	1.04	1.277	1.277
Measured non-household billed six-monthly	1.04	1.04	1.345	1.345
Unmeasured non-household	1.04	1.04	1.345	1.345
Unbilled	1.065	1.066	1.481	1.513
Distribution system operational use	1.00	1.00	1.00	1.00
Leakage	1.00	1.00	1.00	1.00

For the **dry year annual average scenario:**

- Measured and unmeasured household water consumption is uplifted by 4.1% and 6.5%, respectively in the base year based on Tynemarch's analysis. The change in the factors through the planning period is driven by changes in domestic water use derived from our micro-component model. The factor for measured households grows modestly to 4.5% and the factor for unmeasured households grows marginally to 6.6% by 2044/45. These changes are largely driven by changing occupancy rates.
- Non-household water consumption is uplifted by 4.0% throughout the period. This is the same value applied to the demand forecasts for WRMP09; Tynemarch's analysis reviewed the previous approach and tested an alternative modelling approach but this did not suggest any requirement to change the factor.
- Unbilled demands follow the same uplifts as unmeasured households. This approach was recommended by Tynemarch.

For the **dry year critical period scenario**:

- Measured and unmeasured household water consumption is uplifted by 19.6% and 48.1% in the base year based on Tynemarch's water balance based analysis. The change in the factors through the planning period is driven by changes in domestic water use derived from our micro-component model. The factor for measured households grows to 23.6% and the factor for unmeasured households grows to 51.3% by 2039/40.
- Non-household water consumption has different levels of uplift depending on billing frequency – this change to our approach followed from Tynemarch's analysis which revealed measured non-household customers that receive their bill on a monthly rather than 6-monthly basis exhibit flatter (lower) peak demands. This can be explained by the fact that non-households that are billed monthly tend not to include the type of businesses that have particularly seasonal demands such as farms and golf courses. Measured non-households

that are billed monthly are uplifted by 27.7% throughout the planning period and non-households that are unmeasured or measured but are billed 6-monthly are uplifted by 34.5% throughout the period. Unbilled demands follow the same uplifts as unmeasured households.

Dry year critical period scenarios do not occur very frequently, by definition therefore, the data that underpins the peak factors is sparse. Whilst the data we have collected through our Tariff Trial study provides us with some good information, the bulk of the data was collected in years that were not particularly hot and/or dry and so there is some risk that the new peak factors have not been fully tested under true peak conditions.

Summer 2018

During the summer of 2018, following publication of the draft water resources plan, and at the time of preparing the draft final plan, we have (and are) experiencing an extended period of dry and hot weather. Demand has increased during this time as shown in Figure 5-2. At the time of writing, we have so far experienced a peak week demand of 428 Ml/d, which is higher than our central estimate of the dry year critical period forecast of 418 Ml/d for 2018/19, but within the limits of this central forecast plus the ~15 Ml/d component of headroom associated with demand uncertainty for critical periods is also accounted for (combined these total 433 Ml/d) (see Section 6.3 for more information on headroom). This provides an independent validation that the peak dry weather during the summer of 2018 is within the range of our forecast uncertainty allowed for in this plan.

The dry conditions in summer 2018 have followed a normal winter period, whereas our design event (1975/76) is a multi-season event where the peak dry summer period follows a dry winter. Following a dry winter period with reservoir and groundwater storage lower than average, our drought plan would likely trigger customer focussed water efficiency campaigns earlier in the spring than was initiated in 2018. Coupled with higher general awareness of what would likely be a national water resources situation, we anticipate this would have a moderating effect on peak demands.

In Section 12.3 , we describe the improvements we intend to make in our modelling of the effects of weather on customer demand that will incorporate work undertaken as part of ongoing academic partnerships. We will incorporate the data collected during summer 2018 into this analysis as we develop our planning methods towards WRMP24.

5.3 Properties

Understanding the current number of domestic and commercial properties that we supply, and forecasting how this will change in the future is an important element of a water demand forecast. While it is people that use water and not properties, the overall number of properties that the population lives in, and their type (e.g. household or communal establishment), determines the occupancy rate of homes, which in turn impacts on overall demand.

5.3.1 Forecast scenarios

Table 5-3 specifies the demand forecasts that have been developed for this Plan. All demand forecasts are based on unrestricted demands. The key details of each are then described below.

Table 5-3: Forecast scenarios developed for WRMP19

	Baseline	Final planning
Dry year annual average (DYAA)	✓	✓
Dry year critical period (peak week; DYCP)	✓	✓
Average year annual average / weighted average (AYAA)	✓	✓

Baseline demand forecasts assume a continuation of current policies relating to metering, leakage and water efficiency throughout the 25-year planning period. This means our baseline forecast assumes standard (not enhanced) optional and change of occupier metering, distribution leakage losses at the current level and the continuation of standard (not enhanced) water efficiency activities.

Final planning demand forecasts include the impact of our proposed options to enhance the promotion of optional metering, provide enhanced services to help customers become more efficient in their use of water and innovation in our management of leakage – see section 5.5.5 and Section 9.

The **dry year annual average (DYAA)** condition is the basic demand forecasting scenario for water resources planning. It is the unrestricted demand for water in a low-rainfall year, averaged over the year and usually expressed as Ml/d.

The **dry year critical period (DYCP)** condition for Wessex Water is the peak week demand in a low-rainfall year, expressed as Ml/d. Peak week demands typically occur between June and September and/or sometimes coincide with Bank Holidays. Our water supply system of treatment works, pipelines and service reservoirs, including new assets associated with our integrated grid, are designed to manage peak seven day demands. Peak demands occurring over shorter time-steps are managed by the storage that we have in our treated water service reservoirs which is linked to company asset design standards.

The normal year annual average (NYAA) condition is developed as a basis on which to calculate the DYAA and DYCP forecasts.

5.3.2 Base year properties

Our base year property figures for 2017/18 are derived from our billing system property records and are shown in Table 5-4.

Table 5-4: Base year properties supplied

Property type	Number of properties
Measured households	352,182
Unmeasured households	200,633
Total households billed water	552,185
Measured non-households	42,870
Unmeasured non-households	3,548
Total non-households billed water	47,779
Void properties	14,173

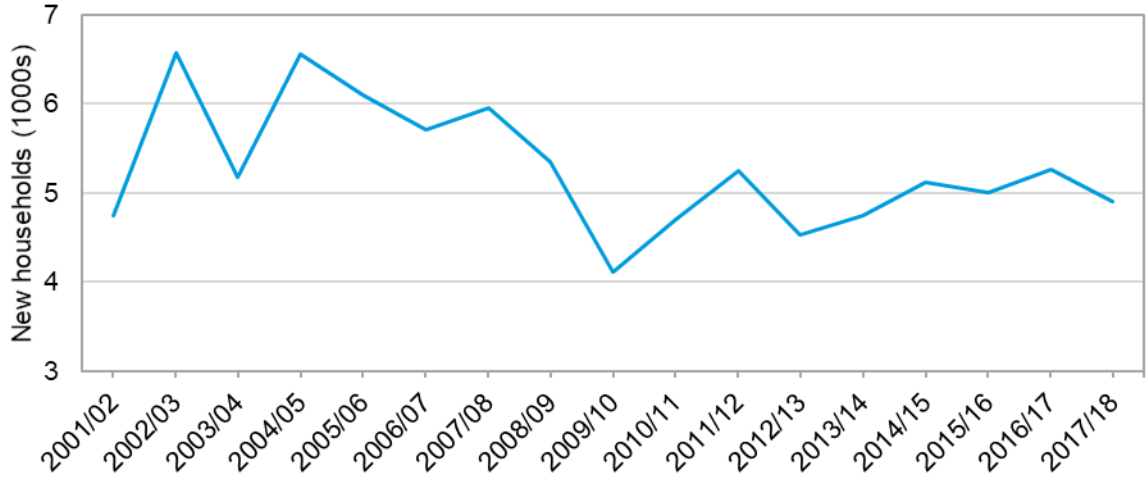
Void properties are properties that are connected to our supply system but are not charged for water services as they are not occupied. The number of void properties is derived from our billing records following a standard reconciliation process. The total number of void properties varies slightly from year to year; the average for the period 2007/08 to 2017/18 was 14,211, which is comparable to the total outturn data for 2017/18 (14,173) – it is reasonable therefore to keep the number of voids constant throughout the planning period.

A small number of 'properties' chargeable only for fixed standpipe, trough or sprinkler charges are excluded from the billed property numbers on the basis that they are not premises receiving water for domestic purposes.

5.3.3 Household properties forecast

House building rates are an important factor in the development of a water demand forecast. Figure 5-9 shows the number of new households in our region that have connected to our supply system each year since 2001/02. The average number of new households per year through this period is approximately 5,300. Throughout much of the 2000s our region experienced a higher property growth rate of around 5,700 new properties each year. This rate fell in 2009/10 to just above 4,000 properties per year, following the economic slowdown. Since 2009/10 there has been slow overall growth in new household connections, reaching just over 4,900 properties in 2017/18.

Figure 5-9: Observed annual rates of new household connections



We have developed forecasts of the growth in household properties and population following section 5.3 of the Water Resources Planning Guideline (2017) and the UKWIR (2016) guidance manual[36]. In overview, we have based our property forecast on local plans published by local councils and unitary authorities that overlap with our supply area, and also applied trend-based forecasts derived from national statistics to compare against local authority (LA) derived trajectories, and also extend our property forecast beyond the period covered by local plans, which typically finish only 12 years into the planning period, up to 2045.

Our water supply system is covered by 16 LA areas (Table 5-2). Of these, 13 have published adopted local plans, one is under review, one published, and one submitted. The largest authority in our region is Wiltshire containing ~30% of our supply households. Five local authorities on the fringes of our supply area collectively contain fewer than 1,000 supply properties (<0.2%). The local plans for each authority cover the first part of our planning period, but the end date of these plans varies from 2025/26 up to 2032/33, leaving between 13 and 19 years to forecast by alternative, trend-based methods.

[36] UKWIR (2016) Population, household property and occupancy forecasting guidance manual.

Table 5-5: Local Authorities in our water supply area

Local Authority/Council	Plan status (August 2017)	Plan period	% of supply households
Bath & North East Somerset Council	Adopted 2014	2011/12 - 2028/29	7.8%
East Dorset District Council	Adopted 2014	2013/14 - 2027/28	0.9%
Mendip District Council	Adopted 2014	2006/07 - 2028/29	<0.1%
New Forest District Council	Adopted 2010	2006/07 – 2025/26	<0.1%
North Devon District Council	Under review 2017	-	<0.1%
North Dorset District Council	Adopted 2016	2011/12 – 2030/31	5.1%
Poole, Borough Of	Published 2017	2013/14 – 2032/33	9%
Purbeck District Council	Adopted 2012	2006/07 – 2025/26	3.7%
Sedgemoor District Council	Submitted 2017	2011/12 – 2031/32	5.8%
South Somerset District Council	Adopted 2015	2006/07 – 2027/28	12.7%
Taunton Deane Borough Council	Adopted 2012	2008/09 – 2027/28	8.7%
Test Valley Borough Council	Adopted 2016	2011/12 – 2028/29	<0.1%
West Dorset District Council	Adopted 2015	2011/12 – 2030/31	7.7%
West Somerset District Council	Adopted 2016	2012/23 – 2031/32	2.8%
Weymouth and Portland Borough Council	Adopted 2015	2011/12 – 2030/31	5.4%
Wiltshire Council	Adopted 2015	2006/07 – 2025/26	30.3%

New households and the growth in total properties supplied

Housing requirements were obtained from local plans and core strategies for each LA. Housing completion rates to-date, alongside revised housing trajectories, were obtained from LA websites and updates/reviews of housing completions against plan requirements, which are required annually by The National Planning Policy Framework[37]. In August 2017, we wrote to each LA to request the latest updates to their housing trajectories, and information on potential revisions to their local plan to support the development of our draft Plan property forecast.

To calculate trend-based household forecasts we obtained the latest household projections from the Department for Communities and Local Government (DCLG). The most recent projections were the 2012-based projections, and the 2014-based projections, which were published in July 2016, and extend to 2039[38]. Following the UKWIR (2016) guidance, we assessed our needs for the forecast, based on our problem characterisation (Section 3.2), and the size of our water resources zone, and chose to base the trend-based forecast on Local Authority level data.

To convert plan and trend-based housing trajectories and forecasts for each LA to a water resource zone level trajectory, we followed the UKWIR (2016) methodology, and used our base-year billing system data and Geographical Information System (GIS) to calculate the proportion of households in each LA for the base-year. These percentages were then used to assign the proportion of household growth in each LA to the water resources zone. To

[37] DCLG (2012) National Planning Policy Framework

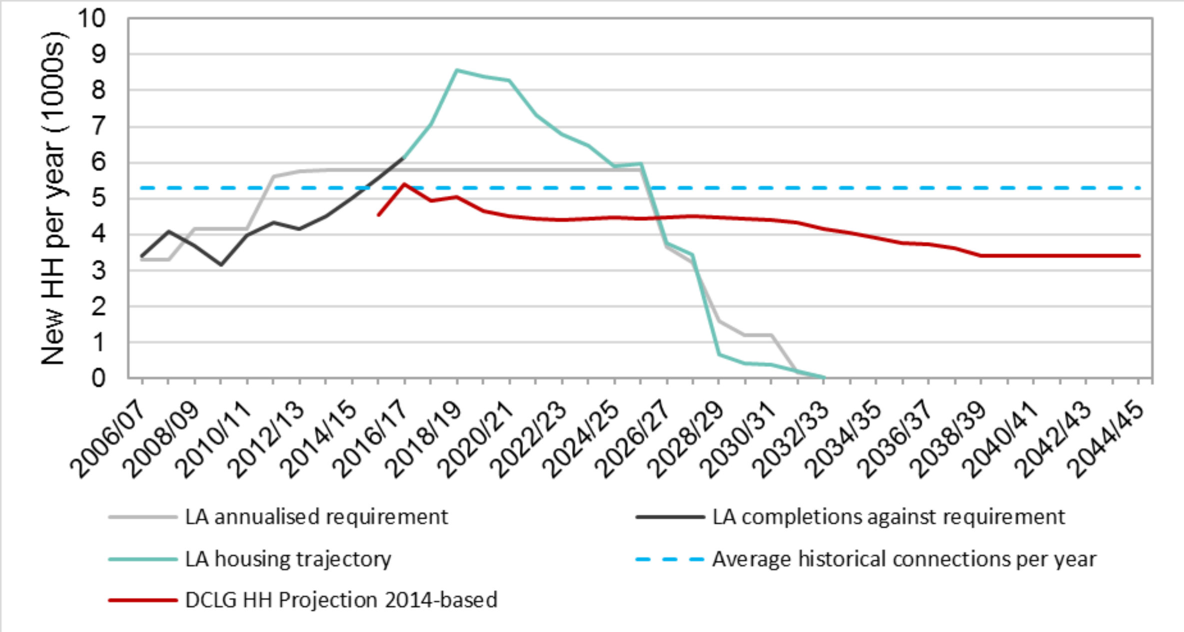
[38] The latest household projections were released in June 2016, and are 2014-based, meaning they run from 2014 onwards to 2039.

extend the trend-based properties forecast from 2039 to the end of the planning period (2045) we applied the average trend from the last 10 years of the forecast.

Figure 5-10 shows forecasts of new households per year in the Wessex Water region based on local authority data and trend-based forecast from the DCLG in comparison to the average actual number of new connections in recent years (dashed blue line) and the annualised long-term housing requirement. The step-increases in LA annualised requirement before 2013, and the drop-off from 2026/27 reflect the relative period over which the different LA planning periods overlap (Table 5-5). The dark grey line shows completions each year against the annual requirement up to the base year.

For the period which all LA plans overlap (2013/14 to 2025/26) there is a total annualised requirement of 5,782 households, approximately 10% higher than the average number of actual new household connections (5,259) in recent years. Since 2006/07, there has been an under-delivery of housing completions compared to the combined annualised requirements of LAs, resulting in a base year deficit of 5,500 households relative to existing local plan requirements (difference between light grey and dark grey lines up to 2016/17).

Figure 5-10: New households per year compared to past completion rates



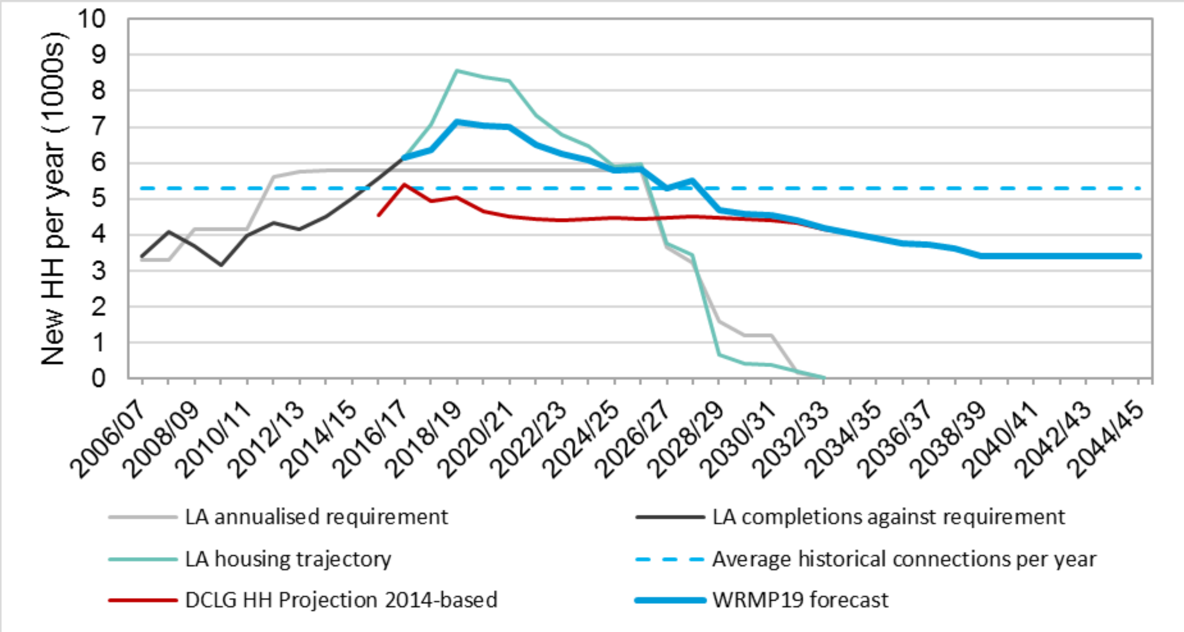
Local Authorities are required by the NPPF to review annually their delivery against housing requirements and identify a supply of specific deliverable sites sufficient to provide five years' worth of housing against their housing requirements. In addition, to ensure choice and competition for land an additional 5% buffer is required, brought forwards from later in the full plan period. Where there has been persistent under delivery, this buffer should be increased to 20%. The combined LA housing trajectory going forwards from 2016/17 forecasts a significant increase in housing over the ten years up to 2026/27, with a peak of ~8,500 houses in 2018/19. This rate of housing delivery is ~2,000 higher than the highest rate of new connections observed since 2001/02, and 55% higher than the number of new connections observed in the base-year.

The DCLG 2014 household forecast of ~4,700 new households per year over the next ten years is lower than the LA forecasts and recent actual new households per year, but similar to the forecast developed for our last Plan. Through the 2030s the DCLG forecast suggests a steady decline in new properties reaching just 3,980 in our region by 2039. The cumulative difference in the number of new properties between the DCLG-2014 forecast and the LA housing trajectory over the next ten years (period for which all local plans are available) is 22,000.

It is important that our water resources management plan accounts for the housebuilding projections produced by local authorities. We have a statutory duty to provide water for new development and we plan to accommodate the growth plans set out by local and national government for our area. The combined LA housing trajectory, however, forecasts an increase in household building rates to significantly rise above recent actual levels. As described earlier in this section, this uplift is in part a result of the annual delivery reviews that have identified under-delivery in recent years – notable uncertainty is therefore associated with this trajectory relating to whether such an uplift will be achieved in the short term particularly given the current economic situation. High inflation, labour market uncertainty associated with Brexit and a weak pound increasing construction costs may all act to moderate any significant increase in house building.

We believe that owing to the uncertainties described above, the LA housing trajectory does not represent an appropriate central estimate of new housing connections that is appropriate for to use in the development of developing our central estimate demand forecast. We have therefore taken account of the LA projections derived from housing trajectories, but opted for a smoother approach over the planning period, that still assumes an uplift in housebuilding from current rates, and still ensures that total housing delivery meets each LA's objectively assessed need over their respective plan periods (Figure 5-11). At the end of each LA's plan period, the DCLG-2014 forecast is used, which means our WRMP19 forecast becomes the same as the DCLG-2014 forecast once the final LA plan in our region ends in 2032/33. The result is a peak new household rate of ~7,100 households per annum that declines through our planning horizon towards the DCLG-2014 forecast.

Figure 5-11: New households per year compared to past completion rates and the WRMP19 forecast



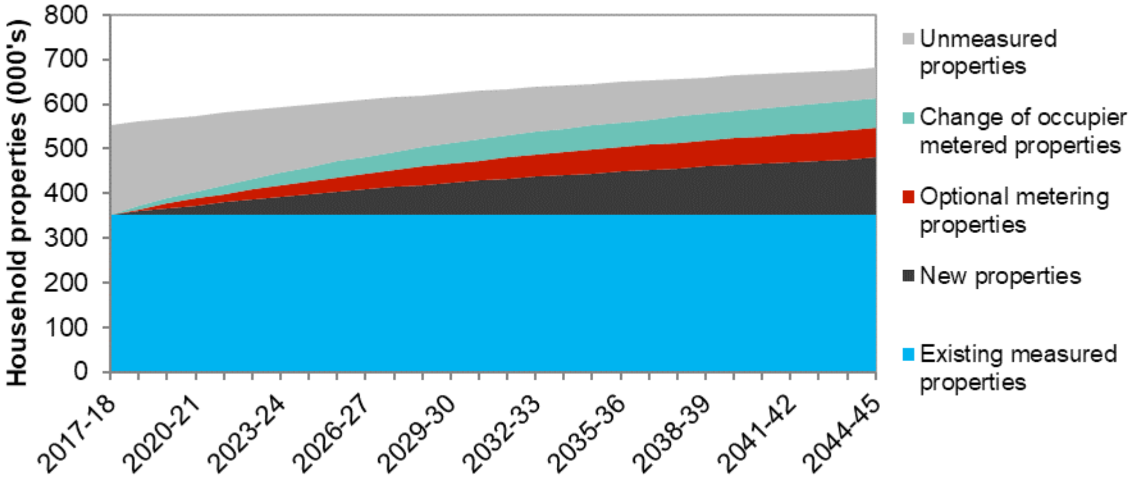
In Section 10.2.4, we demonstrate through scenario analysis that should the high housing delivery rates in the combined LA projections be achieved over the coming five years - in accordance with the combined local authority housing trajectories - that we would have sufficient supply to meet the projected demand, and therefore meet the requirements of the water resources planning guidelines and our statutory obligations.

Summary of baseline household property forecast

The forecast of housing growth will see the number of billed households in our area increase by approximately 128,000 over the planning period from ~565,000 properties in the base year to ~692,000 in 2044/45 representing an increase of ~23%.

Figure 5-12 shows that alongside the growth in households, the proportion of households that pay metered charges for the water services they receive will also increase. Currently 61% of properties in our supply area are metered and this is forecast to grow through the addition of new measured households, as considered above, and by the conversion of unmeasured households by our optional and change of occupier metering policies.

Figure 5-12: Household property numbers by customer type (baseline)



For the baseline scenario, by 2024/25 77% of households will be metered and 90% by 2044/45. Further discussion of our modelling approach and a comparison of the impacts of our baseline and final planning metering strategy is provided in Section 5.6.4.

5.3.4 Non-household properties forecast

The number of **unmeasured non-household properties** is forecast to decline through the planning period from just over 3,500 in the base year to just over 1,000 in 2044/45, because of customers becoming metered either optionally or selectively.

- **Non-household optional metered customers:** 16 years of data from 2000/01 to 2016/17 was analysed – on average 203, or 4.7%, of unmeasured non-household customers opt for a metered supply every year. This has a minor impact on non-household demand, and for forecasting purposes it is assumed that 4.7% of unmeasured non-household customers will opt each year of the planning period.
- **Non-household selectively metered:** we selectively meter a small number of unmeasured non-household customers each year and have assumed that 2% become metered each year of the planning period.

The forecast number of **measured non-household properties** decreases through the planning period from approximately 43,000 in the base year to approximately 41,400 in 2044/45. The forecast number reflects the balance of unmeasured non-household customer connections, and the net result of new non-households and account closures.

An analysis of data reported in Table 7 of regulatory returns since 2007/08 reveals that on average there are 497 new non-household property connections each year. However, during the same period there has been a net decline in overall non-household properties, because of disconnections, amounting to 147 fewer properties on average each year[39]. For forecasting we assume a decline in total non-households of 147 properties per year.

[39] This figure accounts for changes in the number of household and non-household properties that occurred in 2015/16 to comply with the requirements of retail separation.

5.4 Population

Since 1994/95 population in the Wessex Water supply area has grown from around 1.14 million people to approximately 1.3 million in 2017/18. This represents a long-term average growth rate of 0.61% per annum, which slightly exceeds the average national population growth over the same period of 0.58%.

5.4.1 Base year population

Our total resident connected population in 2017/18 is 1,330,799 people. This was calculated as follows:

- The starting point for the 2017/18 data is the Office of National Statistics' (ONS) mid-year population estimate for 2016, which is the most recent Local Authority level data, published in June 2016[40].
- The Local Authority populations are apportioned according to the percentage of properties in Wessex Water's company area, based on GIS analysis.
- A downward adjustment is made for properties within our water supply area that are not connected to our supply system (i.e. private supplies), which represents 8,800 people.
- A downward adjustment is also made for inset appointments (properties in our company area that are served by another water undertaker). In the base year, the only inset appointment within our supply area is with Scottish & Southern at Old Sarum and Brewery Square (2000 people).
- An upward adjustment was made to account for population growth in the 15-months since mid-2016 to the middle of reporting year 2017/18.
- Finally, an upward adjustment of 15,882 people was made to account for clandestine and hidden populations within our region, following a study undertaken by Edge Analytics[41].The study was commissioned to estimate the sub-populations within our region that are not captured as 'usual residents' by official ONS statistics, but nonetheless contribute to the water-using population (e.g. irregular migrants; short term residents; second address residents; visitors to friends and relatives).

Our base-year population is then sub-divided, as shown in Table 5-6. Our population split has been informed through triangulation of several sources of information following a bespoke customer occupancy survey conducted in June 2017 (see box below and Annex A).

[40] A more recent mid-year population estimate was published by the ONS in June 2017, after the submission of our regulatory return.
[41] Edge Analytics (2016) Wessex Water: Clandestine & Hidden Populations

Table 5-6: Breakdown of supply area population in the base year (000s)

Category	Population
Measured household	745.8
Unmeasured household	546.3
Total household	1292.2
Total non-household	38.6
Total	1330.8

2017 Household occupancy survey

From May to June 2017, we conducted an online household occupancy survey to understand how our total household population is divided between measured and unmeasured households. The survey was promoted to our customers through social media channels, and we received a total of 2,300 respondents. The survey was designed with specific questions to allow us to understand the representativeness of the respondents compared to our total population. Continual review of this information during the survey period helped us to target social media advertising to achieve as representative a sample as possible and allowed us to assess and account for bias when interpreting the results.

The survey results were used alongside other sources of occupancy information we collect through billing, customer research and water efficiency work, was used to derive our base-year occupancy estimates.

The occupancy survey results suggest that average occupancy in our measured households is higher than previously thought, with an average occupancy of 2.1 people per property in 2016/17 compared to the 1.8 people per property we had assumed previously.

We have used the updated household occupancy information allocate our household population to measured and unmeasured households, and also to reallocate population from the non-household category to households. Reallocating the population has had an impact on our water balance, in particular it has reduced measured per capita consumption. This change has had an impact on the water balance, notably reducing measured per capita. Please refer to Annex A for further information.

5.4.2 Population forecast

As with the household properties forecast, our population forecast has been developed using the UKWIR (2016) guidance manual[42]. We have developed a number of different forecasts, based on local plan information and trend-based forecasts from national datasets for household population and non-household population.

<u>Household population forecast</u>

Figure 5-15 shows four household population forecasts and Figure 5-16 the growth rates of each of these forecasts; two trend-based and two plan-based, alongside a reference forecast assuming the long-term historical population growth rate of 0.61%. For reference, the 90th percentile uncertainty bounds are also shown, which are based on examination of the accuracy of past forecasts[43] provided by the UKWIR guidance. The alternative forecasts have been derived as follows:

- TB-2012: trend-based forecast, based on DCLG 2012 household population forecast.
- TB-2014: trend-based forecast, based on DCLG 2014 household population forecast.
- PB-annualised: plan-based household population, based on annualised housing requirement combined with DCLG 2014 household population[44].
- PB-smoothed: plan-based household population, based on WRMP19 most likely household forecast.

Both the 2012 and 2014 trend-based forecasts have a similar growth rate to the regional historical rate at the start of the planning period, with a slow decline in growth rate towards the end of the planning period. The plan-based forecasts have a higher rate of population growth forecast over the first 10 years of the planning period compared to historical growth rates, declining thereafter to the rates of the trend-based forecasts. At the end of the planning period the range between the alternative forecasts is ~83,000 people, or ~6% of the total population. The range of uncertainty in forecasts, as determined from the UKWIR report[43], is approximately four times higher than the variability between plan and trend-based forecasts.

[42] UKWIR (2016) Population, household property and occupancy forecasting guidance
[43] See UKWIR WRMP19 Method – population, household property, and occupancy forecasting guidance manual section 6, and supplementary guidance section 4.9
[44] The plan-based population forecasts have been derived based on the approach taken by Experian for the last Plan, who produced forecasts as part of a collaborative project for 9 water companies including Wessex Water. Local Authority level population is derived by applying trend-based projections of household occupancy to plan-based household projections. At the end of each Local Authority's plan period, the DCLG 2014 forecast is used thereafter.

Figure 5-13: Household population forecasts for the Plan-Based (PB) and Trend-Based (TB) forecasts

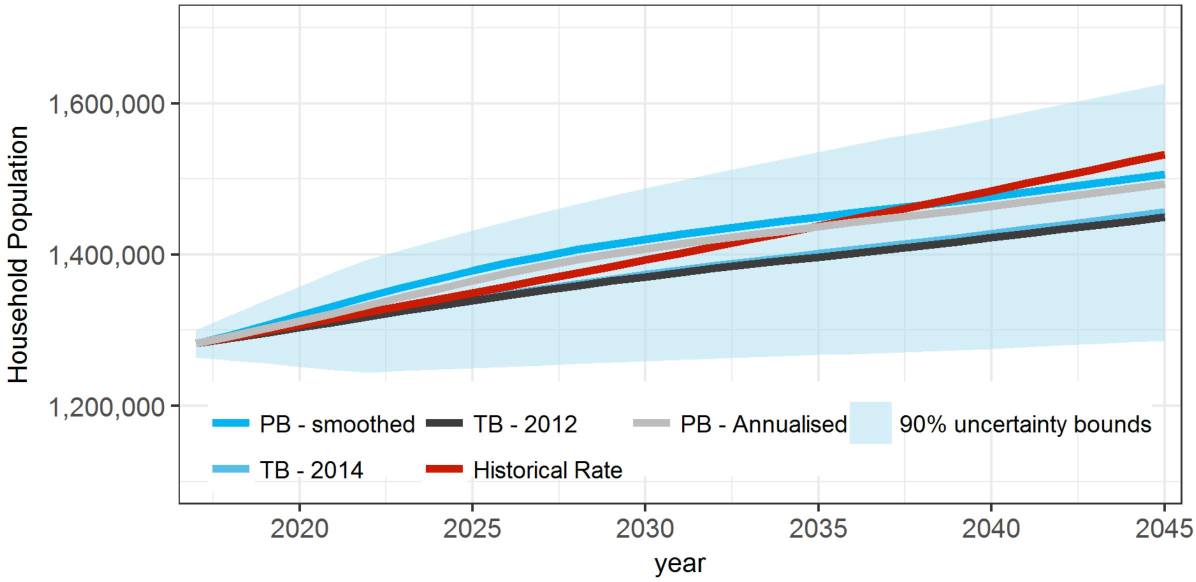
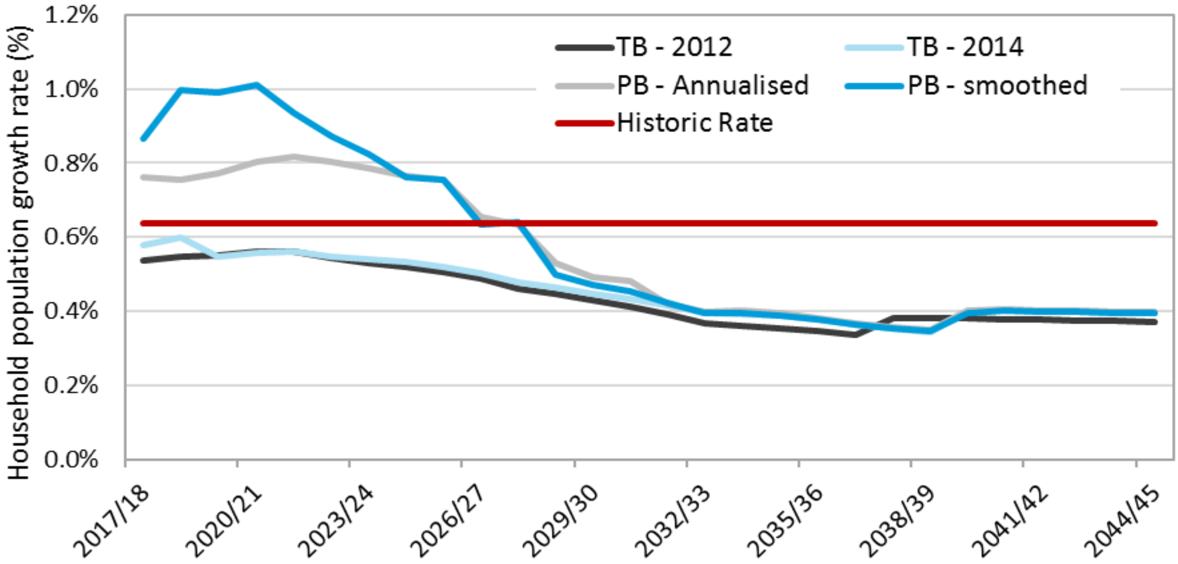


Figure 5-14: Household population growth rates, and ONS total population growth rates.



For this Plan we have selected the plan based annualised population growth rate, as this forecast is based on the annualised housing requirement produced by Local Authorities. Uncertainty in future population growth-rate is accounted for through headroom analysis, where we have used the 90th percentile uncertainty bounds (see Section 6).

Measured household population is forecast to increase over the planning period (Figure 5-15; Figure 5-16) because of changes to the existing metered household population, plus additional population residing in new properties, meter optant and metered on change of occupier properties, as reported in WRP2:

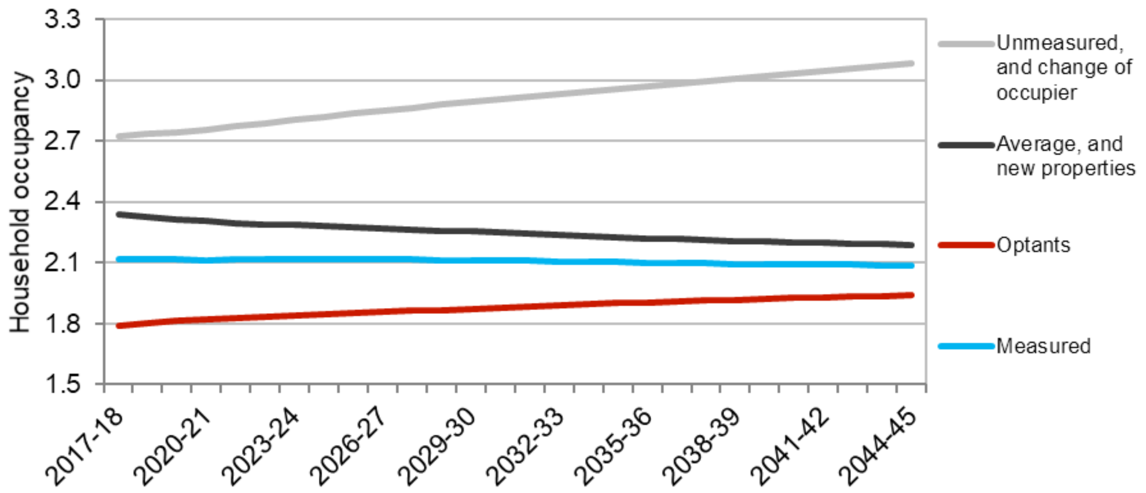
- **Existing measured population** is forecast to change as a function of the change in average household occupancy, which is forecast to decline over the planning period.

- **New properties' population** is forecast as a function of the number of new properties and an occupancy, assumed to be the same as the overall average household occupancy, which in 2017/18 is 2.34 declining to 2.19 in 2044/45.
- **Meter optants' population** is a function of the number of new optant households in the year, and their assumed occupancy. Base year occupancy is derived from actual records of occupancy recorded when customers opt for a meter, which in 2017/18 is 1.79. We assume that optant household size will increase through the planning period, as the smallest households opt first as they potentially have greater financial gains to make and so optant households progressively become larger on average. Optant occupancy is modelled to increase each year by the magnitude of change in overall average household size, leading to an average optant household size of 1.94 in 2044/45.
- **Metering on change of occupancy population** is calculated as a function of the number of households metered on change of occupancy and average occupancy for unmeasured households. In the base year, 2017/18 this is 2.72 people per property, rising to 3.08 in 2044/45.

Overall, measured household population is forecast to increase from ~745,000 in the base year to 1,276,000 in 2044/45.

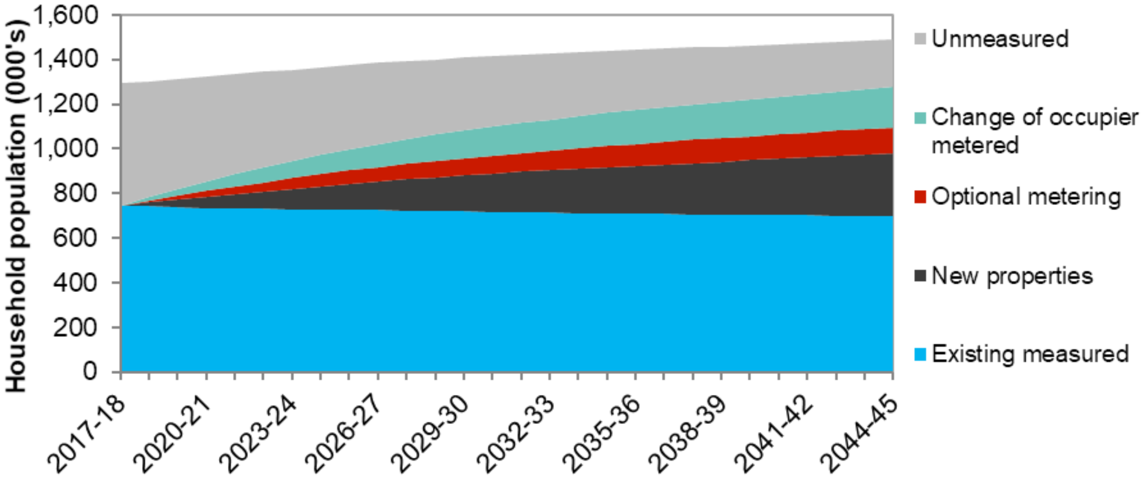
Unmeasured household population in each year is calculated as the total household population less the measured household population. Average unmeasured household occupancy is calculated as the unmeasured household population divided by the unmeasured household properties, and was updated following our customer occupancy survey (see pop out box, Section 5.4.1). Over the planning period the unmeasured household population is forecast to reduce from around 546,000 in the base year to around 212,000 in 2044/45 as properties become progressively metered. Over the planning period the average occupancy of an unmeasured household increases from 2.72 in the base year to 3.08 in 2044/5.

Figure 5-15: Changes in household occupancy (baseline)[45]



45 Note the change of occupier occupancy is assumed the same as the unmeasured occupancy, and is therefore not shown in this figure.

Figure 5-16: Household population forecast by customer type (baseline)



<u>Non-household population forecast</u>

The total non-household population forecast growth-rate has been derived as the residual between the ONS 2014-based sub-national population projections and the DCLG 2014-based household population projections. The non-household population is forecast to grow by ~6,000 over the planning period, at an average growth rate of ~1% per year.

The measured non-household population is forecast through the planning period by adding the in-year non-household optant and selectively metered population (number of properties multiplied by the assumed occupancy rate) to the previous year's non-household measured population. It rises through the planning period from 19,976 people in the base year to 36,559 people in 2044/45.

Unmeasured non-household population is the balancing population – i.e. total population less population accounted for in any other category. It falls through the planning period from 19,976 people in the base year to 9,529 people in 2044/45.

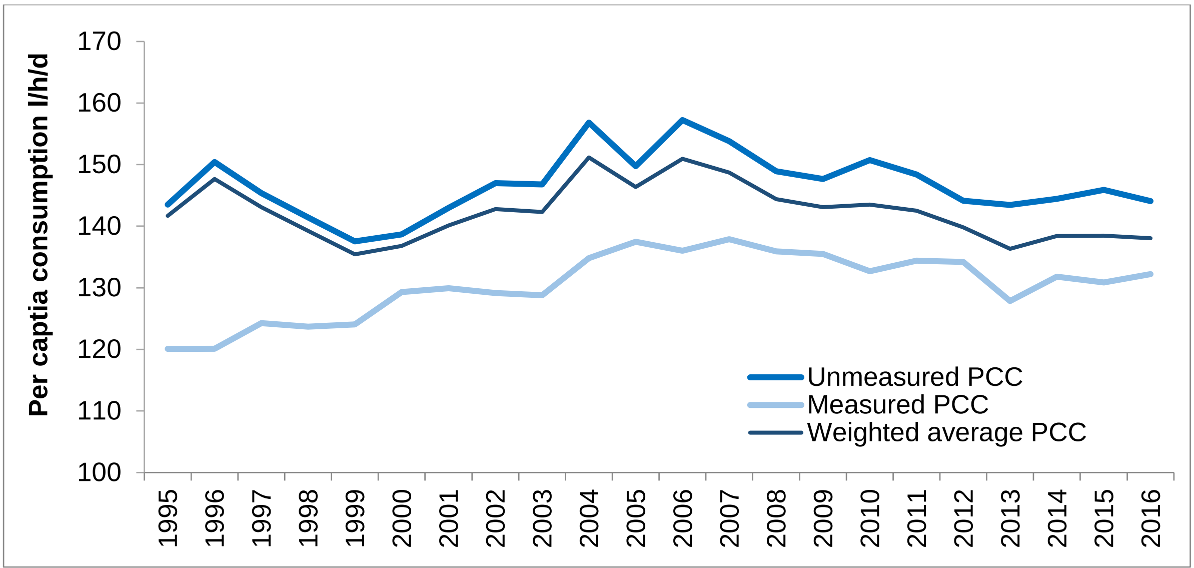
5.5 Household water consumption

In parallel to determining the size of the population and the number of households we expect to supply in our region, we need to also consider how much water on average each person will require (per capita consumption) and how these demands may change into the future.

Per capita water consumption for a normal weather year in the Wessex Water region in 2017/18 was 144 litres per head per day for unmeasured customers and 121 litres per head per day for measured customers. Weighted average PCC is 131 litres/head/day[46].

Figure 5-17 below shows the trend in average PCC for the weighted average, measured and unmeasured households since 1994/95. There was an upwards trend in PCC in measured and unmeasured households until the mid-2000s and since then PCC in our area has flattened out and started to decline.

Figure 5-17: Actual outturn weighted average, measured and unmeasured per capita consumption since 1994/95



* Data presented in this graph is consistent with regulatory reporting figures – these have not been amended to account for the changes described in Annex A, nor have they been normalised to account for in year weather variability by which they are strongly influenced. For discussion of normalised demand patterns and explanatory variables see Section 5-3 on weighted average demand.

It is reasonable to expect an underlying increase in PCC in unmeasured households as each year several thousand unmeasured households (typically with lower water) use opt to have a meter installed thereby increasing the average PCC of the remaining unmeasured households.

We might also expect that measured households would exhibit an underlying downward trend in PCC as each year ~5,000 thousand new homes are built (section 5.4.2) that are increasingly water efficient and measured customers are also more likely to take up water

[46] This is lower than the weighted average PCC reported in our annual regulatory return in 2018 (141 litres/head/day). The change is due to changes resulting from the leakage consistency work and associated water balance review, in particular the increase in measured household occupancy. Further detail is provided in Annex A.

efficient behaviours and devices as they stand to financially benefit from reducing their water use. This trend may be diluted somewhat by the addition of newly metered households resulting from our change of occupier metering programme as these households will have a broader range of water use characteristics.

In 2017/18 the industry average PCC was 141 litres/head/day[47], with the lower quartile at 136 litres/head/day. The values reported by water companies in 2017/18 will have changed slightly due to the WaterUK leakage consistency project (Annex A); however, it seems likely that our PCC will be within or very close to the current upper quartile.

5.5.1 Unmeasured per capita consumption – base year

Unmeasured PCC values are calculated annually from our domestic unmeasured consumption monitor which was set up over 15 years ago to provide an estimate of water use by households that pay for water services on an unmeasured basis. The monitor design, data collection and analysis methods follow the UKWIR best practice guidance[48] (1999) and UKWIR Future Estimation of Unmeasured Household Consumption (2017).[49]

Key features of the monitor are listed below:

- Households are selected to be representative of our region's mix of property types, socio-economic (ACORN50) categories, household occupancy, council tax bands and geographic locations.
- The monitor includes approximately 1,000 households and when customers leave the monitor (i.e. they opt to become a standard measured customer) additional households are recruited to maintain the sample size.
- Households have a meter and data logger that captures water consumption data at 15 or 30 minute intervals. Data is automatically transferred to our systems using mobile technology.
- Consumption data is reviewed monthly and where supply pipe leaks are suspected the property is excluded from the analysis for that month, so that true consumption is not overestimated and our leakage team investigate and fix where appropriate.
- PCC is calculated on a per property basis by dividing the overall monthly household consumption by the household occupancy. Occupancy data for each household is collected when they sign-up and is reviewed at least every two years. An occupancy survey of all households on the monitor was completed in 2017.
- To ensure that the households on the monitor, and therefore the derived PCC, are representative of our wider customer base, monthly PCCs are weighted by household size to reflect the overall composition of households in the Wessex Water area.

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[47] https://discoverwater.co.uk/
[48] UKWIR (1999). Best practise for unmeasured per capita consumption monitors.
[49] UKWIR (2017). Future Estimation of Unmeasured Household Consumption 17/WR/01/16
[50] ACORN is a geodemographic information system categorising UK postcodes into various types based on census data and other information. The population is divided into 5 categories from *Wealthy Achievers* to *Hard Pressed.*

We regularly review our consumption monitor to understand variability around the average PCC particularly in the context of housing type, occupancy and other socio-economic influences. Servelec completed a review of the properties currently on the unmeasured monitor in 2016[51] and compared them to the social demographics within our region to make sure the households on the monitor are a representative sample. This study suggested that the monitor sample is broadly representative but additional recruitment should target flats and lower income/lower occupancy properties. The recommendations from this study were used to inform the selection of the additional households we are recruiting to the monitor in 2017/18.

5.5.2 Measured per capita consumption – base year

Measured normalised per capita consumption in the base year (121 l/h/d) is calculated from measured sales volumes taking account of meter under registration, leak allowances, supply pipe leakage and the increase in the estimate of population owing to the recent occupancy survey. Further detail on the occupancy survey can be found in Annex A.

5.5.3 Forecasting per capita consumption

<u>Existing measured and unmeasured households per capita consumption – micro-component modelling</u>

The micro-component approach to forecasting domestic water demand is a 'bottom up' way of understanding customer water use. Individual components of water use at home are considered in terms of devices and behaviours and how these might change in the future.

Modelling undertaken for this Plan is consistent with the household consumption forecasting approaches outlined by the 2012 UKWIR report [52] and the 2016 UKWIR guidance manual[53].

The approach involves the following key elements:

- Segmentation of customer water use by measured and unmeasured customer types
- Subdivision of household water consumption into different activities or 'components'
- Estimation of *ownership* of the device or participation in the activity, *frequency* of use amongst the applicable proportion, and *volume* of water used each time
- Inclusion of a residual miscellaneous use component
- Projection of water consumption by component based on changes in ownership, frequency and volume over the 25 years of the planning period.

This Plan made use of the Excel-based model for measured and unmeasured customers developed for our previous Plan by Servelec (then Tynemarch). We worked with Mott MacDonald to review and update the data inputs to the previous model, their technical report is summarised in this section but is also available as an Appendix to this Plan[54]

[51] Servelec (Tynemarch) 2016, J517\GD\009\02Review of unmeasured consumption monitor representation

[52] UKWIR (2012) A good practice manual and roadmap for household consumption forecasting, Tynemarch and Blue Marble (CU02)

[53] UKWIR (2016) WRMP Methods – Household Consumption Forecasting – Guidance Manual

[54] Mott MacDonald (2017) Micro component analysis for Wessex Water

Micro-component modelling is underpinned by a wide range of detailed data and assumptions on how water is used at home such as how often toilets are flushed a day; what is the average volume per flush; how long people spend in the shower and how the average volume per washing machine cycle will change over the next 25 years.

We developed our model inputs from a variety of data sources including company specific records, national data sets including Defra's Market Transformation Programme (2007[55] and 2011[56]) and relevant industry publications[57]. Since our last Plan we have significantly improved the availability of data from our own customer base for micro-component analysis. Data sources include the Energy Saving Trust water-energy calculator (over 15,000 respondents up to 2016), the Save Water Save Money calculator (over 5,000 respondents since 2016), our Home Check project (over 5000 households included) and data from bespoke customer surveys.

The starting point for forecasting by micro-components is defining the base year split of water use into components.

5-18 and Figure 5-19 show how water is used by measured and unmeasured domestic customers in the base year (average year scenario). It should be noted that Basin Tap, Showering and Bathing combine to form the Personal Washing category for the planning tables.

The charts show that the majority of water use occurs in the bathroom; for toilet flushing and personal washing. For measured and unmeasured customers personal washing forms the biggest component of household water use (45% each). Toilet flushing makes up 21% and 18% in measured and unmeasured households respectively.

The other components are smaller, with clothes washing and dishwashing forming 13% and 6% of use in measured households, and 9% and 4% in unmeasured households. The miscellaneous use category includes water used for cleaning, drinking and wastage through plumbing losses.

[55] Defra (2007) The Market Transformation Programme report

[56] Defra (2011) The Market Transformation Programme report

[57] UKWIR (2015) Integration of Behaviour Change into Demand Forecasting

Figure 5-18: Measured customer base year water use by micro-components in litres

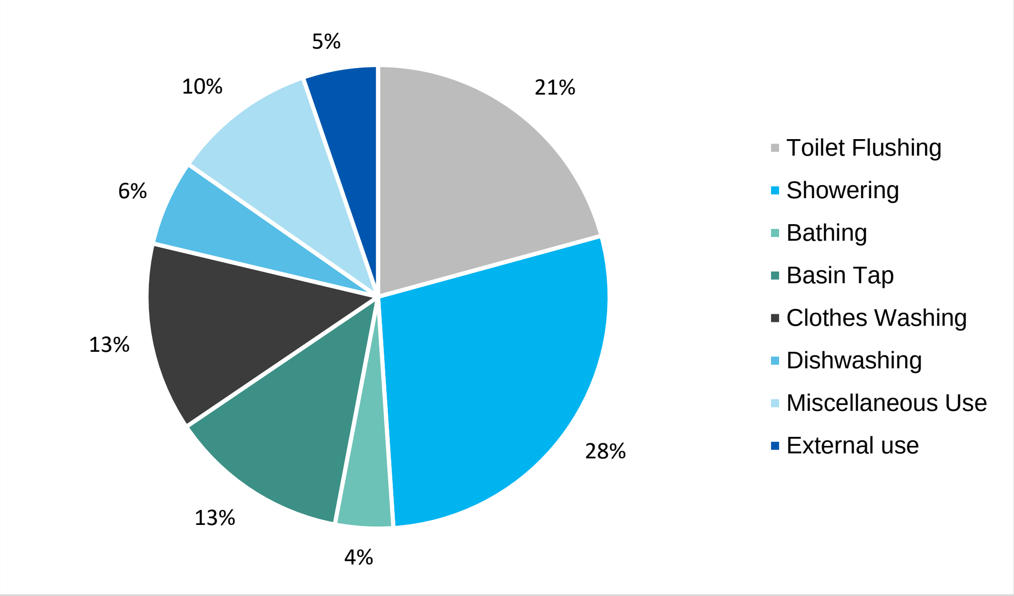
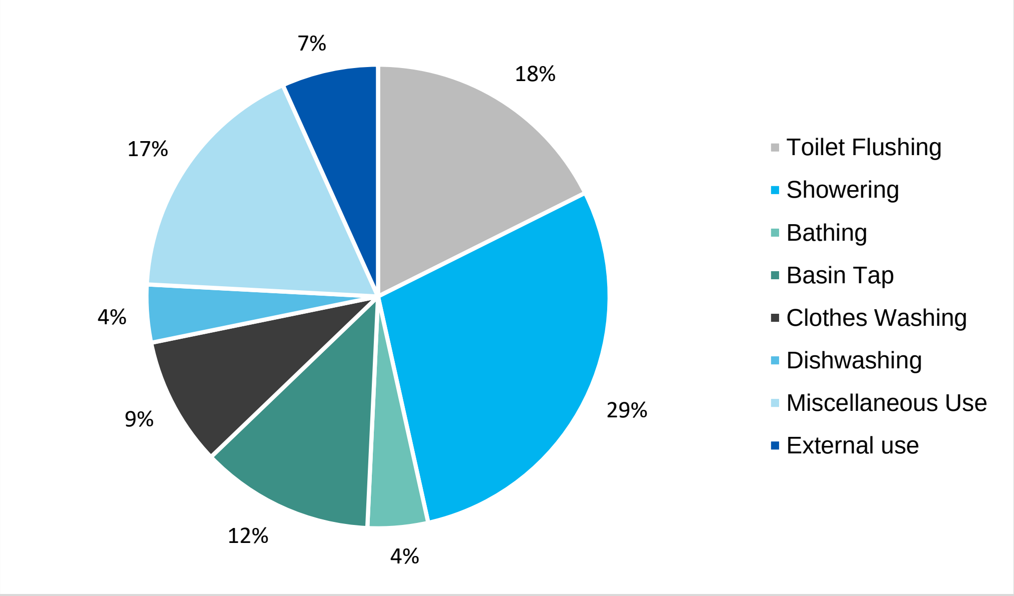


Figure 5-19: Unmeasured customer base year water use by micro-components in litres



A summary of the changes in ownership, frequency and volume of each component included in the model is provided below.

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Table 5-7: Summary of micro-component changes during the planning period

	Measured			Unmeasured		
Sub component	Ownership	Frequency	Volume	Ownership	Frequency	Volume
Toilet flushing	→	→	↓↓	→	→	↓↓
Showering	↑	→	→	↑	→	→
Bathing	↓	↓↓↓	→	↓	↓↓↓	→
Basin tap use	→	→	↓	→	→	→
Dishes - machine	↑↑↑	↓	↓↓↓	↑↑↑	↓	↓↓↓
Dishes - hand	→	→	→	→	→	→
Clothes - machine	→	→	↓↓	→	→	↓↓
Clothes- hand	→	→	→	→	→	→
External use*	n/a	n/a	→	n/a	n/a	→
Plumbing losses*	n/a	n/a	→	n/a	n/a	→
Miscellaneous	→	→	→	→	→	→

* Water use associated with external use and plumbing losses are considered in terms of a total volume rather than as a function of ownership, frequency and volume.

Key

→	No change between 2017/18 and 2044/45
↓	Decrease of up to 10% between 2017/18 and 2044/45
↓↓	Decrease of between 10% and 20% between 2017/18 and 2044/45
↓↓↓	Decrease of greater than 20% between 2017/18 and 2044/45
↑	Increase of up to 10% between 2017/18 and 2044/45
↑↑	Increase of up between 10% and 20% between 2017/18 and 2044/45
↑↑↑	Increase of greater than 20% between 2017/18 and 2044/45

The key trends and their explanatory factors are described below:

- Toilet volume decreasing owing to increasing number of dual flush toilets
- Showering volume increasing due to increasing shower ownership
- Bathing volume decreasing due to decreased bath ownership and frequency of use
- Dishwashing volume decreasing due to increased efficiency of machines and decreasing frequency of use related to increasing future machine capacities
- Clothes washing volume decreasing due to increased efficiency of machines
- Unmeasured external use is not expected to change

Our baseline demand forecast assumes a continuation of basic water efficiency activities through the planning period. The micro-component model therefore incorporates savings from activities relating to the distribution of free-pack devices such as save-a-flushes, shower flow regulators and shower timers (see section 8 for more details).

The resulting forecast indicates that the average PCC of an existing measured household will fall 2.2% by 2025 and 6.2% by 2045. Similarly, the average PCC on and existing unmeasured household will fall 2.4% by 2025 and 6.7% by 2045.

Meter optants per capita consumption

Optional meter PCC at the start of the planning period was derived from the analysis of ~30,000 optant households that opted to become metered between 2010/11 and 2016/17. The analysis derived an average (post opting) PHC of 210 l/prop/d, and a PCC of 117.3 l/h/d for the base-year (2017/18). There was also a consistent positive trend in post optant PHC since 2011, rising linearly from 186 l/prop/d. It is assumed that optants reduce their water use by 6% following their switch to metered charging and therefore their pre-opting PCC is calculated as 124.8 l/h/d (i.e. they are already more water efficient than the average unmeasured customer).

Post-opting PCC is assumed to rise through the planning period (up to 128.9 l/h/d), which is in line with an overall increase in unmeasured PCC (up to 149.7 l/h/d). This increase in PCC for meter optants and overall unmeasured PCC reflects that by the end of the planning period we forecast that only approximately 10% of properties will remain unmeasured, and that those will be the most inefficient water users remaining, as more efficient users have switched, for whom switching is more cost effective.

New properties per capita consumption

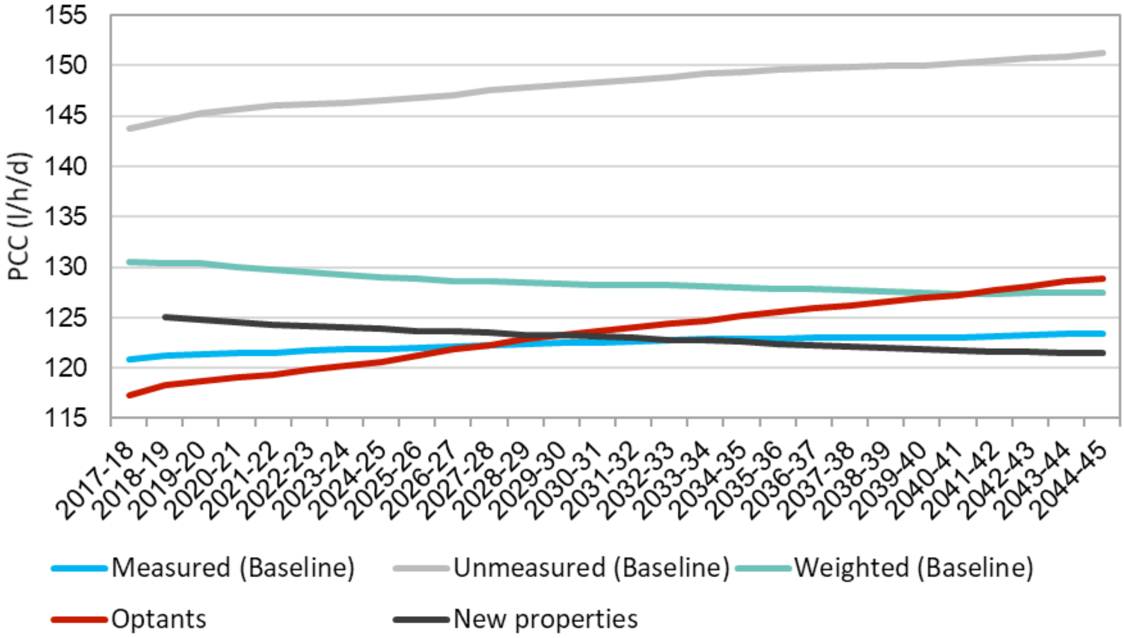
New property PCC at the start of the planning period is assumed to be in line with the requirements of the Building Regulations at 125 l/h/d[58]. It is assumed that new properties will experience some overall reduction in PCC in the same manner that other measured customers will but to a lesser degree, as the new properties are already designed to be water efficient and so the opportunities for saving are less. The effect has been modelled as 50% of the PCC savings that existing measured customers make (as derived by the micro-component analysis) meaning that new property PCC will marginally fall through the planning period to 121.5 l/h/d by 2045.

Overall per capita consumption forecast (baseline and final)

The overall changes in PCC by customer group are shown in Figure 5-20. It shows that measured average PCC is forecast to increase from 121 l/h/d to123 by 2045, while unmeasured average PCC will remain higher than 140 l/h/d throughout the planning period. Overall weighted average PCC is forecast to decline though the planning period to around 128 l/h/d in 2045.

[58] Part G of the Building Regulations came into force in April 2010. It specifies a whole building standard of 125 litres per person per day for domestic buildings. This comprises internal water use of 120 litres per person per day, plus an allowance of 5 litres per person per day for outdoor water use (Communities and Local Government, 2009).

Figure 5-20: Per capita consumption changes by customer group - baseline (average year)



5.5.4 Impact of metering on household demand – baseline scenario

Our baseline scenario assumes a continuation of current policies and therefore accounts for standard optional metering, our change of occupier policy and basic promotion of water efficiency. In the development of this Plan we have considered the impact on demand and customer views associated with enhanced metering strategies including the introduction of smarter metering technologies – see Sections 5.5.5 and 0for further details.

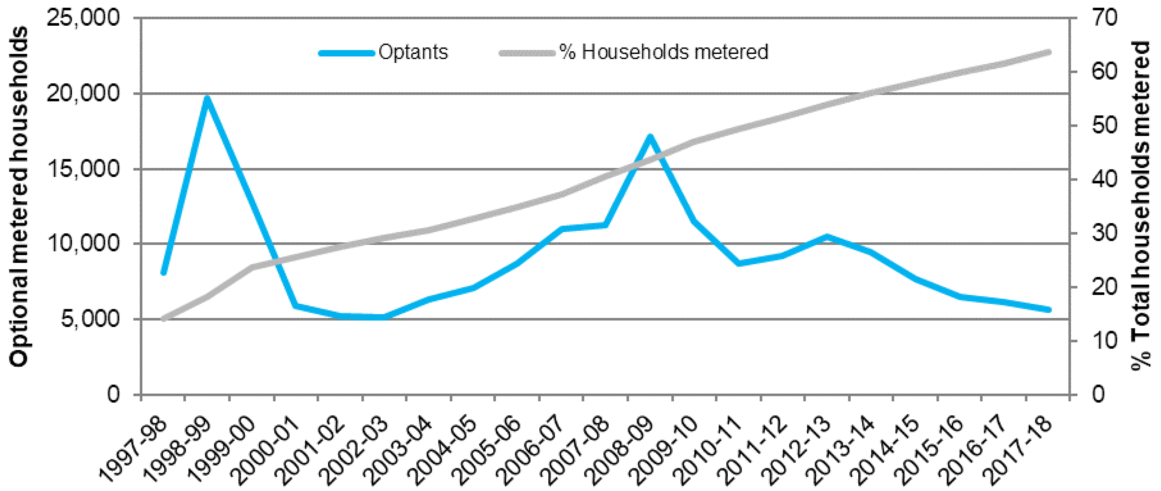
<u>Optional metering</u>

We have provided customers with the option of switching from an unmeasured supply to a metered supply for free[59] since 1996, and the proportion of our customer base that is metered has been steadily growing as a result so that in 2017/18 64% of customers pay for water services based on the volume they use.

Figure 5-21 shows that the number of households that have opted for a meter since the late 1990s has typically been between 5,000 and 10,000; there were particular peaks in meter optants in 1998/99 and 2008/09 because of increased promotion of the benefits of being on a meter in those years.

[59] Meters are installed free of change to the customer unless the cost of installation would exceed £1000; in which case customers can opt to be charged on an ‘assessed’ basis rather than according to rateable value.

Figure 5-21: Meter optants and overall proportion of customer metered since 1997



To forecast the proportion of the unmeasured customer base that will opt to switch to metered charges in the future we commissioned consultants Tynemarch to develop a predictive model for our last Plan. Their technical report[60] is available as an appendix to this Plan. For this Plan the model has been re-calibrated taking into account additional data since 2013.

To develop a model various input data was analysed to identify factors that are significant in explaining the number of customers that opt to switch to a metered supply each year:

- Historical numbers of optants in each year
- Historical counts of measured and unmeasured households
- Historical household tariff data
- Details of individual optants, including rateable value (RV) and post opting consumption
- Identification of years with targeted campaigns to encourage opting
- Measured consumption data from our tariff trial study (including logged unmeasured consumption monitor customers)
- Regional employment data, including forecasts to 2020
- Gross disposable household income (from ONS)
-

Findings from the analysis included:

- Unmeasured charges have a significant positive impact on optant levels. This is expected as the higher the unmeasured charges, the more unmeasured customers stand to gain financially by opting.
- Measured charges have a negative impact on optant levels. This is expected as the lower the measured charges, the more households stand to gain financially by opting. The effect is less significant than for unmeasured charges as unmeasured customers do not know what the measured bill will be.
- The lower the previous year's unmeasured bill (or, equivalently, the greater the difference between the unmeasured bills in consecutive years), the greater the optant level. The inference is that a large increase in unmeasured charges encourages customers to opt.

[60] Tynemarch (Oct 2012), Wessex Water Demand Forecast Analysis for PR14 WRMP.

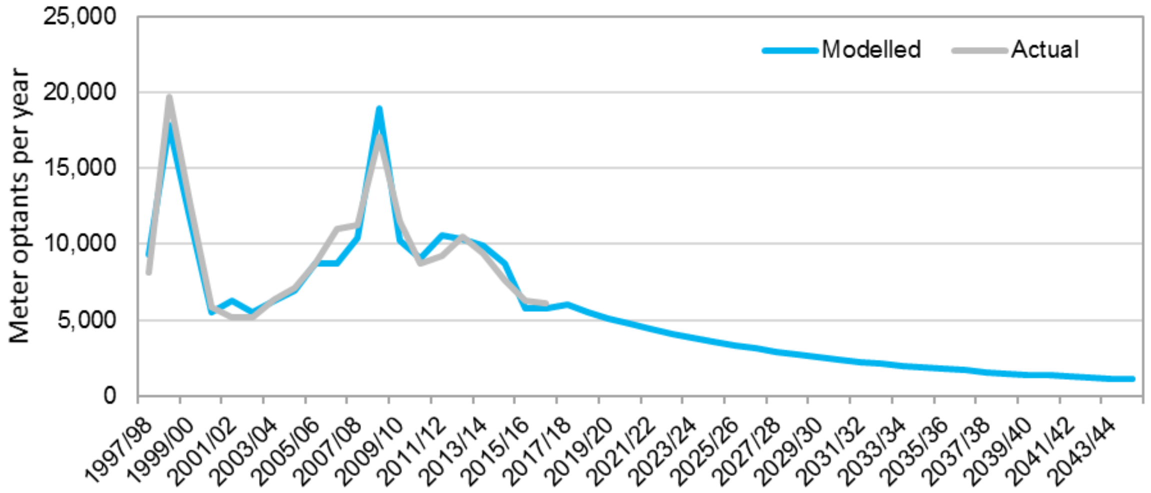
- Targeted promotion of meter opting as in 1998/99 and 2008/09 significantly increases the number of optants. There is also evidence to suggest it had an impact on the types of customers opting.
- There is some evidence to suggest that the level of opting is positively correlated with household income. A possible explanation is that households on low incomes prefer the certainty of unmeasured bills when budgeting, rather than the variability of metered charging. This variable is highly correlated with other variables considered and was not included in the final model given the lack of significance when other factors were taken into account.
- There is some evidence to suggest that the level of opting is positively correlated with employment. The principles are similar to those for household income. As with household income, this factor was not included in the final model given its lack of significance when other factors were taken into account.

Since development for the last Plan, the model has been re-calibrated taking into account additional data since 2013. The model used to support this Plan uses the following variables to predict the proportion of unmeasured customers opting in each year of the planning period:

- Number of years since the introduction of the free meter option (1996-97 is 0)
- Unmeasured bill in the year for a typical recent optant (RV=£207.80)
- Measured bill in the year for a typical recent optant (73.34 m3 per year)
- Whether there was/is promotion of meter opting.

Actual versus modelled meter optants is shown in Figure 5-22 illustrating good model performance. The baseline forecast assumes no additional promotional uplift, and projects a continued decline in the number of households opting for a meter over the planning period, which in part reflects the decline in the absolute number of unmeasured households available to opt as the proportion of metered households increase.

Figure 5-22: Actual, modelled and (baseline) forecast meter optants



Our optional metering policy includes a clause that we will install a meter free of charge to a customer providing the cost of the installation does not exceed £1000. If the cost exceeds this value, we offer the customer an 'assessed charge' instead meaning that their unmeasured bill is apportioned based on the number of occupants and water use characteristics. We currently have around 5,400 customers on an assessed tariff. An analysis of the numbers of optants and the number of customers moving onto assessed charges over the last 10 years indicates that approximately 3.6 % of potential optants have moved onto assessed charges instead. The optional metering model therefore takes account of the 10,600 “unmeasurable” properties (3.6% of the remaining unmeasured properties).

Change of occupier metering

In addition to optional metering, our baseline demand forecast also includes our current change of occupier metering policy. The Water Industry Act 1991 gives water companies the power to install meters on a selective basis such as when there is a change in occupier, provided unmeasured charges have not been raised for the customer against the property.

We proposed a change of occupier policy for our supply area[61] in our last Plan and introduced it from October 2016. In 2016/17 we installed 7,079 change of occupier meters, and 12,751 optional meters, which represents 6% of the unmeasured customer base of the previous year. This is the largest number of meters Wessex Water has installed since 2008/09, and the largest percentage of unmeasured properties metered in any given year.

The forecast of the number of change of occupier meters installed each year is calculated as a combination of the number of changes in household occupation combined with the percentage of those properties that can have a meter installed. To calculate the total number each year, the number of unmeasured households is segmented by owner-occupier, social and private rented households, as these different property types have different rates of occupier changes. For each category, we derived from national statistics a percentage of properties that will move in each category in each year (Table 5-8), and calculate the total change of occupier properties as the sum across categories.

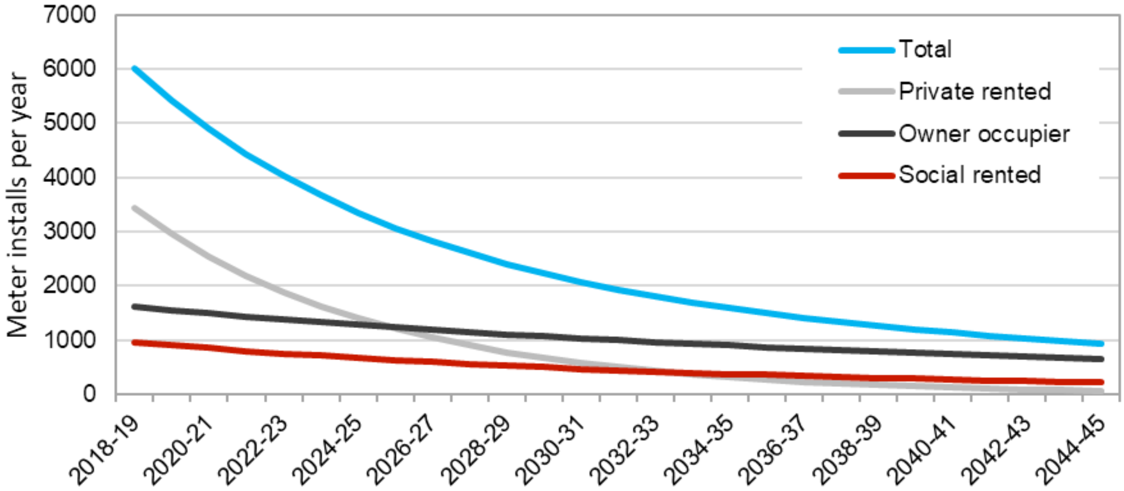
Table 5-8: Unmeasured property breakdown

Unmeasured property type	percentage of unmeasured households	Percentage moving per year
Owner-occupier	69	3.1%
Social rented	16	8.4%
Private Rented	15	28%

The resultant change of occupier metering forecast is shown in Figure 5-23; it starts at around 6000 per annum decreasing to just under 1,000 by 2044/45. The higher rate of people moving property in the private rented sector means these properties contribute most to the total number of meter installs; however, this rate declines quickly due to meter saturation in the sector. The overall decline is also influenced by the rising overall proportion of metered households and therefore a decreasing pool of households from which people have a meter installed; by the end of the planning period, only 70,000 properties remain unmetered.

[61] providing the cost of installation was less than £1000, for costs higher than this we would offer the customer assessed charges.

Figure 5-23: Change of occupier metering by housing category (baseline)



5.5.5 Impact of enhanced metering and water efficiency programme – final planning scenario

Given our baseline surplus over the planning period, the options we are including in our final planning scenario focus on demand-side management, as it is not necessary for us to develop new water resources. Reducing demand helps satisfy our objectives to improve resilience, increase our surplus to facilitate resource sharing with other companies, meet customer expectations and better protect the environment (see Section 9). With particular reference to household demand management, we plan to deliver schemes to increase the uptake of optional metering and enhance customer participation in water saving via personalised in-home water use advice and device fitting and digital engagement services.

This section outlines the impacts of an enhanced metering programme and water efficiency services on the baseline demand forecast. Issues relating to customer preferences, costs and benefits of these options are discussed in Section 9.

The enhanced metering programme included in our final planning scenario will see an additional 10,000 households switch to a metered supply by 2025 on top of the baseline projection (40,000 households). This will be achieved by enhanced promotional strategies such as a ‘cash back guarantee’ offer to encourage the segment of customers who are risk-adverse and do not opt for a meter for fear of being financially worse off with a higher bill than their unmeasured charges. If after two years the customer’s bill has increased, we will proactively offer to revert them back to unmeasured charges and return the difference to them. We will link this scheme to our water efficiency Home Check service – customers who do pay more in the first year will be offered bespoke devices and behavioural advice to support reductions in their water use and thereby encourage them not to revert to an unmeasured supply. Further details of our enhanced optional metering scheme option are provided in Section 9.
Figure 5-24 shows the final planning optional metering forecast relative to the baseline forecast and Table 5-9 compares the absolute numbers of meters fitted under each scenario.

Figure 5-24: Forecast of unmeasured households switching to a metered supply

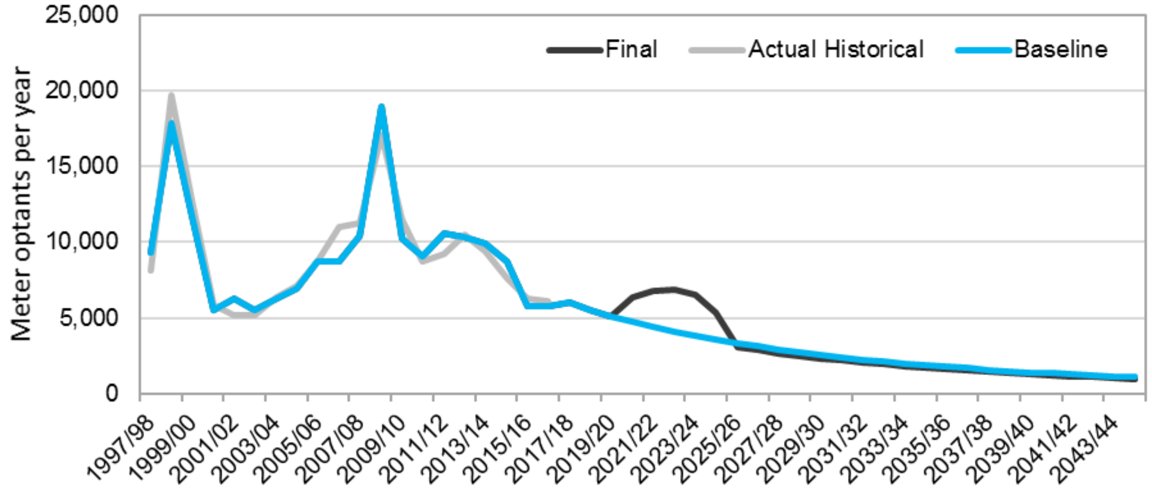


Table 5-9: Comparison of baseline and final planning household metering forecasts

000s of meters installed		2020-25	2025-30	2030-35	2035-40	2040-45
Baseline	Optional	19.3	13.6	9.9	7.4	5.6
	Change of occupier	20.4	13.1	9.0	6.7	5.2
	Total	39.7	26.8	19.0	14.0	10.8
	% metered (end of period)	**76.7%**	**82.0%**	**85.5%**	**88.0%**	**89.9%**
Final plan	Optional	29.5	12.6	9.2	6.9	5.2
	Change of occupier	19.8	12.1	8.4	6.2	4.8
	Total	49.3	24.7	17.6	13.0	10.0
	% metered (end of period)	**78.3%**	**88.2%**	**86.4%**	**88.8%**	**90.5%**

Our final planning metering forecast shows that we will install over 49,000 meters in the first 5 years of this Plan. By 2025 78% of our customer base will be metered and this proportion will reach 90% by 2045.

Our last water resources management plan set out proposals for our flagship Home Check water efficiency service. By 2020 we will have delivered the service to 20,000 homes in communities across our region.

Going forward we plan to accelerate our successful Home Check programme to reach more customers and particularly those for whom the affordability of their water bill is a key concern. During a 45-minute home visit Water Safe qualified plumbers fit water saving devices, such as eco-showerheads, repair easy to fix plumbing leaks and offer personalised behavioural advice at no charge to the customer. Each visit leads to savings of approximately 40 litres per household per day and has been very well received by customers. In the 2020 to 2025 period we will deliver the service to a further 30,000 customers.

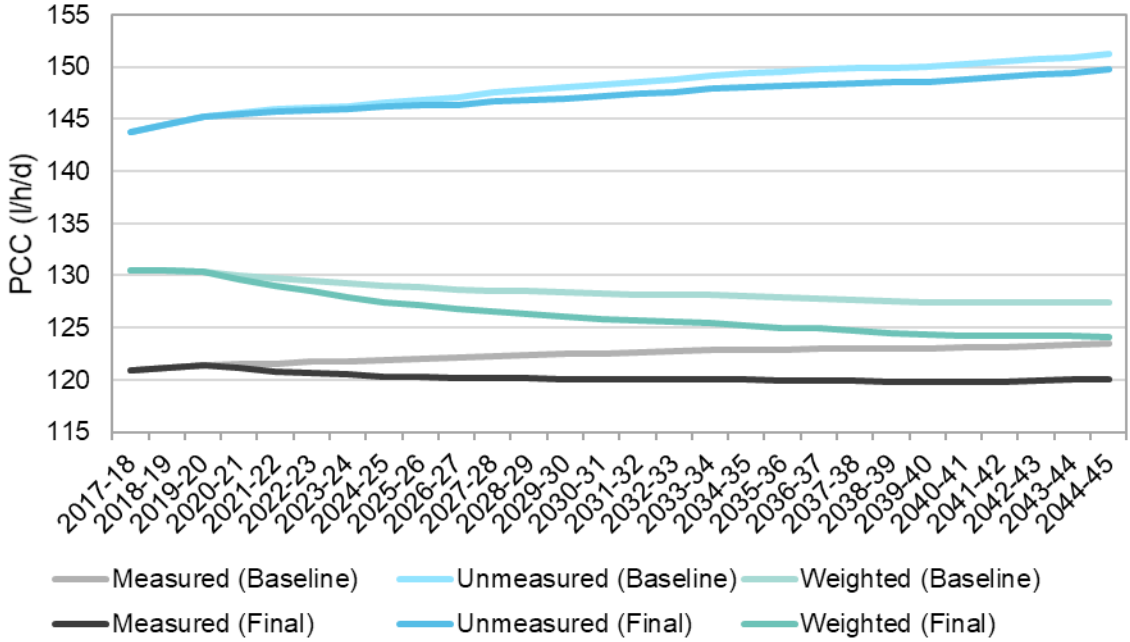
Digital engagement is growing in its reach and importance to us and our customers. We plan to enhance our online services to help customers better understand their water use at home and compare their usage with similar households in their community – a well-recognised approach to support behavioural changes that lead to reductions in consumption.

The impact of our final planning metering strategy on per capita consumption is summarised in Table 5-10 and illustrated in Figure 5-25. These show that our water efficiency and metering proposals will reduce average use per person per day in our area by nearly 3 litres by 2025 (to 127.4 litres) and by a further 3 litres (to just over 124 litres) by 2045.

Table 5-10: Comparison of per capita consumption in a normal year under baseline and final planning scenarios

Scenario	PCC component (l/h/d)	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Baseline	Measured	121.4	121.8	122.5	122.9	123.0	123.4
	Unmeasured	145.2	146.5	148.0	149.4	150.0	151.2
	Weighted average	**130.3**	**129.0**	**128.4**	**128.0**	**127.4**	**127.4**
Final	Measured	121.4	120.3	120.0	120.0	119.8	120.1
	Unmeasured	145.2	146.2	147.0	148.0	148.6	149.8
	Weighted average	**130.3**	**127.4**	**126.0**	**125.2**	**124.3**	**124.1**

Figure 5-25: Comparison of per capita consumption in a normal year under baseline and final planning scenarios



These reductions in household water use act to reduce the overall volume of water that we need to put into our distribution network each day. By 2025 in a dry year the combined savings of our final planning metering and water efficiency schemes will amount to over 2 Ml/d and by 2045 savings will exceed 5 Ml/d (Table 5-11). These savings are in addition to our baseline optional metering programme, which in itself will save 5 Ml/d by 2025 and 11 Ml/d by 2045.

Table 5-11: Final planning metering and water efficiency impact on household demand (Ml/d)

Planning scenario	2024/25	2029/30	2034/35	2039/40	2044/45
DYAA	-2.08	-3.39	-4.27	-4.84	-5.23
DYCP	-2.56	-4.16	-5.19	-5.88	-6.32

5.5.6 *Impact of climate change on household demand*

The latest UKCP09 forecasts predict that by the 2050s average summer temperatures may be 2-4°C warmer and summer rainfall will be 10 – 30% lower. However, it is also likely from our climate change analysis (Section 4.10) that we will experience wetter winters on average in the future. Whilst the impact of climate change on water consumption is uncertain[62], the relationship between weather and demand (Section 0), and in particular increased personal washing and garden water use in warmer drier periods, suggests water consumption patterns may alter with climate.

In 2013 UKWIR published a study on the *impact of climate change on water demand*[63], which examined the relationships between water use and weather variations for five case studies – including overall household consumption, micro-component consumption patterns and non-household consumption. Of particular interest for our forecasts were the household water consumption case studies that were developed from household monitor data-sets obtained from Severn Trent Water and Thames Water. The weather demand relationships were combined with climate projection data from UKCP09 to develop a set of regionally based look-up tables to estimate the future impacts of climate change on household demand. A range of percentiles were produce for each year between 2012 and 2040 to reflect the uncertainty associated with the climate change projections.

Table 5-12 summarises the outputs from the study for a selection of years through the planning period. Taking the 50th percentile as a central estimate of the impact of climate change suggests that demand will increase by 0.68 % and 0.99% over the planning period as a result of climate change depending on whether the Severn Trent Water or the Thames Water model is used.

Table 5-12: Estimates of climate change impacts on domestic demand (% change relative to base year) for south-west England. Reproduced from UKWIR (2013)

	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
Severn Trent Water model							
P10	0.00	0.04	0.11	0.18	0.24	0.31	0.38
P50	0.00	0.11	0.28	0.46	0.63	0.81	0.99
P90	0.00	0.18	0.47	0.77	1.06	1.35	1.65
Thames Water model							
P10	0.00	0.02	0.05	0.10	0.14	0.17	0.21
P50	0.00	0.07	0.17	0.32	0.44	0.56	0.68
P90	0.00	0.13	0.31	0.58	0.80	1.03	1.25

The two models suggest broadly similar impacts. We selected to use the Severn Trent outputs for our forecasting because they ensure we incorporate the marginally larger factors in our planning.

[62] Water resources planning guidelines
[63] UKWIR (2013). Impact of climate change on water demand. CL/04.

Our central demand forecast applied the 50th percentile uplift factors to both measured and unmeasured households; the 10th and 90th percentile impacts were used in our headroom analysis to account for the uncertainty around the climate change projections. Whilst these figures were produced for the 2011/12 to 2039/40 period, we have applied them to the 2016/17 to 2044/45.

Table 5-13 presents total and per capita consumption for key years for measured and unmeasured households to demonstrate the impact of climate change being included in the baseline planning forecast. It shows that by the end of the planning period the increase in overall consumption resulting from climate change amounts to 1.7 Ml/d (measured and unmeasured combined) representing a very small proportion of overall distribution input (*c.* 0.5%).

Table 5-13: Changes to per capita and overall household consumption (baseline forecast) with climate change. (NYAA = normal year annual average)

Customer type	Demand category	2017/18	2024/25	2044/45
Measured household	NYAA PCC without CC (l/h/d)	120.8	121.5	122.2
	NYAA PCC with CC (l/h/d)	120.9	121.8	123.4
	NYAA consumption without CC (Ml/d)	90.11	118.1	155.3
	NYAA consumption with CC (Ml/d)	90.14	118.4	156.0
Unmeasured household	NYAA PCC without CC (l/h/d)	143.7	146.1	157.5
	NYAA PCC with CC (l/h/d)	143.8	146.5	151.2
	NYAA consumption without CC (Ml/d)	78.5	57.4	31.7
	NYAA consumption with CC (Ml/d)	78.5	57.6	32.1
Total household	Increase in demand due to climate change (Ml/d)	0.0	0.5	1.9

In accordance with the planning guidelines, no adjustment has been made to peak demands to account for climate change.

We are currently supporting research projects to improve our modelling of the relationship between weather and demand (Section 12.2). Such models may subsequently be driven with climate forecast changes to weather conditions in the future (e.g. Table 4-13), to revise our predictions of climate change impacts on demand.

Section 9.10 describes that our preferred options for the final planning scenario include leakage reduction, increased optional metering, and water efficiency activities. The impact of climate change on the metering and water efficiency options are inherently accounted for in the percentage uplift that we apply to household demand. The uplift is applied to consumption in both the baseline and final scenarios. Table 5-14 shows the impact of climate change on each of the final plan demand options. As the baseline demand forecast is larger under a scenario with climate change, so the savings associated with implementing demand reduction options are also larger. Although the impact is very small, with a total difference of -0.05Ml/d. We do not expect any implications of climate change on leakage reduction.

Table 5-14 Impact of climate change on final plan demand options*

Option	Option name	2017/18	2019/20	2044/45
M1a	Enhanced Metering	0.00	0.00	0.00
WE1	Home Check	0.00	0.00	-0.04
WE2	Customer Engagement Dashboard	0.00	0.00	-0.01
ALY	15% reduction in leakage by 2025	0.00	0.00	0.00
Total	Total	0.00	0.00	-0.05

*the impact of climate change in enhanced metering is not zero, but too small to be shown at two decimal places.

5.6 Non-household water consumption

Water demand from metered non-household properties in the Wessex Water region has steadily decreased from 117 Ml/d in 1994/95 to 82 Ml/d in 2017/18 (Figure 5-26), which represents a 30% reduction in 22 years. The most rapid period of decline occurred between 2004/05 and 2009/10, with more gradual decline observed over the last five years.

Figure 5-26: Historical measured non-household water delivered with base year water delivered (grey point)

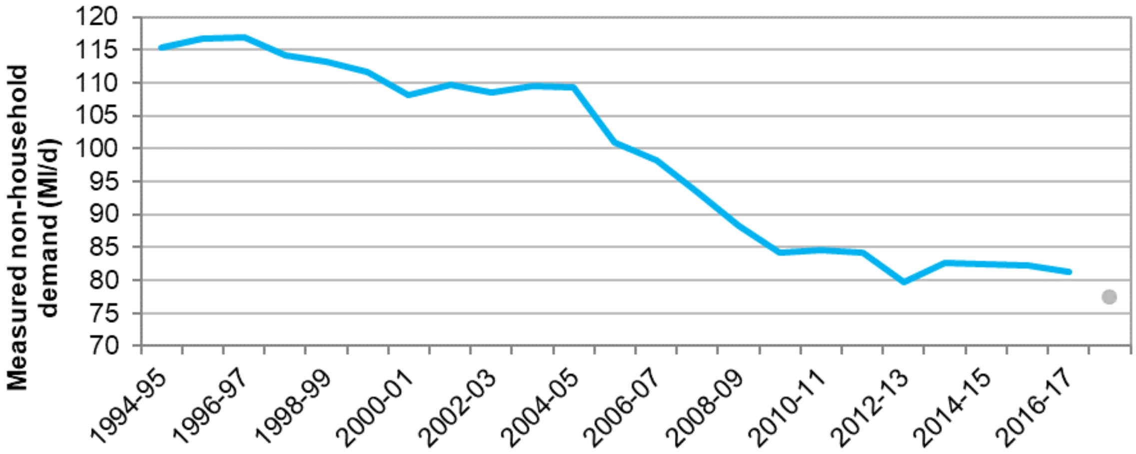


Figure 5-27: Historical measured non-household demand by industrial sector

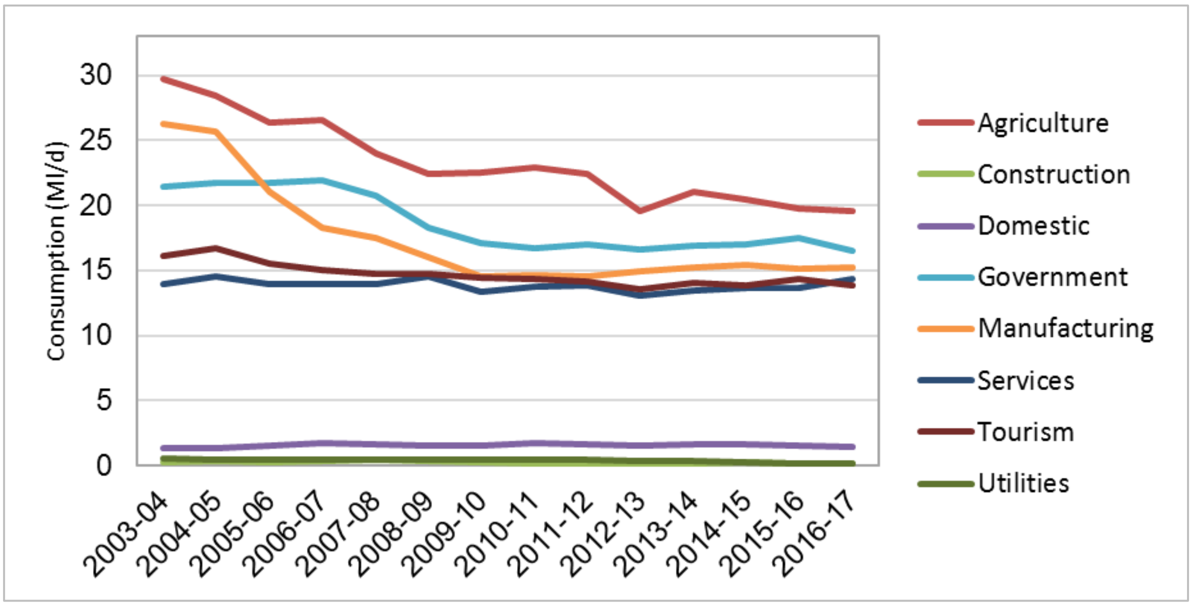


Figure 5-27 shows that the agricultural sector is the largest component of measured non-household demand accounting for approximately 19.5 Ml/d in 2016/17, which is 7% of total distribution input and 27% of measured non-household demand. Other important sectors in our region in the base year are government (16 Ml/d), the service sector (14 Ml/d), tourism (14 Ml/d) and manufacturing (13 Ml/d). Overall non-household demands has fallen in recent years, most notably between 2004/05 and 2009/10, as a result of reductions seen in the manufacturing, agriculture and to a lesser extent government sectors. Consumption in other sectors has remained relatively stable.

<u>Non-household properties</u>

In April 2017, Ofwat required a change to how water services are sold to non-household customers. Non-household customers are now able to choose their retailer with Wessex Water remaining the wholesaler for water services. When the market opened, the retailer became responsible for managing the accounts of non-household customers.

We followed relevant guidance from Ofwat[64] in determining customer/property types that we have considered as non-household, and whether non-household customers were eligible to switch their retailer. We were required to undertake an external review of the data for upload to the market systems, and also of the broad approach taken to eligibility. Shepherd and Wetherburn undertook this audit review, and Wessex Water (like all companies) had to pass this review to enter its data to the market.

5.6.1 Base year non-household demand

Measured non-household demand in the base year is consistent with the normalised outturn data as reported in Table 10 of our Regulatory Return in 2017.

[64] Water Supply licensing – guidance on eligibility (latest revision Feb 2015 – published by OFWAT); “Supplementary Guidance on whether non-household customers in England and Wales are eligible to switch their retailer (latest revision July 2016 – published by OFWAT); Response to OFWAT consultation on guidance to eligibility” (latest revision August 2015 – published by OFWAT).

The initial outturn data for regulatory reporting is derived from raw meter reading data and the following adjustment steps:

- We make an adjustment at the end of each reporting year to capture the water that people have been using but has not yet been confirmed through meter readings. We ensure that the assumption on usage in the prior reporting year is subtracted from the first meter reads within the reporting year so as to not double count this consumption.
- The volume of water allowed to metered non-household customers as a rebate on charges due to our leak allowance policy is added back to the resulting total.
- We make an adjustment for water delivered under special agreements that are not registered on a meter.
- Non-household meters are assumed to under-register the throughput of water by 4.2%. The figure relates to both positive displacement meters and turbine meters used on non-household properties. Refer to annex A for further information on our recent review of meter under registration.

Following the approach outlined in Section 5.2, non-household demands are normalised for the base year by making an upward adjustment of -0.01 Ml/d.

Unmeasured non household demand accounts for 1.7% of total demand. We currently have just over 3,500 unmeasured non-household properties which include some nursing homes, agricultural properties and guest houses. The amount of water used by our unmeasured non-households is estimated by applying the average unmeasured per capita consumption as calculated in our unmeasured household consumption monitor to the population allocated to unmeasured non-household (see section 5.5.2). We then add a discretionary 354 m^3 per annum per property which is an estimate of actual non-domestic usage at these properties in 2017/18. This compares with average water delivered at each of our measured non-household properties of approximately 700m^3 [65] per annum and reflects the fact that most non-domestic customers that use significant amounts of water have already been metered.

5.6.2 Non-household demand forecast

Measured non-household demand forecast

We commissioned Servelec to analyse historical measured non-household consumption data and develop a model that could be used to forecast measured non-household demand over the planning period. The modelling was conducted by evaluating historical relationships between sector-based consumption and potential predictors, and building predictive regression models for each industry sector, which were then used to forecast future demand. The approach is summarised here, and a technical report is available as an appendix to this Plan[66].

To build the models, the following data was analysed:

- Historical monthly consumption data by industry (sector) code (2003-2015).

[65] Based on 2016/17 outturn data.
[66] Servelec Non-household Demand Forecasting 2017

- Historical tariffs data (volumetric rates), including optional large user tariffs (1991-2013)
- Historical time-series of total measured non-household water delivered (1992-2015). The sum of the individual sector data is less than the total non-household water delivered data owing to adjustments for special agreements, meter under registration and the treatment of supply pipe losses.
- Economic data for the Wessex Water region, including Gross Value Added (GVA). GVA is a measure of the value of goods and services produced in an area, industry or sector of the economy.
- Soil Moisture Deficit (SMD) for the Wessex Water region
- Population time-series for the WW region from 1997, including a population forecast to 2045.

The following variables were found to influence non-household consumption:

- Higher GVA for a sector has a tendency to increase water consumption. This is to be expected and effectively represents water as an input to the overall industrial process.
- Higher SMD has a tendency to increase water consumption for the agriculture sector in particular. This represents the additional water required in, for example, irrigation during a dry year. Manufacturing processes and office-based activity are much less influenced by weather conditions.
- Higher water prices have a tendency to reduce water consumption, reflecting the price-elasticity of demand.
- Time trends: Several industries showed a decline in non-household consumption that could not be readily explained through other factors. Potential explanations include the impact of increasing water efficiency and the aggregate impact of other factors that are not in themselves statistically significant. The correlation between input variables distorts the individual impacts of each upon consumption.
- Population: increase in population causes increased water consumption.

Based on the data analysis, predictive regression models were developed for each industry sector, with input variables shown in Table 5-8. We reviewed the initial outputs from the models and made a modification to the agricultural sector model as we were concerned that the projection could be estimating too much of a future decline. Some elements of water use by the agricultural sector such as feeding livestock and perhaps watering crops will not benefit from significant efficiency reductions that have been experienced in the recent past. As a result, a base level consumption of 3000 Ml/a was excluded from the modelling to moderate the future projected demand reduction.

Figure 5-28: Variables included in the non-household demand forecasting models

Sector	GVA*	SMD	Tariff**	Population	Time-Trend
Agriculture***		X			X
Construction	X				X
Domestic			X	X	
Government††				X	X
Manufacturing	X				X

Services				X	X
Tourism				X	X
Utilities	X				X

* The GVA count included was for the relevant industry sector and the WW region.
** Tariff variables considered included the standard marginal rate, the optional tariff marginal rates. Where tariff is included in the model the standard marginal rate is used.
***a base level consumption was applied for the Agriculture model for irreducible demand.
†Model developed only using data since 2005, due to customer re-classification.
††Model fitted since 2008 due to data step-change at the time.

The input variables for the various models have been forecast as follows:

- Forecasts of tariff variables have been developed on the basis of 0.5% K and 2.5% Retail Price Index, annually[67].
- Forecasts of Gross Value Added (GVA) have been calculated assuming a 2% increase per annum.
- Soil Moisture Deficit (SMD) has been assumed as the average observed from 2003 - 15. This is appropriate for NYAA forecasts.
- Forecasts of population variables have been explicitly provided by WW to 2045 (see section 5.5).

The sum of the individual sector models is adjusted for special agreements, and meter under registration. Figure 5-29 shows the individual sector forecast, and figure 5-30 shows the combined sector forecast. The forecast for most sectors is relatively flat, with the exception of Agriculture, Tourism and Manufacturing, with forecast declines in consumption. These forecasts reflect continuations in observed water efficiency saving, that up to 2016/17 were in part delivered by Wessex water, and going forwards will be delivered by non-household retailers.

In April 2017, when the non-household market opened, the retailer became responsible for providing water efficiency advice. Before April 2017, Wessex Water had a dedicated team that worked with business customers. Business customers are often particularly ‘tuned in’ to the financial incentive to save water and associated energy, and some have sustainability and corporate social responsibility drivers too. We provided advice on reducing water use and waste minimisation to our business customers in a variety of ways. Seminars and workshops were used to engage with business customers as they facilitate discussion and knowledge sharing. Businesses using large amounts of water also benefitted from an account management service where expert advice on water efficiency and wastewater minimisation was provided and site water audits undertaken. Non-household customers were also able to view their 15-minute consumption profile providing an invaluable tool for process optimisation and leakage monitoring. We expect the effect of similar activities

[67] The ‘K factor’ is the price limit that is set for each individual water company by Ofwat for each 5 year Business Planning cycle. At the five yearly review, Ofwat assesses, for each year, what each company needs to charge in order to finance the provision of its services and meet its obligations. The price limit is then applied according to a formula laid down in the water companies' licences. Ofwat checks that the increases do not on average exceed inflation plus the K factor (K can be negative).

undertaken by non-household retailers to continue, as in-part reflected in the downward consumption trends shown in Figure 5-29.

Between 2015 and 2017 we ran a retrofit programme with non-profit non-households including schools and council buildings. High usage organisations received an audit and the fitting of water efficient devices where appropriate if they wished. The programme achieved savings of 94,207 litres per day.

The total forecast decline over the planning period is ~14 Ml/d, which is less than the historic decline of ~35 Ml/d since 1995. We believe that the large reductions in historical demand were a consequence of large customers relocating out of the region or ending production; such changes are becoming progressively less likely as most of the largest water-use customers have now already ceased production. Customers that continue to be large users of water are increasingly dominated by military, educational and health establishments in the region (Government sector) where the probabilities of closure and/or relocation are low.

We consulted with retailers on the validity of the non-household demand forecast particularly in the context of their future water efficiency programmes and received nothing to challenge the validity of the forecast.

As described above, we expect the effect of water efficiency initiatives undertaken by non-household retailers, and the businesses themselves, to continue to lead a decline in overall non-household water use. Ofwat[68] published a review of the first year of the business retail water market, and:

- estimates that the customers who switched or renegotiated in the first year saved 270 to 540 million litres of water.
- found that some large customers bypassed retailers by choosing self-supply, which has delivered water efficiency savings. For example, Greene King became a self-supplier and reduced their consumption by around 140 Ml in the market's first year through targeted water efficiency measures.

In June 2018, Business Stream announced its ambitions to help its customers reduce their water consumption by 20% by working with its customers to identify and deliver water efficiency solutions. Furthermore, in June 2018 Waterwise launched the first Retailers Leadership Group for Water Efficiency to encourage greater efficiency measures in the sector.

In Section 12.2 of this plan we describe how we are adopting an open systems approach to the future delivery of our core business outcomes and this has been set out in our Business Plan submission to Ofwat in September 2018. Our Open System Coordinator (OSC) concept proposes that a distinct process within Wessex Water will be tasked with pro-actively identifying opportunities for third party delivery of services and for ensuring that the most efficient / effective services are procured. This is an approach that we have already taken with, for example, the creation of GENeco and EnTrade, but we see greater opportunities for other market solutions to be explored, with potential further engagement with the non-household sector to reduce demand from potable sources.

[68] Ofwat (2018) Open for business: Reviewing the first year of the business retail water market.

Figure 5-29: Measured Non-Household consumption forecast by sector

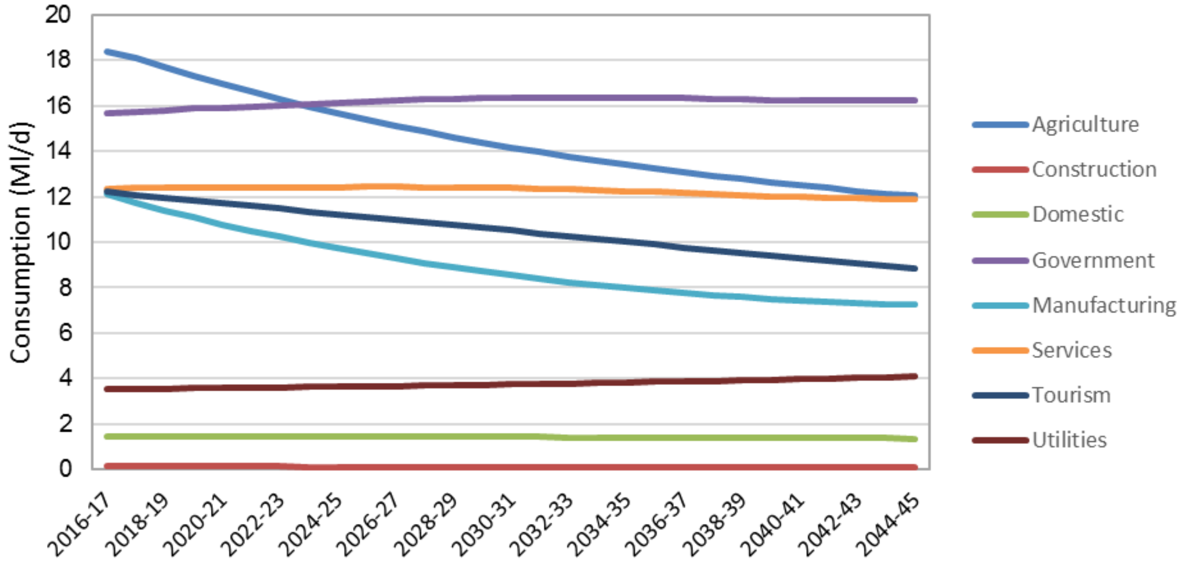
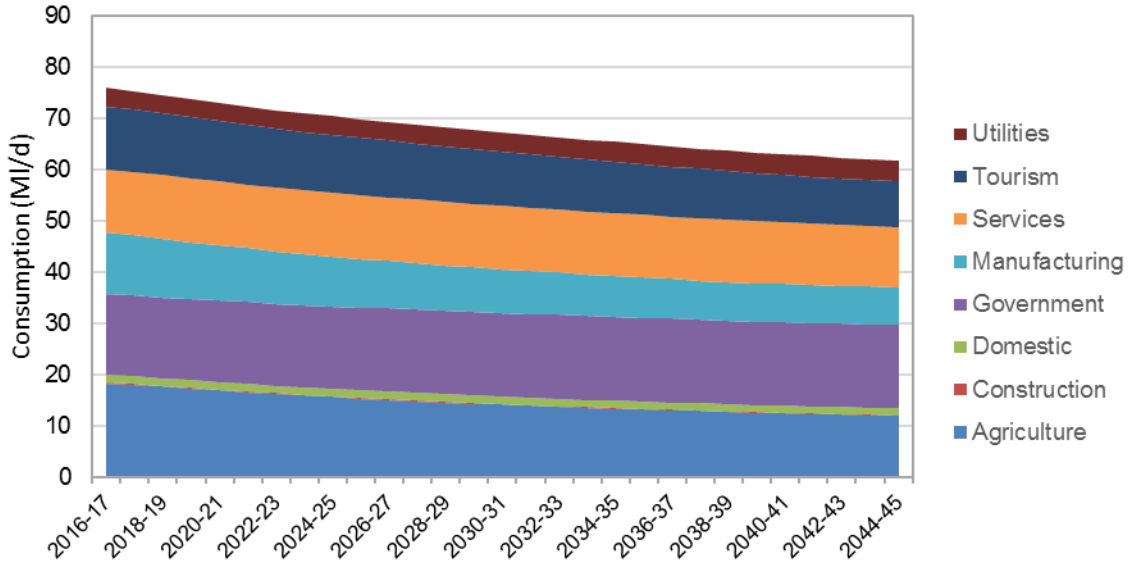


Figure 5-30: Measured non-household demand forecast by sector



Following the normalisation process outlined in Section 5.3, Figure 5-31 and shows the overall forecasts of measured non-household demand that were derived for the dry year annual average and dry year critical period scenarios.

Figure 5-31: Measured non-household demand forecasts

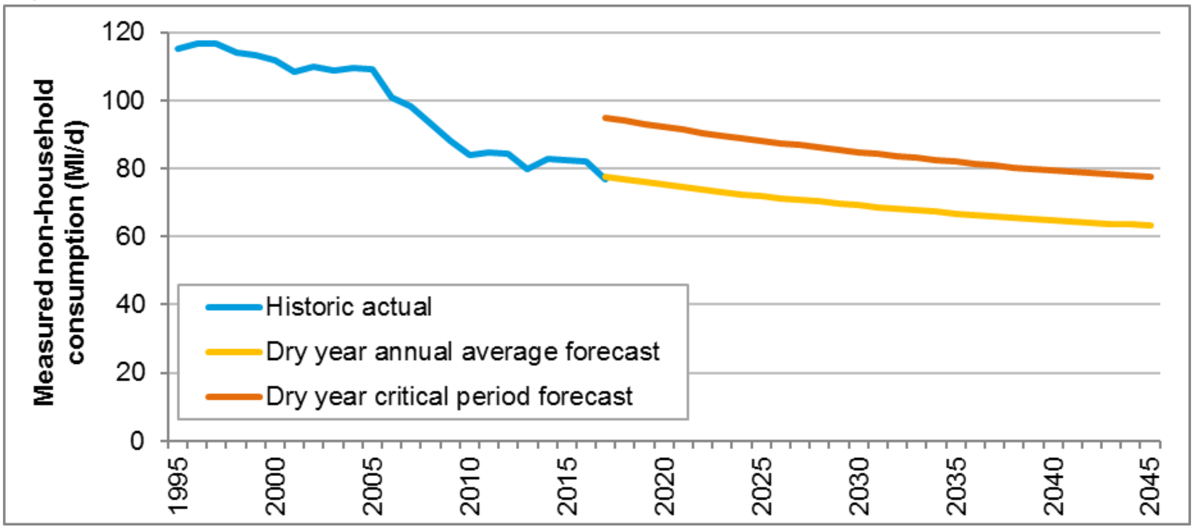


Table 5-15: Baseline measured non-household demand forecasts

Scenario	2016/17	2024/25	2044/45
DYAA (Ml/d)	77.39	71.91	63.21
DYCP (Ml/d)	94.92	88.18	77.61

Unmeasured non-household demand forecast

Unmeasured non-household demand declines through the planning period as the unmeasured non household properties progressively move to metered charging (see Section 5.3.4 for further details). The population reduces through the planning period from 19,134 people in the base year to 12,781 people in 2044/45.

Table 5-16: Baseline unmeasured non-household demand forecasts

Scenario	2016/17	2024/25	2044/45
DYAA (Ml/d)	4.65	3.52	1.54
DYCP (Ml/d)	5.97	4.51	1.98

Impact of climate change on non-household demand for water

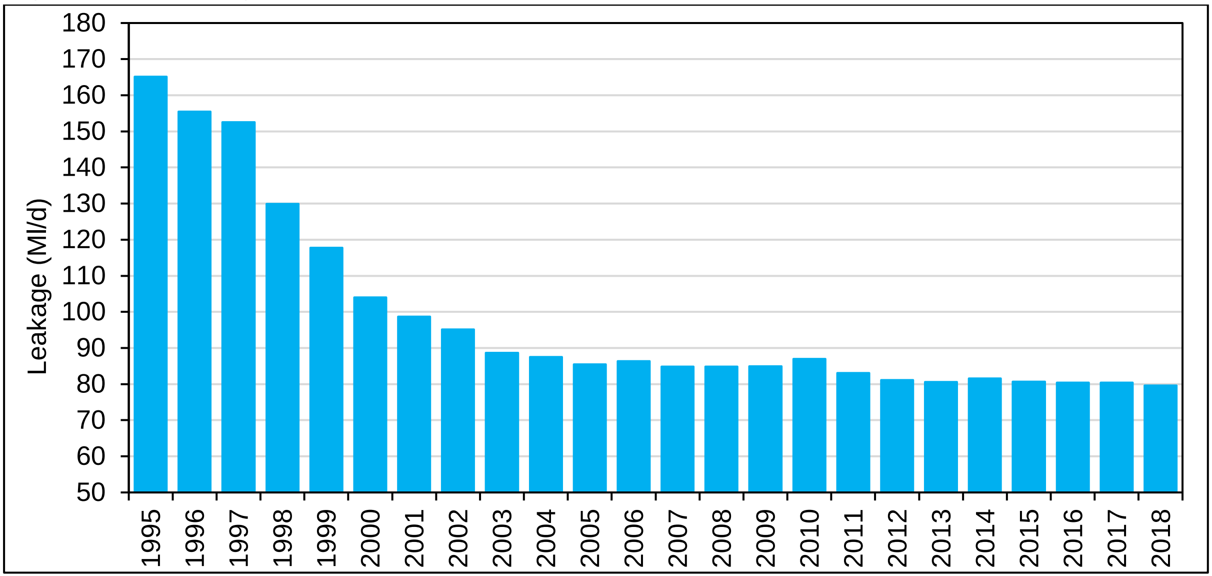
Our forecasts of non-household demands are not specifically adjusted to account for the potential influences of climate change. The impacts are likely to be small relative to other (economic) influences and agriculture is the only sector that was identified as being linked to weather variables (soil moisture deficit).

5.7 Leakage

5.7.1 Historical leakage reduction and base year position

Since the mid-1990s we have halved the amount of water that leaks from our network (Figure 5-32) this is around 15% more than the industry average reduction over the same period. We managed to continue the downward trend in leakage despite our network growing each year by approximately 40 km of new water mains, around 5,000 new property connections and the ageing of our distribution network.

Figure 5-32: Leakage reduction since 1995



*Note: The values shown are different from those reported in annual regulatory returns as they have been adjusted to reflect the new best practice approach for estimating leakage[69]; refer to Annex A for more detail.

Leakage in our base year is estimated at 79.7Ml/d using the UKWIR best practice methodology as recommended by the Environment Agency's supplementary guidance to the water resources planning guidelines[70].

Current leakage activities

Our leakage management strategy is based on an active leakage control policy which includes with continuous flow monitoring, pressure management, asset repair and asset replacement.

We spend £16m a year on managing and reducing leakage. Leakage detection staff costs amount to approximately £2.5m, customer service pipe repair and replacement costs are approximately £2.75m[71] and the remainder of the spend is associated with mains leakage repair costs and other leak detection apparatus. In addition, we spend a further £12m each

[69] UKWIR (2017) Consistency in Reporting Performance Measures.
[70] Environment Agency (Revised August 2017). Leakage in WRMPs.
[71] Our customer supply pipe repair and replacement policy is generous compared to the policy offered by other water companies in the UK.

year replacing older water mains that are more susceptible to burst to prevent a future increase in leakage.

The work is carefully planned based on historical information and known risk factors. Every year we mend around 12,000 leaks, of which about 60% are customer reported and 40% are company detected. We also replace approximately 50 km of our supply network each year. Key features of our active leakage control strategy are summarised below and further details can be found in our report on the Sustainable Economic Level of Leakage[72].

- We undertake continuous night flow monitoring of over 98% of properties in over 650 District Meter Areas. The data is transferred electronically to our bespoke computer systems (WRIMS and Waternet73) and analysed daily enabling local Leakage Inspectors to target areas where the leakage has shown an increase from the normal base level.
- Approximately 85% of our network is under active pressure management using over 1000 Pressure Reducing Valves (PRVs), with most of the remaining areas not requiring pressure reduction. We continue to update our set of hydraulic models which cover our entire network. These models are used to identify areas with potential for new and improved pressure management – a small number of new PRVs are installed each year but we are close to the technical limit with pressure management and our focus is on optimising the performance of our existing systems rather than new installations.
- The focus of improvement in recent years has been in reducing the time between leak occurrence, detection and repair. This has been achieved by improvements to monitoring to provide near real time data, fixing leaks as quickly as possible and performance driven incentives for leakage inspectors. For an example of these activities see the case study box in this Section on 'next day repairs for customer reported leaks'.
- Since 1997 we have offered our domestic customers a leak repair service. We will detect and repair or replace a leaking service pipe to a domestic property up to the outside wall of the house providing it is accessible and does not pass under any structure. We provide over 4000 supply pipe repairs each year.

<u>Impact of our current leakage activities</u>

Our Sustainable Economic Level of Leakage (SELL) assessment included an updated calculation of the Natural Rate of Rise (NRR) in leakage.

The NRR in leakage can be defined as the increase in leakage that would occur over a year in the absence of leak repairs or other leakage control activity. Total NRR (referred to as NRRt) is the hypothetical annual increase that would occur if neither reported nor detected leaks were repaired and in the absence of other leakage control interventions. If the equivalent volume of reported leaks is subtracted from NRRt, the remainder is the theoretical

[72]Servelec (2017) Sustainable Economic Level of Leakage, Phase 2 report.

[73] RPS Waternet system was introduced in 2011/12. The tool is a significant improvement over the previous system and enables daily updates of leakage results at DMA level.

leakage that needs to be “detected” (NRRd) or overcome through other means for leakage to be maintained.

Our updated NRRt and NRRd estimates are 83 Ml/d and 40.5 Ml/d respectively. These are the amount by which leakage would increase over a 12-month period and are based upon the average of reporting years 2015/16 and 2016/17.

To combat the NRR in leakage we have an active leakage control policy and pressure management strategy. This is supported by our integrated network maintenance/replacement strategy to maintain stable asset health in the longer term and to minimise leakage, supply interruptions, water quality compliance and customer contacts about appearance of drinking water.

We repair over 12,000 leaks per year, with around half of these detected by our team of almost 50 full time leakage inspectors. Our pressure management team maintain over 800 individually pressure managed areas.

Our mains replacement programme is primarily targeted to preventing future increases in NRR whereas our active leakage control and pressure management teams are employed to minimise current leakage. Our current level of mains replacement alone is not sufficient to reduce leakage in the short term.

Our option analysis for this Plan (Section 9) shows that increased mains replacement is not the most cost-effective strategy to reduce leakage.

CASE STUDY: 'Lift and Shift' – an innovative approach to location leaks.

In 2016 we experienced an increase in leakage over the summer and we needed to reduce leakage quickly to get back on track before winter. Every year we mend around 12,000 leaks, of which about 60% are customer reported. Our dedicated team of leakage inspectors locate the remaining nonvisible leaks. It can take up to two years to become a skilled leakage inspector that is proficient with the range of technologies and approaches needed to accurately locate a leak and become familiar with our complex water distribution network.

We did not have enough skilled leakage staff to complete the work, and therefore needed to find an alternative way to identify leaks. The solution came in the form of 'lift and shift' leak detection. This innovative approach uses a combination of high specification correlating leak noise loggers, logger technicians (who only require two weeks training) and an analyst to identify areas to target to review the results.

Leak logger deployment / retrieval

- We target a zone requiring leak detection intervention from our leakage monitoring system
- A logger technician deploys the noise loggers to mains fittings across the zone. The loggers are programmed to wake up and record acoustic measurements at periods during the early hours.
- The next day the technician retrieves the loggers and remotely transmits the recordings for analysis in the logger manufactures cloud based software.
- Our analyst interrogates the software to determine 'hot spots' of possible leakage points.
- The points of interest are followed up by skilled inspectors to confirm and pinpoint the source of leakage for repair.

This approach has proved successful to the extent that we now have up to 1,300 loggers being systematically deployed and retrieved each day by a now business-as-usual team of eight staff. This 'lift and shift' approach generates nearly one-third of the total number of leaks identified by our leakage inspector team. The approach helped us overcome the skilled resource shortage and significantly reduced the amount of time it takes to survey a complete zone for leakage.

Sustainable economic level of leakage

The sustainable economic level (SELL) of leakage is the point at which the cost of fixing a leak is greater than the cost of not fixing a leak. The cost of not fixing a leak includes environmental damage and the cost of developing new water resources to compensate for the water lost through leaks.

We have updated our estimate of SELL for this Plan. The current leakage levels are a fundamental component of the SELL analysis and therefore the analysis needed to be updated to reflect the change to our base year leakage volume from using the UKWIR method to estimate leakage (refer to Annex A for further information).

Our SELL is 104.4 Ml/d against an operating level of 78.3 Ml/d[74]. This was undertaken by an industry leading external consultant following the latest best practice guidance methodology. We operate significantly below our SELL because we have a surplus of available supplies over demands; the value therefore attached to reducing leakage equates to the marginal cost of producing water (approximately 9p/m^3), rather than the marginal cost of developing a new water resource (over 100p/m^3).

Even though our operational level of leakage is below the SELL and the most economic strategy would arguably be to let leakage rise, this is not a strategy that we would propose. The Government's view that leakage should not rise is consistent with that of our Board and the majority of our customers (discussed further in Section 9.1).

CASE STUDY: Next day repairs for customer reported leaks

In 2012 we moved from targeting the repair of customer reported leaks from 10 days down to by the end of the next working day. A special project was set up to deliver this scheme. The "Visible Leak Initiative" required a number of changes to internal procedures and system, including taking more information over the phone to enable a gang to be dispatched direct to a customer's address to complete the repair immediately avoiding the need for an initial visit by an inspector.

This has been a very successful initiative, and we made fixing customer reported leaks within a day as one of our performance commitments in our 2015 to 2020 business plan. We now repair around 75% of all leaks on our network by the end of the next working day unless we are prevented from doing so by third party issues like private land access of highways restrictions, or due to health and safety issues like with deep excavations. Our target is to get to 90% of all customer reported leaks fixed within a day by 2020. This does contribute to our continuing efforts to drive down leakage.

[74] As per our SELL analysis which was undertaken for the 2016/17 reported data.

Leakage comparison with other companies

Using data that is available from Discover Water it is possible for us to compare our leakage performance with that of other water companies. Current comparative data is available for 2017/18[75], which uses data prior to the implementation of the leakage consistency methodology and so should be interpreted with some caution. Data that is consistent with the new Water UK and UKWIR method is not publicly available for all companies.

Error! Reference source not found.6 shows that we have achieved the second highest leakage reduction by mains length in the industry since 1994/95.

Table 5-17: Historical leakage reduction comparison

Company	Reported Leakage m^3/km/day		
	1994/95	2016/17	% reduction
Welsh	15.5	6.4	59%
Wessex	12.9	5.7	56%
Yorkshire	19.4	9.3	52%
UU	21.7	10.5	52%
Severn Trent	16.2	9.2	43%
South West	9.5	5.5	42%
Thames	34.7	21.6	38%
Southern	10.2	6.4	37%
Bournemouth	10.2	6.8	33%
Northumbrian	11.5	7.8	32%
South Staffs	17	11.6	32%
Anglian	6.9	4.8	30%
South East	8.7	6.1	30%
Bristol	9	6.9	23%
Portsmouth	10.1	9.1	10%
Weighted Average	**16.1**	**9.1**	**43%**

Figures 5-33 and 5-34 present a comparison of leakage by company in 2017/18 by length of pipeline and per property, respectively. The figures show that Wessex Water has below average leakage by both metrics, and of the 20 companies shown, ranks 3rd lowest for leakage per km of pipeline, and 11th lowest for leakage per property. Figure 5-36 illustrates that we have the largest length of pipeline per property in England and Wales, being such a rural company makes it harder for us to perform as well as some companies with large metropolitan areas on the leakage per km of pipeline metric.

[75] https://discoverwater.co.uk/leaking-pipes

Figure 5-33: Comparison of company leakage per length of pipeline for 2017/18 (Source: Discover Water)

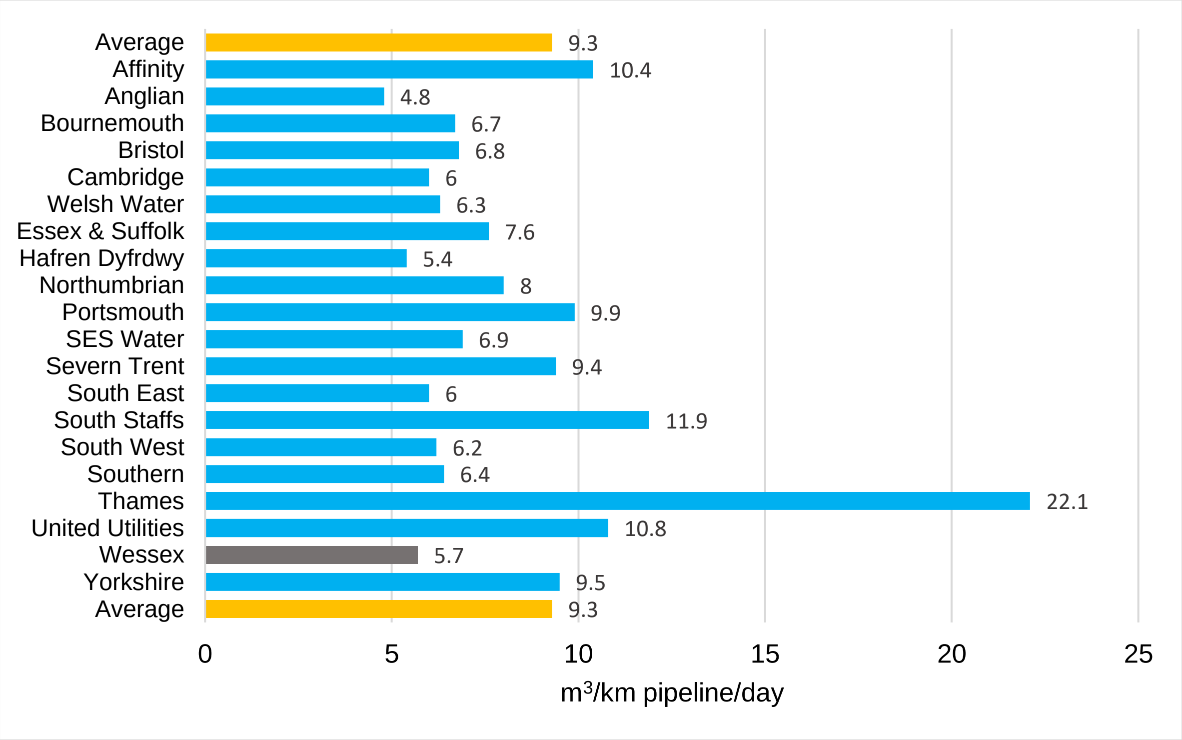


Figure 5-34: Comparison of company leakage per property for 2017/18 (source: Discover Water)

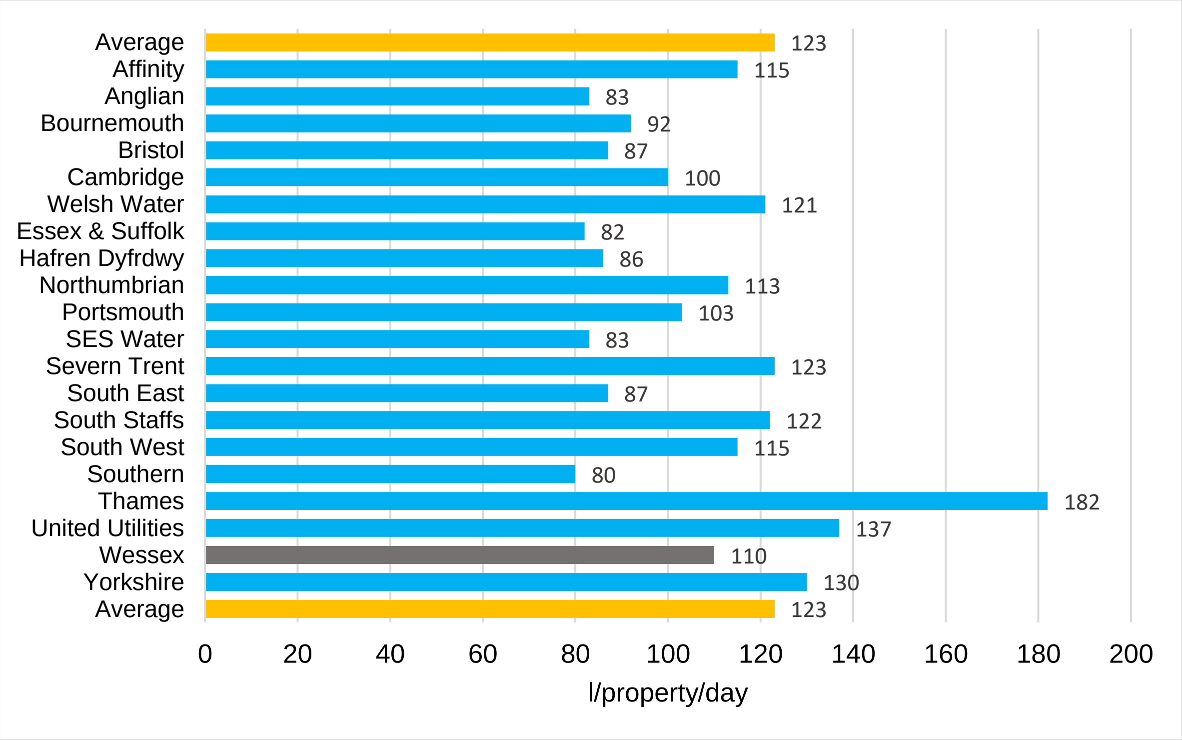
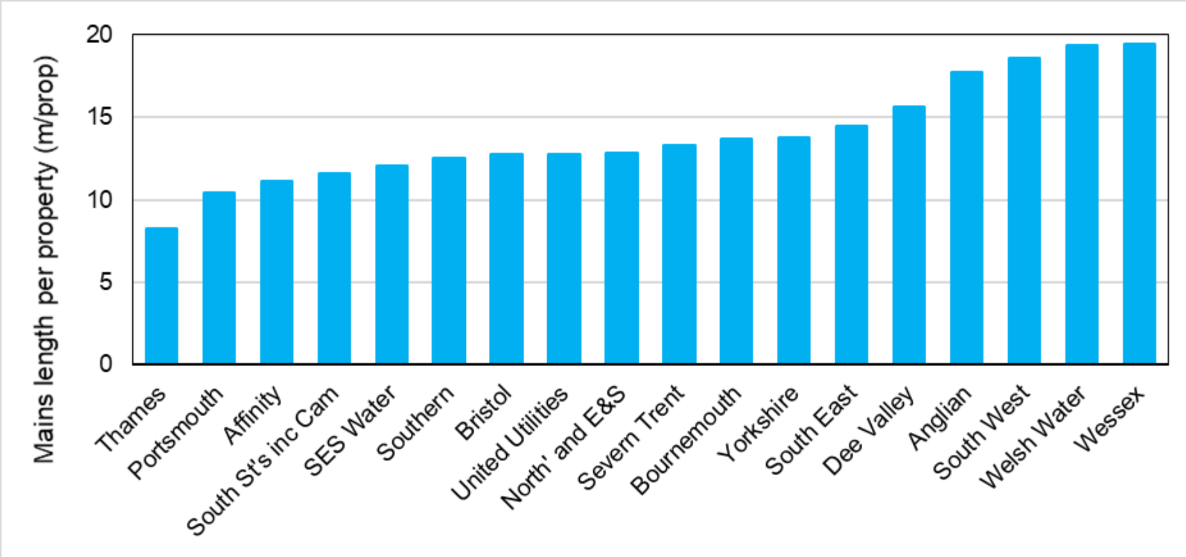


Figure 5-35: Current comparative data mains length per property



5.7.2 Baseline leakage forecast

Our baseline leakage forecast assumes a continuation of current leakage strategies. We are on track to deliver the leakage reductions promised in our last Plan, which equates to 3.5 Ml/d (5%) over the 2015-20 period. Our baseline forecast proposes to continue to manage leakage below the SELL and not allow leakage to increase.

The leakage benefit associated with our baseline household metering programme (Section 5.5.4) is included in the baseline leakage forecast. Metering helps reduce leakage as monitoring household water use makes it possible to identify usage patterns that can indicate a leak – these can then be found and fixed. A recent study of these ‘supply pipe losses’ (see Annex A) indicates the average difference in losses between metered and unmeasured properties is around 30 litres a day.

Our baseline forecast assumes that we will maintain distribution losses at the 2020 level (the level reached once the leakage reductions planned in this period have been delivered) and will not let them rise through the planning period. Leakage reductions will be delivered as a result of reductions in customer supply pipe losses arising from our household metering programme. Table 5-17 shows that the baseline forecast includes a leakage reduction of 1 Ml/d in the 2020-25 period, and a further 1.4 Ml/d up to 2045.

Table 5-18: Baseline leakage forecast through the planning

Scenario	2019/ 2020	2024/ 2025	2029/ 2030	2034/ 2035	2039/ 2040	2044/ 2045
Baseline (Ml/d)	78.2	77.2	76.6	76.2	76.0	75.8
Reduction below 2020 position	-	1.0	1.6	2.0	2.2	2.4

5.7.3 Final planning leakage reduction forecast

Our final planning leakage forecast includes a stretching target to reduce leakage by 15% by 2025 (see Section 9) plus our long-term aspiration to reduce leakage by a total of 27% from 2020 levels by 2045.

The final planning forecast shows that leakage will reduce by 11.8 Ml/d by 2025 and by over 21.2 Ml/d by 2045 (Table 5-19). The final planning forecast relative to historical trends is shown in Figure 5-33 below.

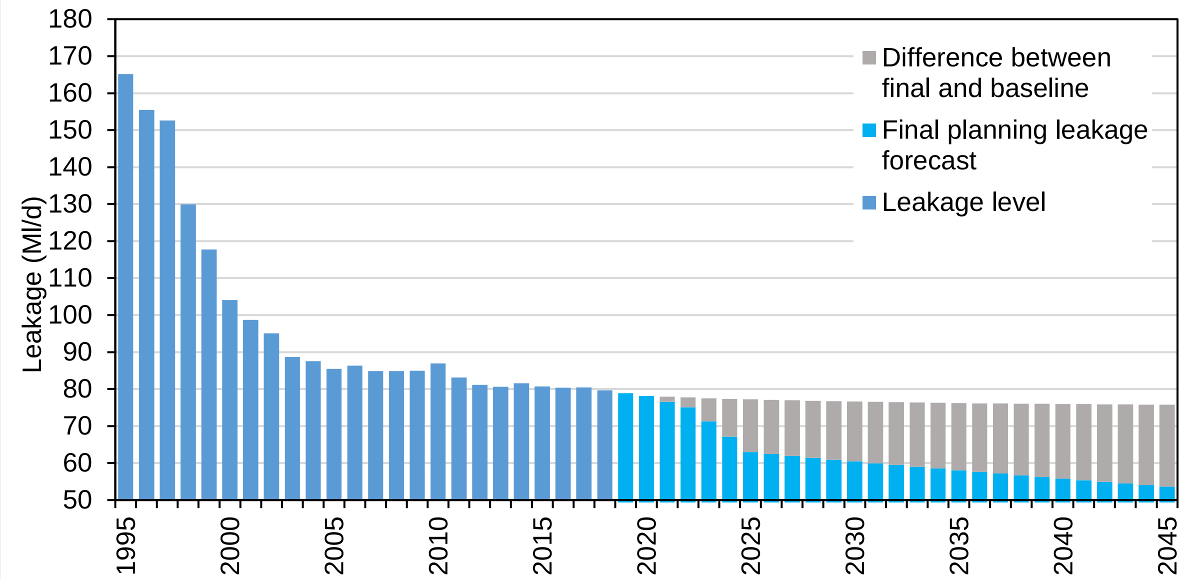
Table 5-19: Baseline and final planning leakage forecasts

Scenario	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Baseline (Ml/d)	78.2	77.2	76.6	76.2	76.0	75.8
Reduction below 2020 position (Ml/d)	-	1.0	1.6	2.0	2.2	2.4
Final planning (Ml/d)	78.2	66.4	63.9	61.5	59.2	57.0
Reduction below 2020 position (Ml/d)	-	11.8	14.3	16.7	19.0	21.2
Difference between scenarios (Ml/d)	-	10.8	12.7	14.7	16.8	18.8

To deliver the 15% reduction in leakage we have developed a package of the most cost beneficial measures from our leakage option analysis (see Section 9.7.3). A step change in our activities will be required, as well as innovation and continued customer support and engagement. Our proposals include:

- reducing losses from our distribution network through additional active leakage control, improved data collection and analytics, further sub-division of district meter areas, innovative pressure management
- reducing losses from customers' pipes through our enhanced metering programme as it is easier to identify leaks on properties that are metered
- promoting ways in which customers can contact us to report a leak via our leak stoppers telephone hotline or our website.

Figure 5-36: Final planning leakage forecast relative to historical trends



5.8 Minor demand elements

5.8.1 Distribution system operational use

Distribution system operational use (DSOU) is the intentional use of water in the operation and maintenance of our supply network. Water is used for a variety of purposes often related to meeting statutory obligations relating to water quality, such as mains flushing, laying and commissioning; service reservoir cleaning and commissioning; sampling and sewage treatment works processes.

DSOU typically represents a small component of demand (approximately <1%). Estimates for annual regulatory reporting are made on the basis of records of reported occurrences and/or estimates of occurrences and assumptions regarding the volume of water used per occurrence. This is consistent with the recommended approach set out in the UKWIR/NRA (1995) report[76] recommended by the water resource planning guidelines.

Over the last 15 years we have seen DSOU fall from 6.5 Ml/d in 2002/03 to an average of around 2.4 Ml/d. The DSOU reported in our base year is slightly higher than this at 3.1 Ml/d, due to significant engineering works flushing requirements associated with our grid project.

Other than the operational use associated with the grid construction, the majority of the operational water use is related to washing processes at sewage treatment works. It would be reasonable to assume that this volume may increase through the planning period in-line with population growth; however it is likely that this would be offset by increased operational efficiencies.

Once the grid construction is complete in 2018 we expect the DSOU to return to around 2.7 Ml/d and remain at this level for the remainder of the planning period.

[76] UKWIR/NRA (1995). Demand forecasting methodology.

5.8.2 Unbilled (legally and illegally)

<u>Water taken legally unbilled</u>

Water taken legally unbilled includes an assessment of water use in the construction of new properties where water is not metered and instead a fixed building water charge is levied. It also includes an estimate of use by fire authorities, unmetered standpipe usage and net consumption read at metered void properties.

Water taken legally unbilled in 2016/17 was 2.9 Ml/d. Water taken legally unbilled varies slightly from year to year depending on the number of void properties and new properties being constructed.

<u>Illegally unbilled</u>

Water taken illegally billed largely comprises unauthorised standpipe use. We have no way of actually measuring water taken illegally unbilled and so rely on industry assessments and assumptions. We use a constant regional figure of 1.1 Ml/d throughout the planning period, which is based on an historical estimate. This value is consistent with our last water resources management plan and recent annual reporting submissions.

Total (legally and illegally) water taken unbilled amounted to 3.98 Ml/d in 2016/17. The UKWIR/NRA (1997) report[77] Forecasting Components of Water Demand (1997) suggests that given the small size and difficulty of measuring these components, it is reasonable to assume that the existing volume continues to apply over the planning period.

The approaches taken for calculating legally and illegally unbilled water are consistent with the recommended approaches set out in the UKWIR/NRA Demand Forecasting Methodology report (1995).

[77] UKWIR/NRA (1997). Forecasting components of water demand.

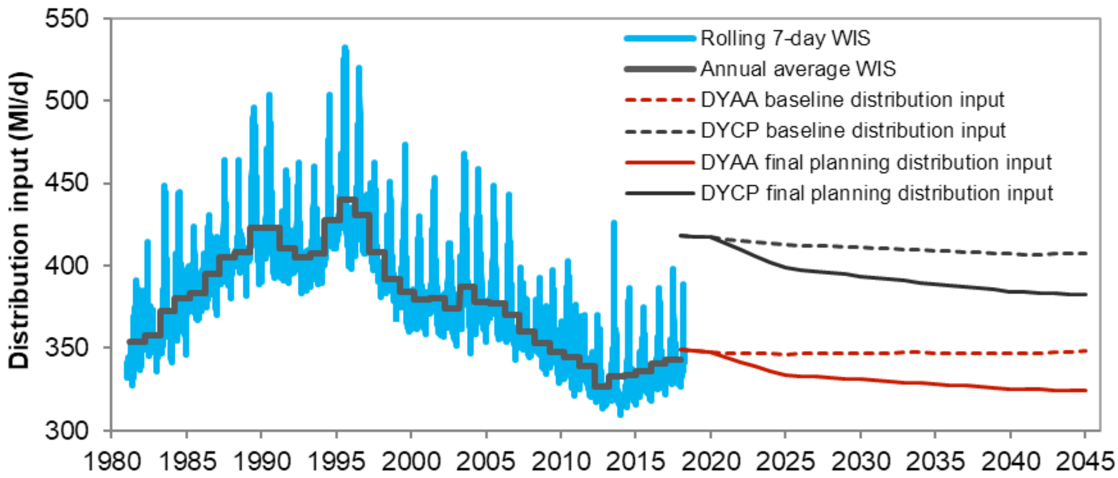
5.9 Summary of demand forecast

This Section has reviewed the building blocks of the demand forecast. Some elements of demand are driving the forecast upwards (i.e. population growth) and other components of are driving a reduction in demands through the planning period (i.e. increased metering).

The combined effect and overall demand forecasts are presented in Figure 5-39 and Table 5-20. The graph and table show that the baseline **dry year annual average** demand is projected to remain broadly stable at 346.45 Ml/d in the base year and 346.13 Ml/d at the end of the planning period, whereas under the final planning scenario, demand reductions of 14.46 Ml/d (4.2%) lead to a forecast demand of 331.98 Ml/d in 2044/45.

For the **dry year critical period** scenario the baseline forecast projects a reduction from 415.16 Ml/d in the base year to 405.54 Ml/d at the end of the planning period, a reduction of 2.3%. In the final planning scenario, total demand reduces by 24.98 Ml/d by the end of the planning period to 390.18 Ml/d by 2044/45, which represents a decline in demand of 3.7%.

Figure 5-37: Baseline and final planning demand forecasts in the context of historical demands



DYAA = Dry year annual average; DYCP = Dry year critical period; WIS = Water into supply.

Table 5-20: Distribution input by scenario through the planning period, values (Ml/d)

Scenario	2017/18	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Baseline							
Dry year annual average	349.16	347.48	346.39	347.19	347.18	346.79	348.09
Dry year critical period	418.42	417.39	412.74	411.11	409.12	407.08	407.28
Final planning							
Dry year annual average	349.16	347.48	333.35	330.96	328.18	325.29	324.26
Dry year critical period	418.42	417.39	398.61	393.68	388.89	384.35	382.23
Differences							
Dry year annual average	0.00	0.00	-13.04	-16.23	-19.01	-21.50	-23.84
Dry year critical period	0.00	0.00	-14.13	-17.43	-20.24	-22.73	-25.04

6 Headroom assessment

It is inevitable that there will be uncertainty associated with several elements of the supply and demand forecasts and it is therefore important that a margin, known as headroom, is allowed for as part of the water resources planning process.

Target headroom is the minimum buffer that is applied to the supply-demand balance to ensure that the chosen level of service can be achieved. Available headroom is the actual difference between water available for use and demand at any given time. A water resource zone is in supply-demand balance deficit if the available headroom falls below target headroom and is in surplus if the available headroom exceeds target headroom.

6.1 Headroom assessment methodology and risks included

We contracted consultants Mott MacDonald to undertake the uncertainty analysis and modelling required to derive an appropriate target headroom allowance for our single resource zone. We used the 2002 (simpler) methodology developed by UKWIR: An improved methodology for assessing headroom. The methodology involves examining the uncertainty of each component as probability distributions that are then modelled using a Monte Carlo simulation. Mott MacDonald's technical report is available as an Appendix[78] to this Plan; the key issues and findings are however discussed and reported in this Section.

The components of the supply demand balance that are included in the headroom assessment reflect the factors that could affect water available for use or actual demand. Here we summarise how the issues were considered in our analysis.

D1 Accuracy of demand side data
This component accounts for water distribution metering inaccuracies in the base data. A triangular distribution has been applied so that the most likely uncertainty allowance is zero and the minimum and maximum allowances are plus or minus 2% from the central baseline demand forecast.

D2 Demand variation
This component accounts for variation around the baseline demand forecast. 'Upper' and 'lower' demand forecasts were developed as alternatives to the central forecast by adjusting key input assumptions in the demand forecasting model. The key assumption changes are:

- **Household population growth rate - 90th percentile bounds of population uncertainty (Figure 5-13), approximately ± 170,000 for low and high scenarios.**
- **Non-household demand** - ±5 Ml/d (8.5%) by 2044/45.
- **Supply-pipe losses** - internal meter (upper: 45 Ml/d; lower: 38 Ml/d); external meter (upper 15 Ml/d; lower: 4 Ml/d).
- **Metering consumption reduction** - optants (upper 6%, lower 14%), change of occupier (upper 8%, lower 16.5%).
- **Change of occupier metering parameters –** percent of meters than can be fixed (upper 30%, lower 50%), percent moving owner occupier (upper 2%, lower 5.1%),

[78] Mott MacDonald Target Headroom Analysis – Water Resources Management Plan 2019

percent moving social renting (upper 6.4%, lower 10.4%), percent moving private rent (upper 22%, lower 34%).
- **Per capita consumption** – multiplier of PCC forecast (upper 0.95, lower 1.05).

We also included a severe winter leakage allowance to account for the risk of getting a very cold winter which causes leakage to rise above our target level. We used a triangular distribution, with a minimum of 0 Ml/d and most likely and maximum of 2.0 Ml/d. This effect was only included in the dry year annual average headroom modelling.

A peak factor uncertainty component was also included in the analysis for the peak demand scenario. Uncertainty around the peak factor was accounted for using a triangular distribution with the minimum and most likely values being 0 Ml/d. The variation, in Ml/d, between the central baseline factor forecast and the upper factor forecast was the value used as the maximum value of the triangular distribution.

D3 Uncertainty of impact of climate change on demand
As explained in (Section 5.5.6) we analysed the impact of climate change on demand using the analysis presented in the 2013 UKWIR study. To account for the uncertainty around the baseline forecast we used the 10th percentile uncertainty (0.38% / -1.24 Ml/d impact by 2045) and 90th percentile (1.65 / +5.39 Ml/d impact by 2045).

D4 Demand management measures
No uncertainty was included in the analysis to account for the uncertainty around possible demand management options.

S1-S3 Vulnerable licences
In accordance with the water resource planning guidelines vulnerable licences (components S1 and S2), were not included in the headroom analysis.

S4 Bulk transfers
Three issues were included in the headroom analysis to describe the uncertainty of import volumes from neighbouring water companies over the planning period.
The issues included were:

- Bristol Water – we expect to have a new agreement from 2020/21 which limits the annual volume to 4.4 Ml/d and we have assumed that most likely volume at risk will be 10% at risk, but up to 4.4 Ml/d.
- Sembcorp Bournemouth Water – Stubhampton – uncertainty over up to 0.13 Ml/d at risk.
- Veolia Water Projects – uncertainty over the possible loss of up to the whole import volume of 2.74 Ml/d from 2022 (the earliest date it could be lost as agreement requires 4 years notice to terminate).

All three issues were described using a triangular distribution.

S5 Groundwater sources at gradual risk of pollution

Nine issues were included in this category, used to describe the different phases (each phase being an AMP period) of possible loss of deployable output due to nitrates and pesticides.

S6 Accuracy of supply side data

All sources were grouped into six different categories in accordance with the level of confidence attributed to the source's output data.

The six categories identified were:

- Licence constrained (with an uncertainty of +5% / -2% of Deployable Output, DO)
- Aquifer constrained (with an uncertainty of +/- 2% of DO),
- Infrastructure constrained (with an uncertainty of +/- 5% of DO)
- Abstraction licence compliance (with an uncertainty between 0 and 3% of DO)
- Reservoir yield uncertainty (with volumes at risk being identified from analysis from -9.1 up to 22.7 Ml/d, with a most likely of 4.5 Ml/d). The reservoir yield uncertainty was applied to average headroom only, as it is not applicable to peak.

A triangular distribution was used to describe the uncertainty in each of the above cases.

S8 Impact of climate change

Two issues were included in the headroom assessment, one to cover uncertainty over the impact of climate change on surface water resources and one for the possible impact on ground water resources. The climate change analysis we undertook (see Section 4.9) derived 11 possible impact values, from the spatially coherent projections scenarios, each with equal probability of occurring. These scenarios were modelled in the headroom assessment using discrete distributions of 11 values of equal probability of 1 in 11.

S3 Time-limited Licences

In 2011/12 the Environment Agency granted a variation to our Wimbleball licence to increase the annual limit from 11,615 Ml/a to 14,917 Ml/a. The additional 3,302 Ml/a (daily equivalent of 9.0 Ml/d) of licence for Wimbleball is time limited until 31 March 2023 (the base licence of 11,615 Ml/a has no time constraints). After discussion with the Environment Agency, we believe there is a small risk that this licence will not be renewed. Therefore, we have represented uncertainty in the volume with a triangular distribution between 0 and 9 Ml/d, with a most likely volume reduction of 0 Ml/d.

6.2 Headroom results – dry year annual average

Figure 6.1 shows the results from the uncertainty analysis for the dry year annual average condition and our selected target headroom profile. Target headroom for the base year, and the end of each AMP period for the 25-year plan is given in Table 6.1 alongside the corresponding uncertainty percentile for the level of headroom.

The target risk profile was determined by selecting the 85th percentile in the 2020/21, and then calculating the associated headroom value (30.21 Ml/d) as a percentage of the dry year annual average distribution input for the year (347.18 Ml/d), i.e. 8.7%. We selected the 85% percentile from 2020/21 to accommodate the some of the step-increase in headroom in the early part of the planning period. By fixing target headroom at 8.7% of distribution input through the planning period the uncertainty percentile decreases with time meaning that a greater level of risk is accepted in the future. In absolute terms our headroom allowance declines marginally through the planning period. This approach is broadly consistent with our last Water Resources Management Plan, which derived the target headroom profiles as 6.9% of distribution input throughout the planning period, and accepts

The most notable changes in the headroom profile occur in the earlier years of the planning period between 2018/19 and 2024/25, due to the start of risks associated with bulk transfers, and in 2040/41 due to uncertainties in groundwater quality, specifically nitrate risks.

Figure 6-1: Baseline dry year annual average headroom uncertainty

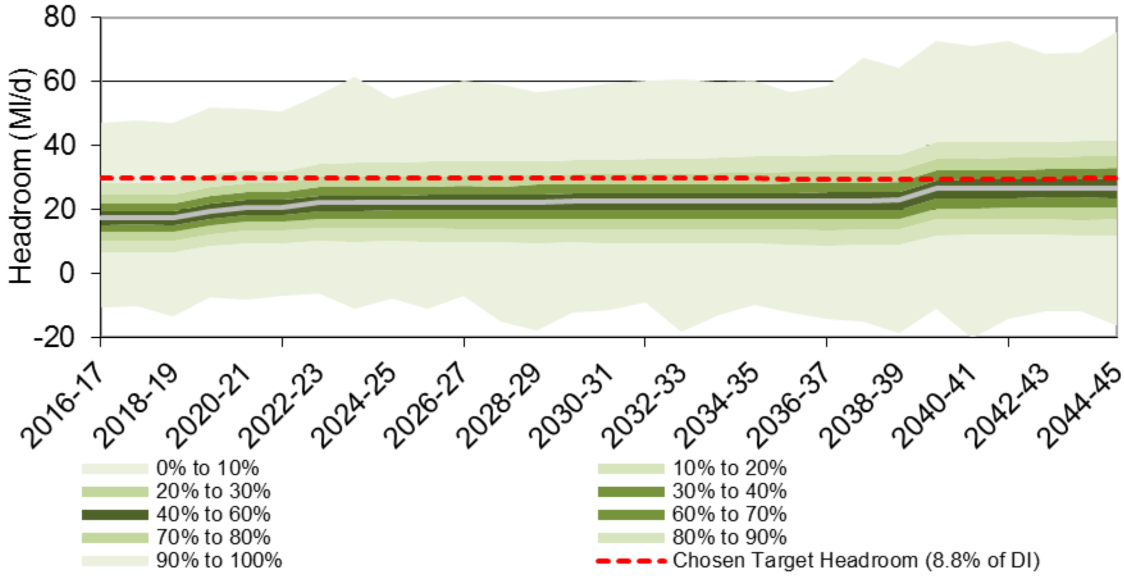
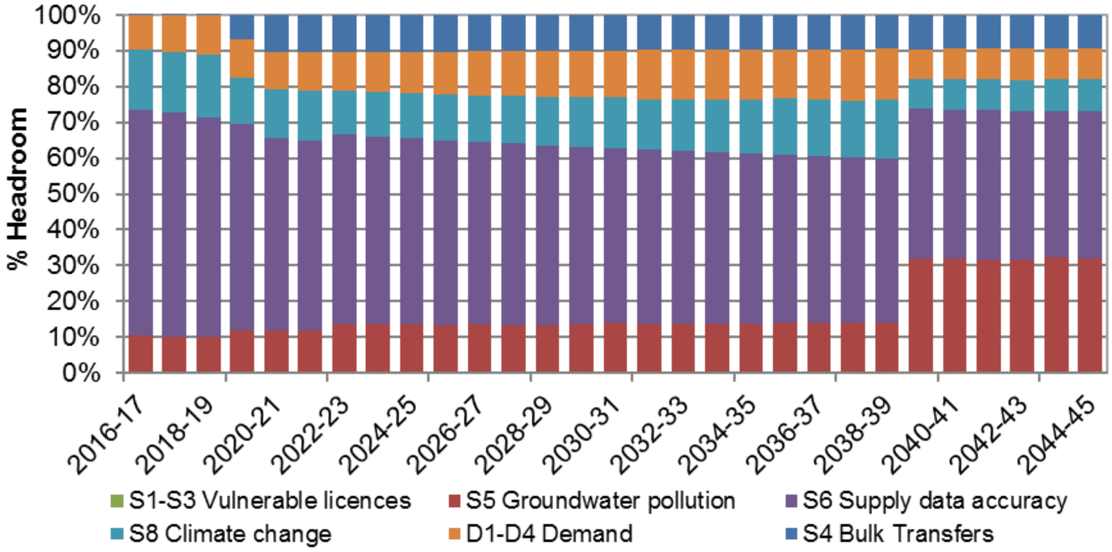


Table 6-1: Dry year annual average headroom uncertainty and risk profile

	2017/18	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Percentile uncertainty	93%	88%	79%	77%	75%	62%	61%
Baseline target headroom (Ml/d)	30.38	30.24	30.14	30.21	30.21	30.18	30.29
Final planning target headroom (Ml/d)	30.38	30.24	29.01	28.80	28.56	28.31	28.22

Figure 6.2 shows the relative contribution of each of the sub-components to the overall target headroom figure for the selected percentile in every year. It can be seen that at the start of the planning period the component accounting for the majority of the allowance is the supply side data accuracy, i.e. uncertainty around the deployable output assessments and potential meter errors, which declines over the planning period. The contribution of groundwater pollution increases over the planning period, most notably in the final 6 years. The contribution of bulk transfers and climate change initially increase, but decline slightly over the planning period, as is the case for demand components.

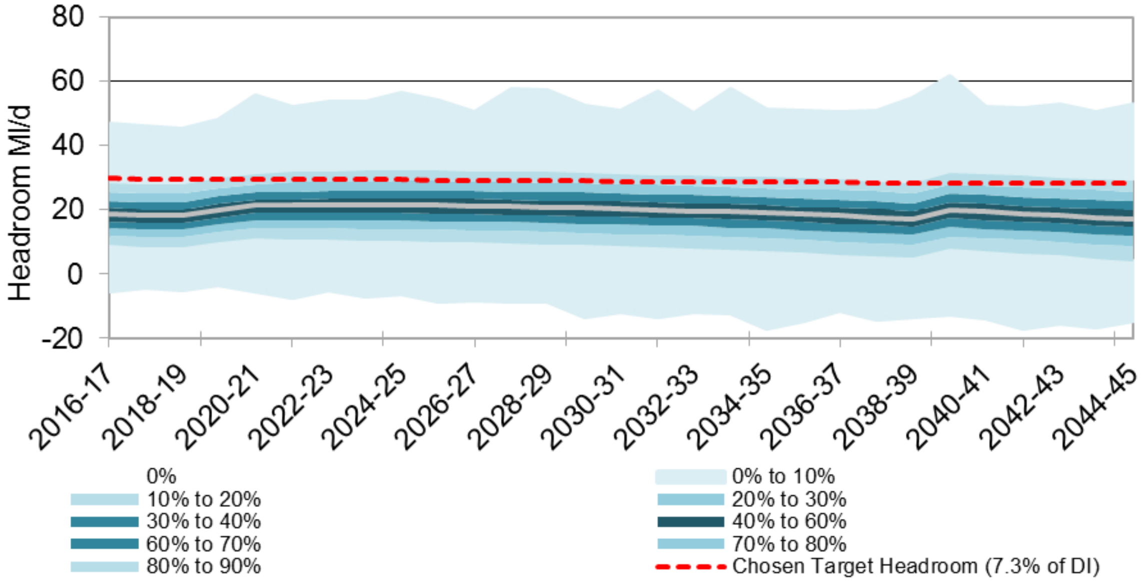
Figure 6-2: Dry year annual average target headroom allowance breakdown by component



6.3 Headroom results – dry year critical period

Figure 6-3 shows the results from the uncertainty analysis for the dry year critical period condition and our selected target headroom profile. Target headroom for the base year and the end of each AMP period for the 25-year plan is given in Table 6-3 alongside the corresponding uncertainty percentile for the level of headroom.

Figure 6-3: Dry year critical period headroom uncertainty



The target risk profile was determined using the same approach as the annual average condition – the 85th percentile was sel
ected for 2020/21 and the associated headroom value (30.08 Ml/d) was calculated as a percentage of the 2020/21 dry year critical period distribution input for the year (416.29 Ml/d), i.e. 7.2%. By fixing target headroom at 7.2% of distribution input through the planning

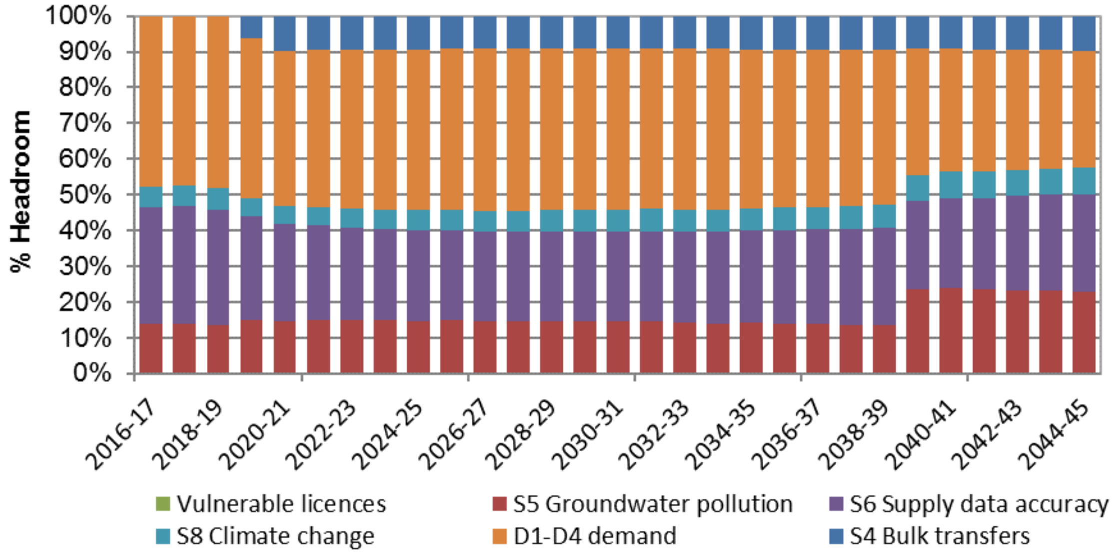
period the uncertainty percentile changes little, given that the step increases in headroom in the early 2020's and 2040/41 are moderated by a declining headroom trend. In absolute terms our headroom allowance declines marginally through the planning-period.

Table 6-2: Dry year critical period headroom and risk profile

	2017/18	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Percentile uncertainty	91%	88%	80%	82%	85%	89%	87%
Baseline target headroom (Ml/d)	30.30	30.16	29.82	29.71	29.56	29.41	29.43
Final planning target headroom (Ml/d)	30.23	30.16	28.80	28.45	28.10	27.77	27.62

Figure 6-4 shows the proportion of the total critical period headroom made up by each component of uncertainty. Demand uncertainty followed by supply-side data accuracy represent the largest components of headroom throughout the planning period, and as with the annual average case, groundwater pollution increases over the plan period, most notably in the final years, as issues associated with nitrates increase.

Figure 6-4: Dry year critical period target headroom allowance by component



7 Baseline balance between supply and demand

The overall balance of the supply system is assessed by comparing the forecast of total water available for use with the forecast of demand (distribution input) plus target headroom. Total water available for use takes into account the deployable output of our sources (less an allowance for source outage and water used by treatment processes) and the net balance between imports and exports with neighbouring companies.

Figures 7.1 and 7.2 show the baseline supply demand balance situation for the dry year annual average and critical period scenarios respectively, key information is also summarised in Tables 7.1 and 7.2.

The Figures and Tables show that we are in supply demand surplus throughout the planning period for both the dry year annual average and dry year critical period scenarios. Figure 7.3 also shows the change in surplus throughout the planning period for both scenarios.

Figure 7-1: Baseline annual average balance between supply and demand

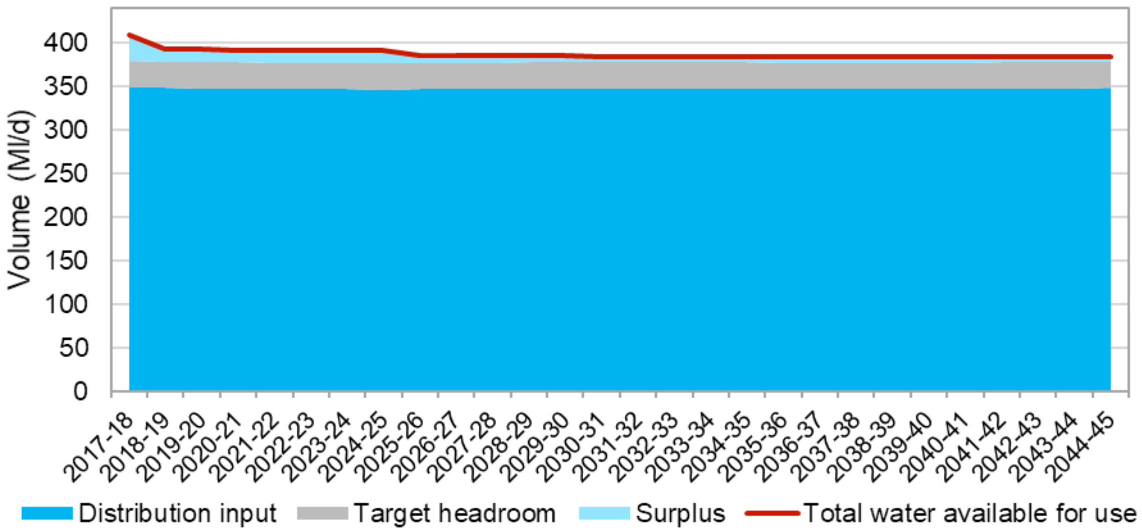


Table 7-1: Baseline annual average balance between supply and demand

Dry Year Annual Average	2017/18	2019/20	2044/45
Distribution input (Demand)	349	347	348
Total water available for use (Supply)	409	393	384
Target headroom	30	30	30
Supply-demand balance	**+29**	**+15**	**+6**

Under both planning scenarios, there are two step-reductions early in the planning period, associated with confirmed sustainability reductions. Following these reductions, and a reduction in total imports from 2025, the annual average scenario surplus is relatively flat, with a reduction of ~2 Ml/d over the remainder of the planning period; the critical period surplus grows from ~22 Ml/d in 2025/26 to 27 Ml/d by 2044/45.

Figure 7-2: baseline critical period balance between supply and demand

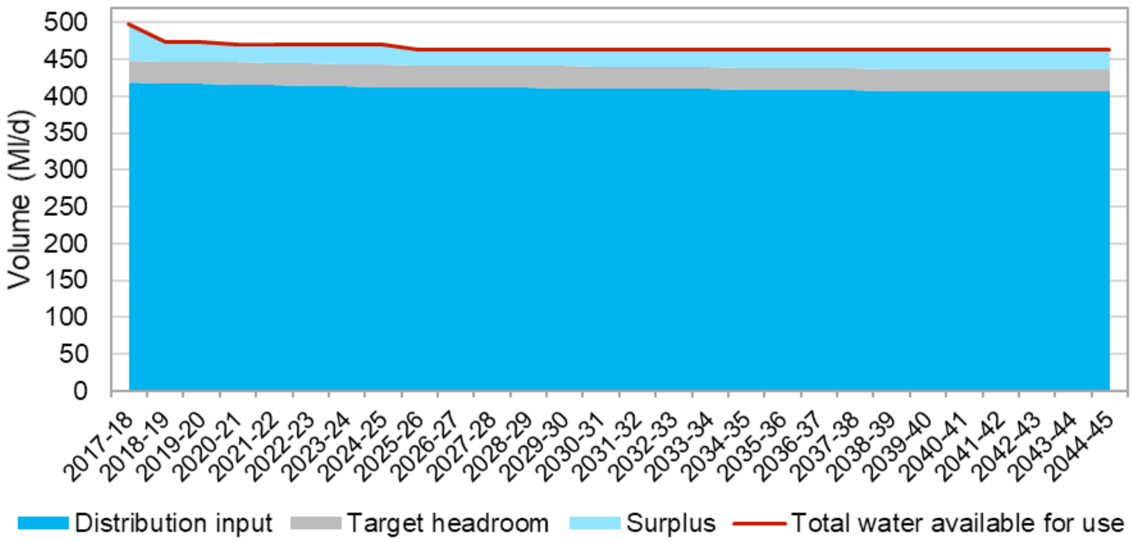
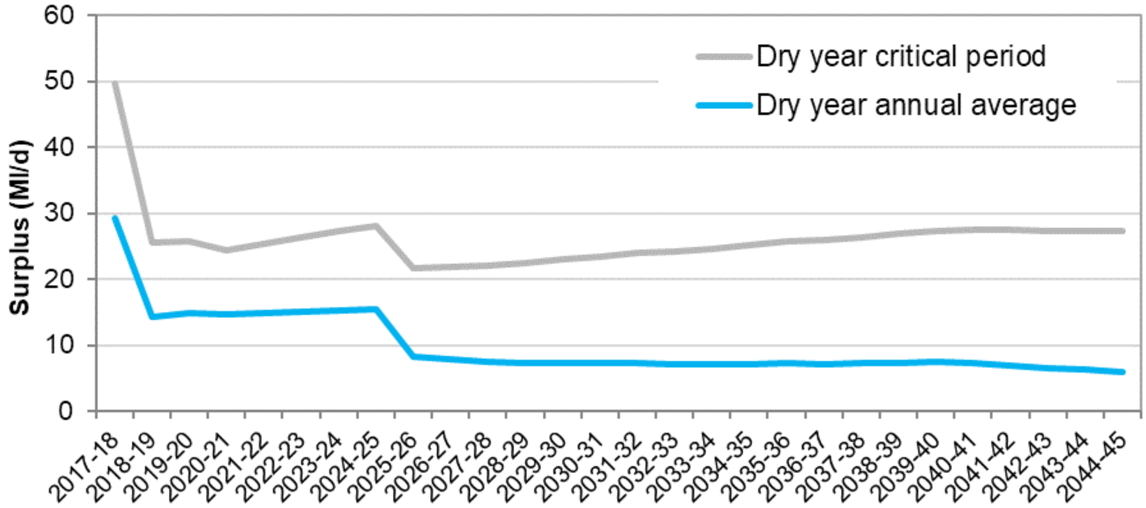


Table 7-2: Baseline critical period balance between supply and demand

Dry Year Annual Average	2017/18	2019/20	2044/45
Distribution input (Demand)	418	417	407
Total water available for use (Supply)	498	473	464
Target headroom	30	30	29
Supply-demand balance	**+50**	**+26**	**+27**

Figure 7-3: surplus over planning horizon for planning scenarios



7.1 Changes between WRMP14 and WRMP19 baseline forecast

A comparison between the WRMP19 baseline forecast and the WRMP14 final plan forecast shows the following changes:

- **Household population is higher than planned** – Our household population forecast for WRMP19 is described in Section 5.4 this is based on the latest information available from local authorities and national datasets. It is accepted that there are uncertainties in any forecast of population growth and this is demonstrated in section 5.4.2 and in Figure 5-13. We use the best available information at the time of preparing our WRMPs every five years, but it is reasonable to expect a difference between WRMP14 and WRMP19 forecasts. In addition, and as described in Annex A, we have updated our understanding of household and non-household populations based on national statistics, customer occupancy survey, and a study undertaken to understand hidden and clandestine population.
- **Metering penetration lower than planned** – the number of properties suitable for being metered under the change of occupier programme is lower than forecast at WRMP14. We have learned from this, and our ongoing experience of implementing the change of occupier programme, and updated our metering forecast for the draft WRMP19 plan accordingly (Section 5.5.4). This was also explained in our Annual Review of WRMP14 (submitted to the EA June 2018)
- **Distribution input is 5% higher than planned –** the distribution input is higher than forecast in 2014, despite achieving our leakage target during the 2015-2018 period, and water efficiency scheme delivery. It is difficult to explain this trend (Figure 5-2), which is partly explain by lower meter penetration than forecast in WRMP14. However, the trend also appears in our measured and unmeasured consumption monitor, and therefore appears to reflect increased customer consumption over the past few years.

8 System resilience assessment

Water supplies and sewerage services are seen as basic requirements, and providing resilient water services to our customers is not a new issue for Wessex Water. We have consistently taken the long-term view of investing to improve the resilience of our services in line with customer preferences and expectations.

Resilience is the ability to cope with, and recover from, disruption, and anticipate trends and variability in order to maintain services for people and protect the natural environment, now and in the future.

Resilience of critical infrastructure and essential services can be secured through four key strategic components (Figure 8-1):

- resistance to the hazard
- reliability of the asset
- redundancy built in to the systems
- response and recovery when an event occurs.

Figure 8-1: The Four 'R's of Resilience

We take resilience and business continuity seriously and consider all four strategic components in managing risk and ensuring a resilient service for our customers.

Resilient services is one of the stated priority areas in our recent strategic direction statement as we look forward to 2020- 2025 and beyond (Figure 8-2), and our proposed strategic resilience outcome is: 'High quality, reliable and secure services to customers and the environment in the face of acute shocks and gradual stresses'.

Figure 8-2: Resilience services is one of the key priorities of our strategic vision[79]

Resilient services

Action points:

We will annually assess our resilience in relation to our business, assets, services and the wider environment.

We will set targets to ensure that objectives and working practices are aligned, and make sure we learn from events.

We will identify further opportunities to work at a wider catchment level to increase the resilience of our resources.

We will also:

- actively promote and assist changes in customer behaviour that can add resilience to our services and to the environment
- develop our risk management processes to facilitate targeted investment in the areas at greatest risk now and in the future
- engage with our customers to understand their resilience priorities and target our investment to meet them
- invest in up to date cyber security systems
- improve incentives for developers to build in greater resilience at a local level
- work with flood risk authorities to share data and plans, and protect our assets from flooding
- ensure that our future water resources plans have adequate headroom and allowances for population growth and climate change
- form partnerships with neighbouring companies and other organisations which have an impact on our water catchments, to build resilience into our services and to the ecosystems that provide our resources.

Outcome:

High quality, reliable and secure services to customers and the environment in the face of acute shocks and gradual stresses.

In this section, we consider key areas of resilience planning and investment, and as part of our ongoing resilience planning and investment, have considered the list of hazards considered in The UKWIR (2013) Resilience planning: good practice guide[80].

8.1 Resilience planning and investment

The resilience of essential services is important for government, regulators and customers alike. They want to know that our services will be provided during acute, disruptive events, or in the face of more gradual long-term changes. In March 2016 Defra set out a resilience road map 'Enabling resilience in the water sector' and through the Water Act 2014 Ofwat was given a new primary duty to 'further the resilience objective'.

The focus on resilient services has been heightened by challenging weather in the last few years. There was major flooding in summer 2007 in Yorkshire and Gloucestershire and in the north-west in 2009. Similarly cold weather at the beginning and end of 2010 caused pipe bursts and big increases in leakage, most problematically in Northern Ireland. Prolonged dry

[79] https://www.wessexwater.co.uk/About-us/The-company/Publications/Our-strategic-direction/

[80] UKWIR (2013) Resilience planning: good practice guide summary report. Report Ref. No. 13/RG/06/2

weather from autumn 2010 to spring 2012 led to water supply restrictions in the south-east, followed by the wettest summer for a century. In the long term, weather events previously regarded as unusual are likely to occur more frequently due to climate change.

Our current customer research suggests that in general customers have a low appreciation for future risks and the need to build resilience in to the water infrastructure. Customers expect water companies to be planning for the future as a matter of course (see Section 9.2 for further details).

Due to planned timely investments we have not had to impose any restrictions on water use (i.e. hosepipe bans) since 1976 and have kept leakage under control throughout recent cold winter periods.

As part of the way we manage risk and have already implemented a programme to protect critical assets and improve security of supply. We continue to assess the resilience of service to our customers against a wide range of hazards and threats to ensure we deliver against customer and stakeholder expectations.

8.2 Drought resilience

Resilience to drought events is at the core of the water resources planning process. The Defra guiding principles for the development of the water resources management plan and the Environment Agency's water resources planning guidelines place increased emphasis on drought resilience, and state that plans should be resilient to historical events, and future events that could be reasonably foreseen, as reflected in the reference level of service (Section 4.9).

Our planning for drought resilience is set out in two documents: the drought plan and the water resources management plan. The two plans share the same broad objective of maintaining a secure and sustainable supply of water for customers, but focus on different aspects of drought resilience. The water resources management plan is a long-term strategic plan to ensure a sufficient balance between supply and demand in the long term, and therefore focusses primarily on the redundancy of the system to cope with drought. The drought plan is a tactical document that set out triggers and measures in response to drought events, and therefore primarily focusses on the response and recovery aspects of drought resilience.

Our latest drought plan was developed and submitted to Defra in March 2017; public consultation on the plan was undertaken in the summer of 2017; and we submitted our statement of response and draft final plan in October 2017.

New for this water resources management plan is the requirement to demonstrate the links between this plan and our drought plan, by setting out how deployable output combines with drought measures to maintain a secure supply of water under a range of drought events. This is documented in Table 10 of the Water Resource Planning Tables.

We have considered drought resilience in more detail as part of developing a 'resilience tested plan' by testing our final supply-demand balance under a range of drought scenarios (Section 10).

8.3 Strategic supply grid and inter-company resilience

An example of our long term resilience planning and integrated resilience approach has been the development over the last two business review periods of our strategic integrated water supply grid that we will complete in 2018 (Figure 8-3).

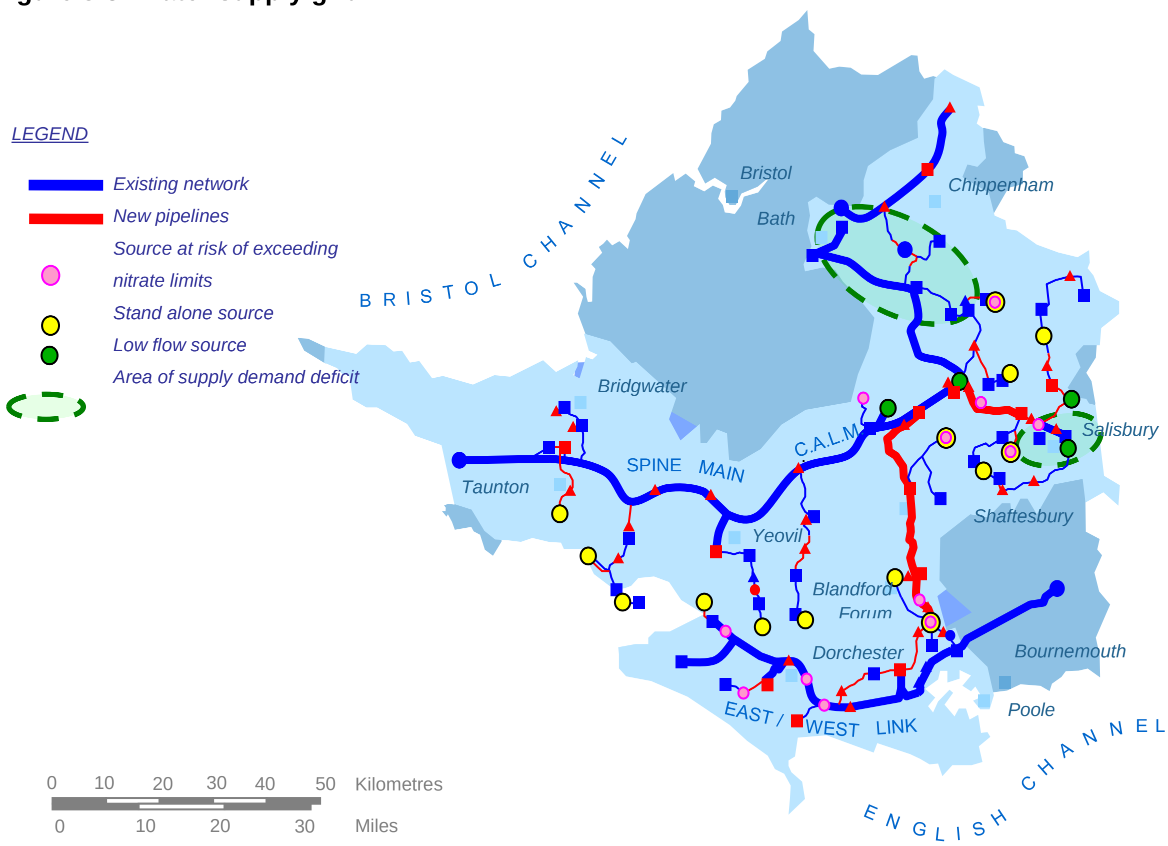
There was an increasing risk to customers' supplies due to a number of issues including:

- standalone sources
- deteriorating water quality
- source reductions to improve low flow rivers
- localised increases in demand.

The development of the grid was the most cost beneficial way of tackling these multiple challenges and improving supply security. The result is that there is only one significant supply area that cannot be fully supported from multiple sources.

With the grid system in place and the current forecast supply demand balance in the region, we are now potential donor region with a relatively robust drought resilience compared with other neighbouring regions.

Figure 8-3: Water supply grid



The development of the grid has also enabled the opportunity to provide additional resilience by connecting with neighbouring water companies to provide support during emergencies.

An example of this is the resilience supply agreement with Bournemouth Water made possible with the construction of a new control monitoring and treatment works at Canford Bottom (See Annex K for a schematic map). This allows the transfer of up to 10 Ml/d between the two companies with up to 20 Ml/d short-term transfer in emergency thereby improving the local resilience in the Poole and Bournemouth area. The scheme has additional operating and resilience benefits for Bournemouth Water linking their Bournemouth and Christchurch areas utilising one of our existing water mains.

8.4 Grid optimiser

To ensure our integrated water supply Grid is operated in the most efficient and resilient manner we invested in a closed loop control system, the Grid Optimiser. The Optimiser manages the Grid semi-autonomously by interpreting a series of inputs and constraints to ensure consistency and quality of supply whilst managing cost. The Optimiser models the operation of the Grid and the demand placed upon it up to 72 hours in advance, repeating this modelling at least hourly to account for potential operational or customer demand changes. This unique approach allows a level of resilience understanding that was not available previously and allows operational teams to test site outages and their impact across the region in a safe modelled environment. The optimiser automatically recalculates the best way to operate the network to mitigate an outage. All of this can be carried out off line as a proof of concept and then converted and used during real outages ensuring a well-planned resilient operation. The optimiser improves the resilient operation of our water supply system.

8.5 Resilient catchment partnerships

As well as investing in our assets we also invest in our people and processes to maintain and improve our resilience. An example of this is that over the last decade, we have created a team of agricultural advisers who work with farmers and other partners to reduce the risk of deteriorating raw water quality. This helps to control and reduce the levels of nitrates and pesticides that reach our boreholes and reservoirs, which in turn means we can avoid expensive additional water treatment. This approach is more sustainable and by improving the natural resilience of the ecosystem it is providing increased resilience at least cost.

Across the Wessex Water region we are working in partnership with organisations and individuals to protect and restore the water environment as a part of the Catchment Based Approach. We recognise that multi-sectoral problems require multi-sector solutions.

The Catchment Based Approach is a way of working at a river catchment scale with partners to improve the water environment for wildlife and people. By working together, the Catchment Partnerships aims to:

- share local knowledge and expertise
- identify the local challenges
- deliver cost effective solutions with multiple benefits.
- Improve the natural resilience of the catchment

We favour an innovative catchment programme to improve the water environment with catchment management at its centre and much more integrated management of land and watercourses.

The outcome of investing in a catchment based approach is improvements in the resilience of the natural ecosystem of the catchment that improves resilience not just for Wessex Water but society as a whole.

8.6 Resilience maturity assessment

Water services are made up of a complex set of operational, corporate, and financial systems. They are also linked with a wide range of other systems including the broader natural environment, social systems, the economy and other infrastructure systems. Impacts on any of these related systems can impact water and service delivery.

The threats to service and expectations with regard to quality of service are continually evolving and therefore our approach to service resilience evolves in line with that dynamic context. To meet our commitment to resilient services we implement policies, systems and processes which provide us with an integrated, business-wide insight into the potential causes of those *'shocks and stresses'* and this enables us to reduce the risk of service disruption to an acceptable level which reflects the expectations of our customers.

To enable us to manage our service risks more effectively and for embedding service resilience best practice across Wessex Water we have developed a resilience maturity assessment approach based on the structure and principles of BS65000 the standard for Organisational Resilience. The maturity framework is divided into six key areas and performance assessed on a six-point scale ranging from 0-Immature to 5-Enhanced using pre-defined assessment criteria (Figure 8-4).

Figure 8-4: Resilience maturity framework - key areas

The maturity assessment:

- defines a corporate resilience outcome for the business
- sets out an annual maturity assessment and assurance process
- identifies principal threats and how they are managed
- promotes integrated approach across core functions
- aims to drive continuous improvement, through targeted, proportionate action to support desired outcome.

The resilience maturity assessment provides a key tool in ensuring that we have the appropriate processes and policies in place to provide an enhanced resilient service and reduce the risk of service shortfalls. The maturity process ensures that we have a resilience focus across the whole of the business that leads to the identification of improvement opportunities and supports the continuous improvement of service resilience.

8.7 Operational hazard assessment

In line with customer expectations, we have assessed the potential risk to our water supply system against a number of potential hazards.

A multiple hazards approach, developed by United Utilities, was used to provide an initial high-level resilience assessment of our water supply systems. The assessment gives each possible point of failure a risk score, which relates to the likelihood of failure, the consequence of failure and the mitigation control factors (Table 8-1).

This was used to prioritise key threats where additional mitigation may be beneficial. This highlighted that our Maundown treatment works was more at risk than our other sources to low probability but high consequence events and required further investment to improve its resilience.

Table 8-1: High level resilience assessment

Source	Type	Capacity Ml/d	Flood		Critical Asset Failure		Raw Water Quality Risk		Malicious damage		Telemetry / Control System Failure		Total System	Risk Category
Maundown	SW	80	395	🟢	23,838	🟡	8,154	🟢	944	🟢	14,899	🟡	48,230	🟡
Durleigh	SW	28.5	4,974	🟢	3,891	🟢	5,324	🟢	308	🟢	6,573	🟢	21,071	🟢
Sutton Bingham	SW	18	6,241	🟢	1,847	🟢	6,680	🟢	866	🟢	8,247	🟢	23,880	🟢
Ashford	SW	15	5,369	🟢	1,589	🟢	5,747	🟢	443	🟢	7,095	🟢	20,243	🟢
Corfe Mullen	GW	33	9,240	🟢	2,735	🟢	5,861	🟢	1,282	🟢	6,105	🟢	25,223	🟢
Sturminster Marshall	GW	30	294	🟢	2,486	🟢	7,992	🟢	1,166	🟢	5,550	🟢	17,488	🟢
Empool	GW	24	235	🟢	1,989	🟢	6,394	🟢	833	🟢	4,440	🟢	13,890	🟢
Chitterne	GW	20	5,600	🟢	1,658	🟢	7,104	🟢	694	🟢	3,700	🟢	18,755	🟢

SW = surface water; GW = groundwater

8.8 Critical assets

The grid has enabled most of our sources and treatment works to be linked and supported by the wider network, allowing for treatment works outage, although the analysis suggests that there are continuing improvements to be made to the water supply system to optimise the resilience risks.

Further discussion of critical assets is presented in Annex K.

8.9 Flood resilience

As part of the requirements of the Security and Emergency Measures Direction our water treatment sites were initially screened for flood risk as part of the 2009 business plan development to determine where further analysis was required. Twelve sites were identified as flood vulnerable sites, and these underwent a detailed flood risk assessment, which included topographical surveys, river modelling and further site inspections. This modelling took into account climate change with a standard of 20% increase in fluvial flow. From the results of the modelling work, flood mitigation works were proposed for each site. For ten sites this involved only minor improvements and two sites required significant flood protection measures. These were addressed by flood protection investment works completed in 2012.

In early 2016, Defra requested data from us to inform the National Flood Resilience Review looking at assets serving more than 25,000 population in greater detail. The flood resilience of our 28 water treatment works of this size was based on:

- the Environment Agency's flood maps for 1 in 50 and 1 in 100 year flood events

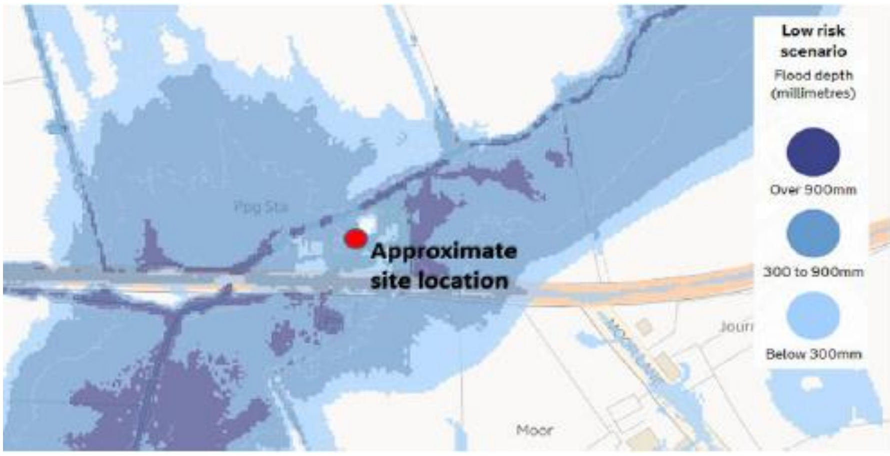
- the flood risk assessment work undertaken to support the 2009 and 2014 business plans
- discussions with operational staff of sites with a history of flooding.

The review highlighted that seven sites would be affected by flooding with regard to the output from the water treatment works, not through damage of assets, but rather prevention of access to site, and shut-down of operations due to raw water turbidity detection or flood level sensors onsite.

Greater focus is being placed on critical infrastructure and their associated resilience. Therefore, all of our larger sites and those highlighted at risk of flooding were subject to review to a 1:1,000 year flood event, termed an 'Extreme Flood Outline'. The flood risk assessment conducted at each site assessed the source of flooding from potential sources including impacts of climate change up to the 2050 horizon for the following return periods:

- fluvial flood risk (1 in 100 year, 1 in 1000 year event)
- tidal flood risk (1 in 200 year, 1 in 1000 year event)
- surface water flood risk (1 in 30 year, 100 year and 1000 year event)
- risk of flooding from reservoirs.

Figure 8-5: Example surface water flood map



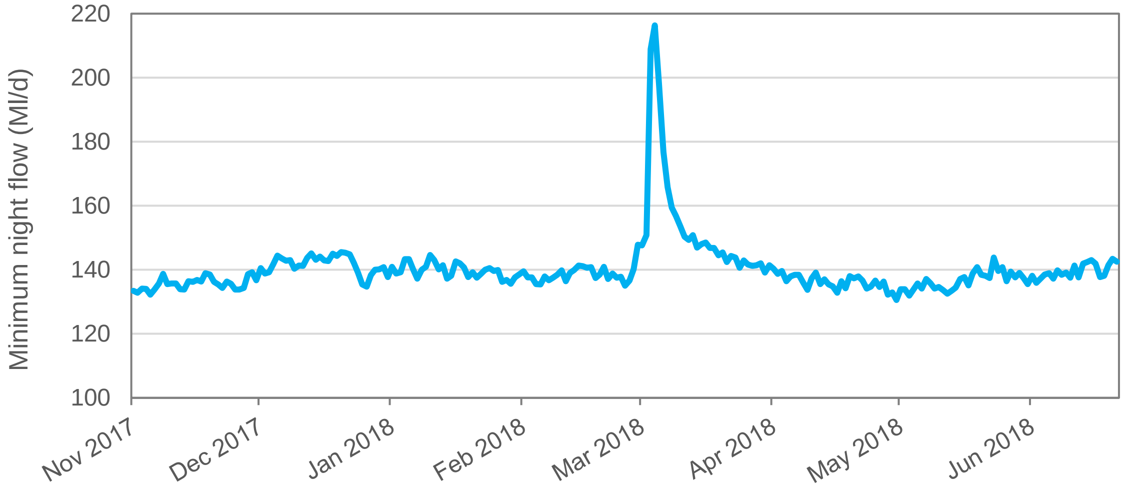
A hierarchy of mitigation methods have been used to assess ways of improving the resilience to an extreme flood event and any investment is subject to an appropriate cost benefit assessment.

8.10 Freeze-thaw resilience

Cold winter weather conditions can lead to short-term increases in leakage related to pipes freezing and bursting. During a winter period we may experience episodes of severe winter leakage breakout but by reacting rapidly we are able to recover our leakage position so that our supply position is not compromised.

Prior to 2018, we last experienced a significant freeze thaw event during the Christmas period of 2010/11. In March 2018, we experienced the so-called "Beast from the East" weather event, that brought an extended period of freezing conditions to much of the UK, and red weather warnings of severe snow and ice to our region. At the end of the cold snap there was rapid ground thawing, which led to a significant 55% step-increase in minimum night flows from approximately 140 Ml/d to a peak of 216 Ml/d on 4 March 2018 (Figure 8-6).

Figure 8-6: Minimum night flow resulting from the freeze-thaw event in March 2018



Baseline minimum night flows relate to legitimate overnight water use by homes and business and small volume leaks that may be difficult to locate. Changes to minimum night flows are therefore indicative of changes to the instantaneous leakage rate.

We dealt with around 200 weather-related leaks and gave advice to more than 1,500 customers who had problems in their home, indicating that the majority of the rise was related to leakage from customer pipes and plumbing which could be quickly isolated and fixed. The increase was reversed dramatically after just a few days, and by 4 April minimum night flows were back down to pre-thaw levels.

Across England and Wales, the event left more than 200,000 customers without water for more than four hours[81]. We managed the event without any material disruption to our services and with no customer experiencing any supply interruption that lasted longer than three hours. This was achieved through:

- prior investment (including our water grid)
- by forward planning in advance of the cold weather and communications with customers
- staff who were willing to go the extra mile for customers following the activation of our adverse weather continuity plan
- the active involvement of the executive team, in particular through chairing the incident response team.

8.11 Resilience from malicious damage

We have made significant investment to provide physical security protection for our water supply infrastructure and comply with current advice from the Centre for the Protection of

[81] Ofwat (2018) Out in The Cold: Water companies' response to the 'Beast from the East'.

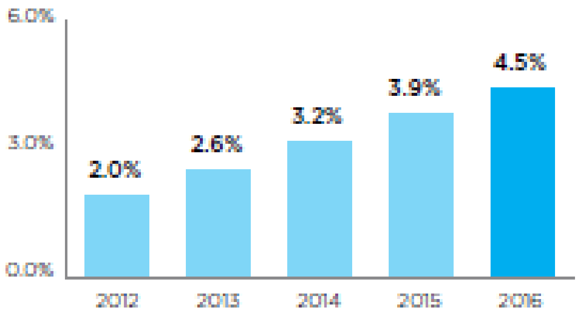
National Infrastructure (e.g. Figure 8-7). We expect no additional investment requirements to manage the physical threat to our assets.

Figure 8-7: Typical physical protection barrier

The dynamics of malicious threats, however, are changing. Increases in information dependency and interconnectivity, which has brought significant benefits in managing our supply system, has increased the risk and potential impact of a software cyber-attack, as we have reduced the scope for standalone and manual operation of the water supply system. The threat extends beyond our infrastructure and could result in significant reputational damage and reduce both investor and customer confidence.

Over time, exploitation of cyber vulnerabilities in the UK's water sector will become more likely as will the potential for more disruptive consequences. As the threat increases, so too must our ability to defend our-self. This makes it all the more important that we continue to improve and invest in our cyber security to ensure we continue to provide a resilient customer service.

Figure 8-8: Benchmark survey of % of IT spend on information security



The amount of money being spent on IT security has been increasing in recent years above its historic expenditure level and it is likely to continue to increase going forward.

8.12 Asset reliability and maintenance

A key priority for customers is to maintain the quality, reliability and resilience of water supply services. Customers want services to be delivered in a sustainable way by reducing our carbon footprint and maintaining our assets for future generations.

We follow Common Framework principles, with risk management embedded in day to day decision making. Our asset management framework, which includes asset strategies and asset group plans, provides business-as-usual asset management processes aimed at ensuring our strategic objectives are achieved.

We aim to strike the optimal balance between maximising performance, long term asset stewardship and managing risk, subject to affordability constraints. We therefore use a mix of asset renewal and refurbishment strategies depending upon the asset type and criticality of the asset.

Our business as usual asset management framework and the findings from bottom up assessments and life cycle analysis have been used to formulate a long term investment programme for our key sites. These are refurbished or renewed as part of a long term proactive strategic programme.

For some assets such as boreholes, dams and service reservoirs we undertake proactive cyclical maintenance inspections which lead to asset maintenance and refurbishment programmes. For other assets we use a run to fail model resulting a set of reactive capital maintenance tasks. The result is the delivery of a resilient supply service to customers in a cost efficient manner whilst maintaining an appropriate level of risk.

8.13 Improving resilience through real-time monitoring

Our long term vision is one of continual innovation and specifically to include more real-time monitoring and control in our business operations to provide a more resilient service to customers.

The PRISM visual platform is the core network management tool used to understand the operation of our assets. The regional telemetry system collects data, alerts and alarms from our distributed assets providing near real time information. PRISM converts this information into an accessible format and enables the business to develop decision support capability by highlighting the most important and relevant information and providing an early warning of supply system issues. PRISM enables a level of logic to be applied to alarms to bring together disparate signals into a higher level overview of network operation so the most important alarms are highlighted enabling root cause analysis and ensuring efficient response and recovery to any asset failure and minimising customer service impacts.

8.14 Customer resilience

Supporting customers to better understand their water use and links with their local water environment can help reduce household demand. Lowering demand leaves more water available to share between our other customers and improves environmental resilience. It also enables the accommodation of growth and drought without the need to develop more resources.

Research indicates that our customers are keen to play their part in the resilience of their local water system (Section 9.2). However, our research and research from other bodies indicated that many customers do not fully understand how their water use behaviours can affect the wider system, the environment and the water cycle. Therefore, helping customers understand the role they play in reducing their demand is a core part of our future strategy.

One of our strategies to engage customers with their water use is our Home Check programme. During a Home Check visit a technician guides the customers through their water use, gives water efficiency advice and fits water efficient devices appropriate for the householder. To date (up to November 2017) we have delivered over 10,000 home visits. We plan to continue this service from 2020-25 targeting 8,500 properties a year (Section 9.7.1).

Our website contains a water use calculator which helps customers to understand how much water they use and offers personalised advice on saving water and devices suitable for their home. The calculator is being developed to enable customers to compare their usage with other similar households in their community and responses to questions about their water use will enhance our ability to offer personalised advice.

We provide a free educational service for schools and to education centres across the region as engaging future generations with water efficiency and the value of natural resources is key to future resilience. At present around 150,000 children participate in the sessions we offer every 5 years.

In 2017, Wessex Water's annual 'town tour' programme focussed on water saving in the garden by providing information on water butts and drought tolerant planting. The summer campaign carried the social media hashtag #everydrop and included the launch of a video to raise awareness of the links between water, environment, our daily lives and why it is important to protect and conserve.

We are also looking at how we can work more closely with whole communities to allow customers to participate in our services and not just receive them. We plan to run a citizen-themed project starting as a town specific trial and look at enhanced community and customer engagement. The project will seek to strengthen customer understanding of their local water environment and water systems and take a multi-behavioural approach rather than our more commonly used approach our engaging on a single issue at a time. The programme aims to engage with customers on topics relating to the local water environment, metering, water efficiency, water quality, sewer misuse and affordability.

8.15 Resilience summary

This section has described the resilience of our system and services in relation to a wide range of potential threats and hazards. Our high levels of resilience are related to the investments we have made in infrastructure and asset management, technology and data management, and catchment partnerships and solutions.

The risks we face are continually evolving and providing resilient services remains a priority area for us and our customers.

Our future strategy for continued improvements to the resilience of our assets and systems include:

- Asset resilience improvements to our largest WTW to reduce the risk of failure by minimising the single points of failure estimated at £5.3m.
- Continuing to invest to improve cyber security.
- A programme of work to reduce supply interruptions to the industry upper quartile, alongside demand management proposals to ensure we meet the requirements of our Water Resources Management Plan.
- Continued partnership working to provide environmental resilience in the most sustainable way.

9 Options and future investments

9.1 Drivers for investment

The combination of our supply, demand and headroom forecasts predicts that we will have a surplus of resources over demands for at least the next 25 years (see Section 7). In the absence of a supply demand balance deficit a 'solution' is not required as no deficit exists. We do not however intend to stand-still, despite our surplus situation, and we have considered options that:

- help maintain the positive supply demand balance,
- achieve Government and customer aspirations,
- improve resilience,
- are better for the environment
- and/or increase our efficiency.

Key considerations that have influenced our strategy for the next five years and beyond are summarised in the sections below.

9.2 Customer preferences and willingness to pay

Section 2.2 outlined the range of customer research activities that have been used to inform this Plan. This section describes the findings from the research summarised by theme.

9.2.1 Saving water and money

During qualitative focus groups with customers, when discussing areas that should be included in future plans, **promoting water saving** was spontaneously mentioned as important, and an area for greater future emphasis. Specifically, customers mentioned water efficiency advice, smart metering, personalised billing information, leak alerts, subsidised water butts, subsidised water efficient devices, the promotion of new technology and grey water[82] reuse without prompting.

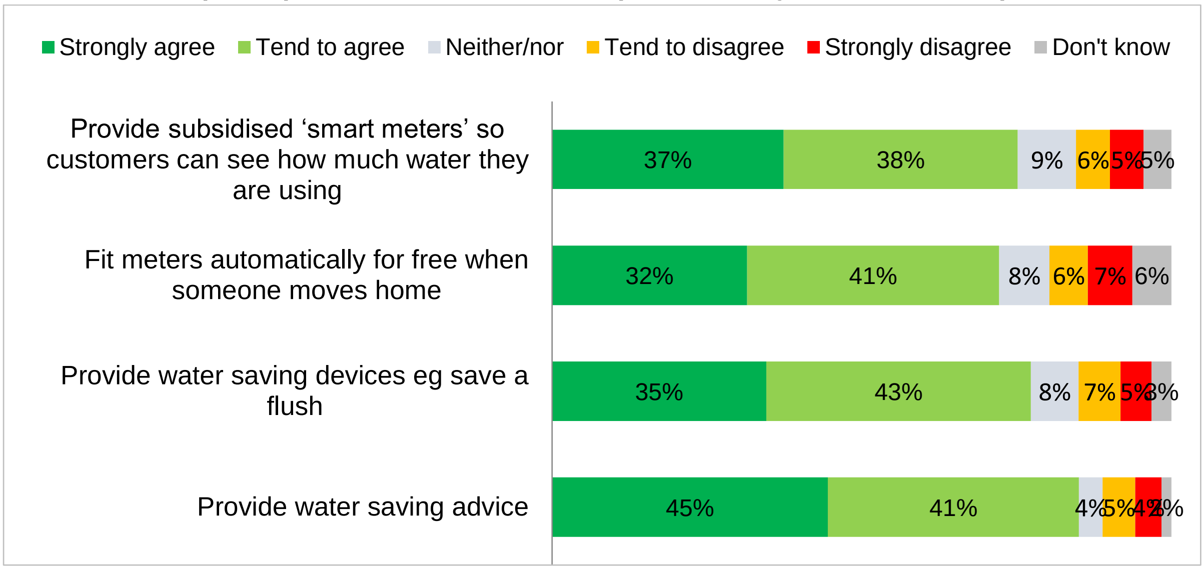
When prompted with the long-term goals set out in our last strategic direction statement, **helping customers save money and water** was consistently rated as one of the most important. Customers are supportive of the idea of being able to control their water bills by using water wisely. Attitudes to metering are however complex; whilst there is support for a continued gradual increase in metering, customers would like to see a greater range of water saving measures to achieve the goal of reducing water usage. Examples include greater use of technology, or grey water. In customers' minds, saving water and saving money are not automatically linked, especially amongst customers without a meter.

Figure 9-1 shows customer preferences for water saving services. All options are viewed positively with the most support (86%) for providing water saving advice – indicating customers' willingness to participate in water saving behaviours to 'do their bit'. Smart

[82] Grey water is wastewater without faecal contamination, i.e. from sinks, showers, baths, washing machines, dishwashers but not toilets. With some simple treatment it can be reused for toilet flushing, garden watering and other non-potable uses.

metering is similarly viewed by the majority (75%) as something we should be including in future plans.

Figure 9-1: Customer preferences on whether various water saving activities should be included in our plans (400 customers from a telephone survey; see Section 2.2)



When customers discussed metering and smart metering in depth within group discussions, the majority preferred the option of a gradual increase of metering rather than installing smart meters for every household. The reasons for this included a dislike of compulsion to take up a meter, and some customers not being clear on the overall benefits of a smart meter regarding water saving.

Evidence from stated preference willingness to pay surveys conducted during 2017 indicated that our customers are prepared to pay for standard metering to become more widespread. The survey estimated that each customer is prepared to pay £0.49 each year for our meter penetration to increase by 1%. Cumulatively this is more than three times as much as it would cost to deliver.

The support for smart metering is less forthcoming, it was estimated that each customer is prepared to pay £0.20 each year for smart meters to be provided to 1% of households. It would not be possible to deliver this for the cumulative value that customer are willing to pay with the costs associated with current smarter metering technology. We anticipate that innovation and new technology will likely change this balance in the future.

In 2016 we launched our Home Check programme and which has now been delivered to over 10,000 homes. The Water Safe qualified plumbers fit water saving devices such as eco-showerheads, repa vir easy to fix plumbing leaks and offer personalised behavioural advice at no charge to the customer. The Home Check programme is very highly valued by customers with an average SIM equivalent score of 4.9 out of 5 and 98.5% of customers rated the service as a 4 or 5 out of 5.

Customers also value the free pack that we have offered all customers since 2009 with many of them saying they look forward to saving money or rating the product as “Excellent”.

Anecdotally, many customers say that the shower timer saw a reduction in the shower times taken by their children and other family members.

There is significant willingness to pay support for water efficiency services in the future – customers are prepared to pay £1.69 for every 1% of households to whom we provide water efficient devices. Cumulatively this equates to being over twice as much as it costs to provide this service in the form of Home Check.

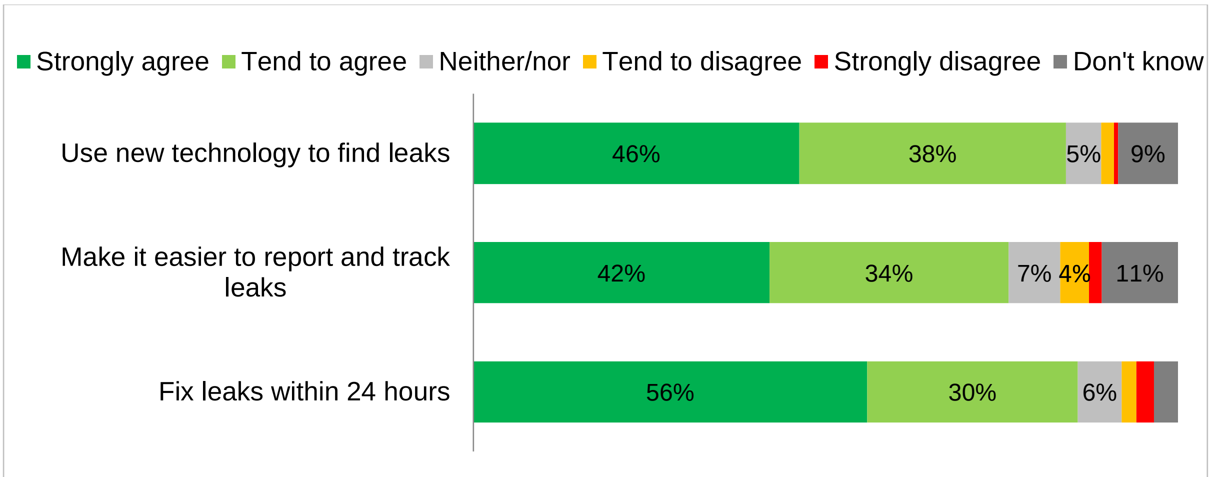
9.2.2 Leakage

Leakage has consistently been rated by customers as one of their top priorities for our business. It can be a complex issue and so we have undertaken two complementary strands of research with our customers in this area in 2016 and 2017 to fully explore attitudes and preferences.

Quantitative research undertaken with uninformed customers to steer our strategic business objectives in 2016 found that when prompted with the overall areas of our work, 69% of customers rate the importance of reducing leakage as 9 or 10 out of 10 (with 10 being 'very important'). Perceptions vary by age though; younger customers are more likely to be satisfied with the current amount of leakage (90% of those under 35 say levels of leakage are satisfactory, compared with 68% of those 55 and over).

When we asked customers how we should improve our leakage performance (Figure 9.2), fixing leaks speedily had the most support (86%), followed by the use of new technology (84%). Making it easier to report leaks to us and track them is also seen as highly favourable (76% support) – which is evidence that customers are keen to participate in services and play their part in leakage management by reporting leaks to us.

Figure 9-2: Customer preferences on whether various leakage activities should be included in our future plans (400 customers from a telephone survey)



When informed about the issues surrounding the 'economic level of leakage' (see Section 5.7.1) and that we are operating significantly below this level, the view that reducing leaks is important is diminished for many customers and the proportion that feel reducing leakage is very important drops from 69% to 39%. The majority of customers (55%) feel Wessex Water should reduce leaks up to the point it costs less than recycling the water, and the remainder (45%) feel Wessex Water should continue to reduce leakage beyond this point.

In 2017 we undertook an in-depth research project focussed on attitudes to leakage when customers are presented with a greater level of information about leakage management, associated costs, the overall water resources situation regarding future demands available supplies and the resilience of services to droughts. Twenty-four customers engaged and participated in the project for over six hours of workshops in two sessions (see Figure 9-3) plus additional deliberative time they spent between workshops discussing issues with family, friends and neighbours for their 'homework' activities.

This in-depth deliberative and co-creative approach enabled us to gain insight into the views of informed customers. The project was facilitated by specialist consultants Populus and their report is available as an Appendix to this Plan[83]. Key findings were:

- Customers trust Wessex Water and have a degree of goodwill towards the company – they accept our expertise and trust our intentions
- Leakage has no direct negative impact on most customers – many could not recall having ever seen a leak or experiencing a service disruption because of one
- Most customers would prefer to see no bill impact resulting from a change in leakage management strategy (but are interested in modest additional investment)
- Once explained, most customers understand and accept the 'economic' reasoning that it can cost more to fix leaks than it costs to produce the water. This makes sound financial sense to most people – as long as they can be reassured that the lost water does not lead to any damage. Customers feel this way because of the trust of Wessex Water and an intuitive sense of the complexity of the problem.
- Leakage is a high priority for customers but not the highest priority and are no more of a priority after deliberation. Bill affordability is frequently more important as are 'hygiene' factors such as the reliability of supply, sewage flooding and taste.
- There are, however, two minority positions at the extremes – do more to reduce leakage (paid for or not by customers) and do less to reduce leakage (i.e. some customers think we should spend less on managing leakage and let it rise up towards the economic level).
- Customers would like to be reassured that there will be continued investment in innovative, technological solutions to better detect and repair leaks. They do not want to see leakage go up, and there is a chance that through better technology leakage will reduce in the long term.
- There was a strong theme of 'customer empowerment' that was identified by this research – customers were keen to see us continue empowering customers with water saving and how to fix their leaks, ideally with subsidies and perhaps specifically targeted for those on low incomes (in this context fixing leaks, refers to 'plumbing losses' within the home i.e. dripping taps and leaky toilets).
- Customers also stress the importance of education of the general public and children on how to use less water to ensure that leakage does not become more of an issue that could threaten the balance between supply and demand in the future – this is

[83] Populus (October 2017). Leakage qualitative debrief.

another example of how our customers recognise the role they can play in the overall water system.

Figure 9-3: Leakage workshop sessions

Through the immersive workshops we developed three different packages of performance commitments around leakage and the efficient use of water which we then tested with uninformed customers – the packages were designed to capture the majority view and the two minority views heard in the immersive sessions. The most popular package was that which combined stable leakage with greater activity to help customers reduce their own use and investment to find cheaper ways to continue to reduce leakage in the long-term.

Our quantitative research techniques however suggested that there is customer willingness to pay for leakage reduction with a 15% reduction close to being cost beneficial.

After the completion of our June 2017 leakage research with customers, Government and regulators (Defra, Ofwat and the EA) set an expectation that companies will reduce leakage by 15% by 2025 and continue to reduce leakage thereafter. In 2018 we therefore undertook further research to gauge our customers' priorities for our wider business plan submission. We found that, once leakage was set in the context of all the other service improvements we were proposing and the overall bill impact, customers accepted paying for further leakage reductions.

9.2.3 Reliability and resilience

Our 2016 customer research on strategic company goals identified that a reliable water supply service is important to customers and their perception of our current performance is high. A large majority of customers (79%) said the chance of their water supply being interrupted was at a satisfactory level, and only 13% said this needed to be improved.

Few customers have experienced restrictions on their water supply and so it is not an issue they think about. From a survey in January 2017 amongst our online panel of 732 customers, only 31% regularly or sometimes water their gardens using a hosepipe, and only 20% regularly or sometimes clean their car using a hosepipe

In early 2017 we undertook some in-depth bespoke research exploring customer views on resilience issues. The key findings are summarised below:

- Whilst climate change is recognised as being important, its impact on the water supply system is not well understood. Customers find it hard to contemplate potential future scenarios and the risks they might pose to water supplies.
- When asked directly about what water companies need to address for the future, the following issues were frequently mentioned without prompting: population increase, saving water and education on water efficiency, better capture of water (e.g. building reservoirs), climate change and weather, avoiding floods and drought. Other topics mentioned include leakage reduction, metering, grey water recycling, water quality, and river environments/pollution.
- Water restrictions are perceived to have low likelihood of happening in the Wessex Water region and are of low impact when they do. This partly comes from the commonly held belief that this is a wet region and droughts are infrequent.
- Most customers feel current levels of investment to maintain supplies without restrictions such as hosepipe bans are acceptable, with the emphasis that customers could be encouraged to use water efficiently at all times. Water restrictions hold little fear for customers, and halving the risk of a hosepipe ban is not desirable. Customers feel we could be more innovative with regard to future solutions, for example the use of grey water.
- When asked to make choices about future investments, most opted to keep investment the same (i.e. flat bills) with an acceptance of the chance of more frequent restrictions in the future. A significant minority opted for a small bill increase (£5) to invest in more water efficiency education and devices. Very few opted for a larger bill increase (£21 pa) to invest in future-proofing new assets such as groundwater supplies and reservoirs.

9.2.4 Sharing resources with other companies

Our 2016 customer research on strategic company goals identified that most customers (71%) are broadly supportive of increased water trading with other companies. 14% disagreed that this should form part of our future plans and another significant minority of 12% were unsure, indicating the often complex issues at play.

When this issue was discussed in our extended group discussions on resilience, over half the participants (46 out of 81 respondents) said they would be willing to trade a reduction on their annual water bill to share water with neighbouring companies. While this is controversial for some respondents this is often because they anticipate trading will happen when other regions are very water stressed and they are troubled by the ethics of selling a natural resource to people perceived to be in dire need.

9.3 Government aspirations and other stakeholder views

The development of this Plan and our proposals for the future have, in addition to customer views, been influenced by the aspirations of Government, our regulators the wider water industry and other stakeholders.

Reducing the demand for water is a core area of focus in the Guiding Principles for Water Resources Planning[84] (May 2016) and also in Ofwat's methodology for the 2019 price review[85] (December 2017). The guiding principles steer water companies to demonstrate how water efficiency will be promoted, leakage will be controlled and, where appropriate, increases in customer metering delivered. Government expects our future plans will continue the trend of reducing the overall demand for water. It is suggested that a 'blanket approach' to water metering is not appropriate; however, there is also an expectation that we will deliver reductions in per capita consumption. The Guiding Principles state that the downward trend for leakage should continue and that companies should ensure that total leakage does not rise at any point in the planning period. Ofwat's methodology for the price review challenged companies to consider leakage reductions of at least 15% by 2025. In January 2018, Defra published their 25-year environment plan[86] which set out their expectation that to ensure a clean and plentiful supply of water for the UK companies would be expected to deliver leakage reductions of 15% by 2025.

Ofwat has specified four priority areas for the 2019 price review – **great customer service; affordable bills, resilience and innovation**. They have encouraged the water industry to develop services that help customers transition from being passive recipients to active participants[87]. Furthermore, in its recent publication the Consumer Council for Water[88] outline how many customers do not link population growth, climate change and other factors to their daily water use and there is work for water companies to do in helping customers understand the wider water system and the role they can play in demand reduction and other issues.

Greater **water trading and resource sharing –** not all areas of the UK experience the same level of water security today and WaterUKs recent Long Term Planning Framework study identified that drought resilience may become even more important for the water industry in the future. Many of these issues can be tackled through better resource sharing across company boundaries and through working with third parties. This agenda is furthered by the

[84] Defra (May, 2016). Guiding Principles for Water Resources Planning
[85] Ofwat (December 2017). Delivering Water 2020: our final methodology for the 2019 price review
[86] Defra (January 2018). A Green Future: Our 25 Year Plan to Improve the Environment
[87] Tapped In. From passive customer to active participant (March, 2017). Ofwat
[88] Water saving: helping customers to see the bigger picture (October, 2017). Consumer council for water

addition of a separate price review for water resources in Ofwat's 2019 business plan and price review.

In April 2018, The National Infrastructure Commission (NIC) recommended that the government should ensure increased drought resilience in England by enhancing the capacity of the water supply system[89]. Specifically, the NIC recommended the following actions to deliver the twin-track approach of demand management and supply investment:

- Ofwat should launch a competitive process by the end of 2019 to deliver additional supplies through a national water network and additional supply infrastructure by the 2030s;
- Defra should set an objective to half leakage by 2050;
- Defra should enable companies to implement compulsory metering beyond water stressed areas by the 2030s, and require companies to consider systematic roll out of smart meters.

Protecting the environment whilst delivering water services is a key concern for many stakeholders. Defra set out the expectation that, through the water resources planning framework, water companies should take account of objectives set out by government and the EU Water Framework Directive and the more local objectives of River Basin Management Plans. The Blueprint campaign[90] challenges the industry to offer better protection to catchments, prevent pollution, use water wisely and price it fairly and to manage abstraction so that it is at sustainable levels. Of particular relevance are the calls for demand reductions, further household metering, and the use of behavioural engagement through reward tariffs. Despite pressures from population growth and climate change, Blueprint are eager to see companies develop water neutral plans that ensure these pressures do not lead to any overall increase in abstraction.

Ensuring and enhancing the **resilience** of essential services like water supply is important for government, regulators and customers alike. In March 2016 Defra set out a resilience road map 'Enabling resilience in the water sector' and through the Water Act 2014 Ofwat was given a new primary duty to 'further the resilience objective'.

9.4 Unconstrained options

The combination of our supply, demand and headroom forecasts predict that we will have a surplus of resources over demand for at least the next 25 years. Although there is an absence of a supply demand balance deficit to address we have undertaken an optioneering process to identify a list of possible solutions to improve the supply demand balance position.

The unconstrained options list is an extensive list of all potential options that:

- help maintain and increase the positive supply demand balance,
- achieve stakeholders and customer aspirations,
- reduce leakage and water use,

[89] National Infrastructure Commission (2018) Preparing for a drier future: England's water infrastructure needs.
[90] Blueprint (2017). Blueprint for PR19 – Environmental outcomes for the price review.

- improve resilience,
- are better for the environment,
- increase our efficiency and
- enhance our ability to trade water with neighbouring water companies that may have a resource deficit in the future.

An unconstrained option list was developed containing over 100 different potential proposals based on company specific technically feasible options[91]. The option types considered on the demand side were metering, leakage and water efficiency, and on the supply side included increased/new reservoir storage capacity, licence changes, catchment management, groundwater schemes, direct river abstraction, desalination, effluent re-use, reinstatement of mothballed sources, and mitigation and compensation schemes. It excludes options that cannot be quantified in terms of yield, cost or risk. We also recognise we have a significant role to play in achieving sustainable abstraction. When formulating our options, we have taken this into account, along with our duties to have regard of the objectives of the River Basin Management Plans, protected area requirements and general biodiversity duties.

The option selection process where practicable and appropriate followed the Economics of Balancing Supply and Demand (EBSD) Methodology. The EBSD is aimed at finding the right balance between resource schemes and demand management schemes, in order to produce a water resource management plan that meets the needs of customers and takes account of the requirements of the natural environment.

The unconstrained option list was subject to qualitative screening to provide a feasible options list for further assessment. The purpose of the assessment is to screen out options which have a high level of uncertainty in terms of yield, technical difficultly or risk of environmental impact. The screening criteria is detailed in Table 9-1. The screening is in line with selected Strategic Environmental Assessment (SEA) criteria. For every option in the unconstrained set, the criteria were assessed using a 1 to 5 scoring system for each criterion (1 = good, 5 = bad). The scores for each criterion were totalled to give a score for each option.

[91] Water Resources Management Plan 2018 Unconstrained Options Report

Table 9-1: Option screening criteria

Criteria	Description
Yield Uncertainty	Score to reflect the risk and uncertainty of the option delivering the estimated yield/savings identified within the option.
Lead Time	Score to reflect the likely time between scheme becoming the preferred solution and being fully commissioned or delivering the full savings
Flexibility	Score to reflect the adaptability of the scheme e.g. for further enlargement or use in combination with other schemes
Security of Supply	Score to reflect likelihood of scheme yield/saving varying over time due to potential licence reductions, reduced savings or water quality issues
Environmental Impact	Score to reflect magnitude of environmental impacts, based on high level assessment of the nature of the scheme and its location using a Strategic Environmental Assessment (SEA) approach
Sustainability	Score to reflect the impact of the scheme on wider sustainability, energy use, social impacts etc using SEA approach
Promotability	Score to reflect how easy it would be to promote the scheme to the public, regulators and to obtain the necessary consents and funding
Suitability	Score to reflect how well the scheme meets the needs of any potential deficit or improving the supply demand balance.
Technical Difficulty	Score to reflect the technical complexity, engineering practicability and difficulty of implementing the scheme

9.5 Selection of options for detailed review

From our review of the drivers for investment set out above we determined that our future strategy should focus on **demand management** particularly relating to:

- Options to manage leakage
- Options to enhance metering
- Options to provide water efficiency services.

The options with the lowest scores that aligned with our investment drivers were selected plus some discretionary options as described below.

To consider the 15% leakage reduction challenge all leakage options (covering active leakage control, asset n=management, pressure management and packages of options) were progressed from the unconstrained list to the more detailed feasibility assessment stage and were therefore excluded from the initial qualitative screening.

With regard to metering we selected options that allow us to compare our current optional and change of occupier policies using standard meters alongside options to enhance the growth in meter penetration and smarter metering options.

We have also evaluated a **selection of supply-side options**, specifically those that have previously been identified as feasible options but not implemented as part of a previous final planning strategy. We believe that it is appropriate for companies to regularly review the costs and benefits of a range of options even in the absence of a supply demand balance need to facilitate a truly long-term vision.

Table 9-2 presents the list of feasible options we have analysed for this Plan.

Given our surplus situation and the resource needs of neighbouring companies we have also explored **options for future trading –** these are examined in Section 10.2.4.

Section 3.3 sets out the **resilience** of our supply system to a drought event of a severity that we would only expect to see once in 200 years. Modelling suggests that we would not need to restrict essential water use (i.e. implement rota cuts) at such times. Given that customers are satisfied with this is level of drought resilience (Section 9.2) we have not examined specific infrastructure options to enhance our level of resilience further. Demand management options (of which we are examining several) all act to enhance the resilience of our system to cope with droughts and growing demands.

Table 9-2: Options reviewed in the development of this Plan

Category	Code	Option name
Water efficiency	WE1	Home Check
	WE2	Digital engagement dashboard
Metering	M1a	Enhanced metering
	M2	Smarter metering - AMR
	M3	Smarter metering - AMI
	M4	Compulsory metering
Leakage	ALC1	Active Leakage Control innovation programme 2020-25 (1 Ml/d)
	ALC2a	Increased Active Leakage Control (2 Ml/d)
	ALC2b	Increased Active Leakage Control (5 Ml/d)
	ALC3	Active Leakage Control – data optimisation (2 Ml/d)
	AM1a	Leakage driven asset renewal (first 2 Ml/d)
	AM1b	Leakage driven asset renewal (further 2 Ml/d)
	AM1c	Leakage driven asset renewal (further 5 Ml/d)
	AM2	Subdivision of district metered areas (DMAs) (2Ml/d)
	AM3	Real time monitoring and decision support (2Ml/d)
	PM1	Pressure management optimisation (2Ml/d)
	ALY	15% reduction by 2025 (10.5 Ml/d)
	ALZ	15% reduction by 2045
Supply side	R1a	Desalination – south coast (10 Mld)
	R1b	Desalination – south coast (30 Mld)
	R2	New reservoir (south of Yeovil)
	R3	Bristol Avon abstraction at Saltford.
	R4	Avonmouth effluent reuse to industry
	R5a	Mothballed sources refurbished and brought back into supply – south
	R5b	Mothballed sources refurbished and brought back into supply – north

9.6 Detailed option analysis

Each option has been assessed to examine its impact on demand or supply; the financial cost to deliver the option; environmental, social and carbon impacts; any wider benefits and customer preferences.

Numerically we have assessed the relative costs, yields and impacts of the various options in three different ways:

1. Average Incremental Cost (AIC) – this includes only the actual construction and operating costs of each option.
2. Average Incremental Social Cost (AISC) – in addition this includes costs and benefits relating to the social, environmental and carbon emissions consequences of each option.
3. Average Incremental Social Cost including Willingness to Pay (WTP) – in addition this includes customers' willingness to pay for an option in the calculation.

The WRMP tables provide for the calculation of only AIC and AISC including WTP we have also calculated AISC excluding WTP.

Customer preferences have been assessed using the quantitative and qualitative findings from our customer research including willingness to pay research (Section 2.2 and 9.2).

Cost estimates have used the 2017/18 price base and have been prepared based on outline designs to determine required assets and their sizes, and up to date cost curves used to work out the cost of each asset. All costs and benefits have been considered over an 80-year horizon as per the guidance.

9.6.1 Derivation of social and environmental costs (for detailed analysis)

The assessment of the environmental and social impacts which formed part of the detailed option assessment used the same methodology as our 2014 WRMP. The method used a 'building blocks' approach, making a qualitative, quantitative then monetary assessments (as detailed in Section 9.4 and 9.5). The use of qualitative and quantitative assessments ensures that options where the environmental and social costs cannot be robustly quantified are not unfairly assessed or discounted.

The monetary assessment methodology adopted for the valuation of environmental and social effects uses the EA's Benefits Assessment Guidance (BAG)[92] approach. While some of the valuation evidence included in the BAG is relatively dated; the availability of suitable alternatives is limited and so this was used as the best available methodology.

For each of the water resource supply and demand management options in the constrained list, there was an initial environmental appraisal. The following specific items of information were provided for each option to support the assessment:

- scheme summary
- summary of any construction details
- a high level hydrological / hydrogeological assessment

[92]Environment Agency (2003)

- Water Framework Directive (WFD) scoping assessment summary
- table of affected resources - this provides supporting information for further assessments (i.e. SEA and HRA)
- tables of valued environmental and social benefits and dis-benefits.

The environmental and social impacts of each option have been assessed using Strategic Environmental Assessment (SEA) criteria. The SEA criteria include appraisal of the following for each option:

- a wide range of social and environmental issues such as heritage, biodiversity, human health, landscape, recreation.
- impacts of construction and operation.
- environmental and social benefits.

The BAG User Guide identifies a set of impact categories which determine the effects to be valued. It states that those most likely to be relevant to the construction and operation of water resource planning schemes include amenity, biodiversity, potential to contribute to climatic change, landscape, noise and recreation. These criteria do not correspond exactly with the topics prescribed by the SEA Directive however, the SEA outputs indicate which effects are significant and should be considered for valuation.

Once effects have been qualitatively assessed, significant effects are quantified according to the approach described by the BAG User Guide. Parameters considered include the affected population and the scale of effect (e.g. length of pipeline). Data collated for each scheme have been derived to facilitate quantification.

Only residual effects are assessed and valued, i.e. those remaining after mitigation. In this respect ‘mitigation’ refers to the common measures implemented throughout construction and/or operation to minimise the adverse effects of a proposed scheme (i.e. odour/noise reduction, best practice during construction works, acoustic enclosures to minimise operational noise/vibration, compensatory habitat etc.). The costs of mitigation are therefore considered to be included in the overall capital and operating costs (capex and opex) of the scheme and as such are not valued as environmental and social costs.

The BAG User Guide and Worked Example provides guidance on the selection of appropriate transfer values for valuation of quantified environmental and social effects. The monetised transfer values used were either the same as those used for the WRMP14 but indexed updated to 2017 base year prices or taken from the cost benefit analysis for our PR19 business plan. The selection of each transfer value was based on a literature search of potential studies suitable to the effects being monetised. Temporary costs are assessed over the relevant period during construction. Operational costs are the annual recurring costs over the scheme lifetime.

The environmental and social impacts of demand management options are undertaken on a modular basis. Depending on sub-option, these modular costs are based on the impacts per property, installation, repair or metre of pipe replaced.

9.7 Demand management options

9.7.1 Water efficiency and behavioural engagement

Customer research findings described in Section 9.2 demonstrated that customers value water efficiency services and they are keen for us to provide more. They are keen to become more empowered to save water to control their water bill.

Customer's appetite for greater engagement on the efficient use of water is mirrored by our regulators and Government who are keen to see us support more customer participation and awareness raising of the wider water environment.

We reviewed our current water efficiency offerings and considered how to enhance services to meet customer and regulator expectations.

From 2020 our water efficiency strategy will include:

- An accelerated Home Check programme of personalised in-home advice and free devices
- Enhanced water use digital engagement dashboard

Although they are described here as two individual options, they are proposed as one combined programme, which would be delivered alongside our complementary metering programme.

This section reviews the impact of these options on demand and assesses their associated costs and benefits thereby justifying why we believe this programme is the right approach to meet customer aspirations and the objectives of our business. Further detailed analysis and discussion of these options is presented in a separate technical appendix to this Plan.

<u>Water efficiency option descriptions</u>

WE1: Home check

This option will see us accelerate our programme of tailored in home advice and device fitting visits. Currently offered in targeted geographical areas of our region, we plan to develop the use of customer data to identify segments of our customer base who have the highest potential to make water savings. These would be identified as those reporting (via the digital engagement dashboard) to have older, larger toilet cisterns suitable for a dual flush retrofit device, leaking taps or toilets, mains pressure/pumped shower and an occupancy of two or more. We will also continue to promote the service in targeted geographical areas, using mailshots and door-knockers to recruit households, to maintain the community engagement opportunities of delivering a service using a street-by-street approach.

The Home Check service offers householders a combination the following water saving devices:

- dual flush retrofit devices / save a flushes / dual flush stickers
- showerheads / shower flow regulators

- flow aerating tap inserts
- shower timers / tooth brushing timers
- simple repairs to leaking toilet ball valves and taps.

The range of devices included in this scheme ensures that savings can be made in every household as there will always be something suitable to fit.

When the service is provided to unmeasured homes the benefits of opting for a meter are always promoted.

This option has been designed to deliver 8,500 Home Check visits a year from 2020-25. This represents a step change in engaging with our customers on water use through this service – in 2015-25 we are delivering and average of 4,000 visits a year.

WE2: Customer engagement dashboard
Digital engagement is growing in its reach and importance to us and our customers. This customer engagement dashboard option will enhance our online services to help customers better understand their water use and to encourage repeat participation.

The dashboard will include a water use survey tool that asks customers information about the water consuming appliances in their home and how often they use them. This information will be used to allow customers to compare their usage with other similar households in their community – a well-recognised approach to support behavioural changes that lead to real reductions in consumption.

Customers will also be offered free and chargeable water efficiency devices that are suitable for their home to help reduce their consumption. Customers will be encouraged (via their preferred channel, e.g. email, text) to return to their dashboard at regular intervals to learn how to further reduce their demand particularly when water usage might increase seasonally or at ‘moments of change’ such as having a baby or a young-adult moving out of home. Regularly engaging with customers through the dashboard will enable us to offer bespoke behavioural advice and offers for water saving devices of particular relevance to their household (including the Home Check service).

Experience from our smart meter trials suggests that personalised online water use engagement through social norming and self-reported water use habits may deliver comparable water savings to smart metering programmes. It is only by helping customers to understand their water use in terms of specific practices that we can help guide them to make choices to reduce their use. While high resolution smart metering data is useful for this purpose, it is customer engagement that will lead to real water savings; more data does not necessarily mean more impact.

Smarter forms of metering will undoubtedly feature in our future strategy (see Section 9.7.2) and this additional data stream will be amalgamated into the dashboard to further enhance the service at that time.

This programme has been appraised to achieve the sign up of 13,250 new customers to the dashboard each year. A small decay factor has been built in to the option appraisal to assume that not all customers will make repeat visits each year, but by 2025 we anticipate having 40,000 subscribers.

Water efficiency impacts on demand

Each Home Check visit is assumed to achieve average savings of 40 litres per household per day. The customer engagement dashboard is assumed to achieve savings of 8 litres a day per subscriber in the first year (slightly higher than the 6.2 litres we currently assume for a one-off use of our online calculator) and a further 3 litres a day in years 2 to 10 since signing up.

Both the Home Check and dashboard options are planned to span the full 25-year planning period. The two proposed schemes are projected to provide dry year annual average savings of 1.98 Ml/d by 2025 and 5.0 Ml/d by 2045 (Figure 9-4 and Table 9-3).

Figure 9-4: Water efficiency savings – normal year scenario

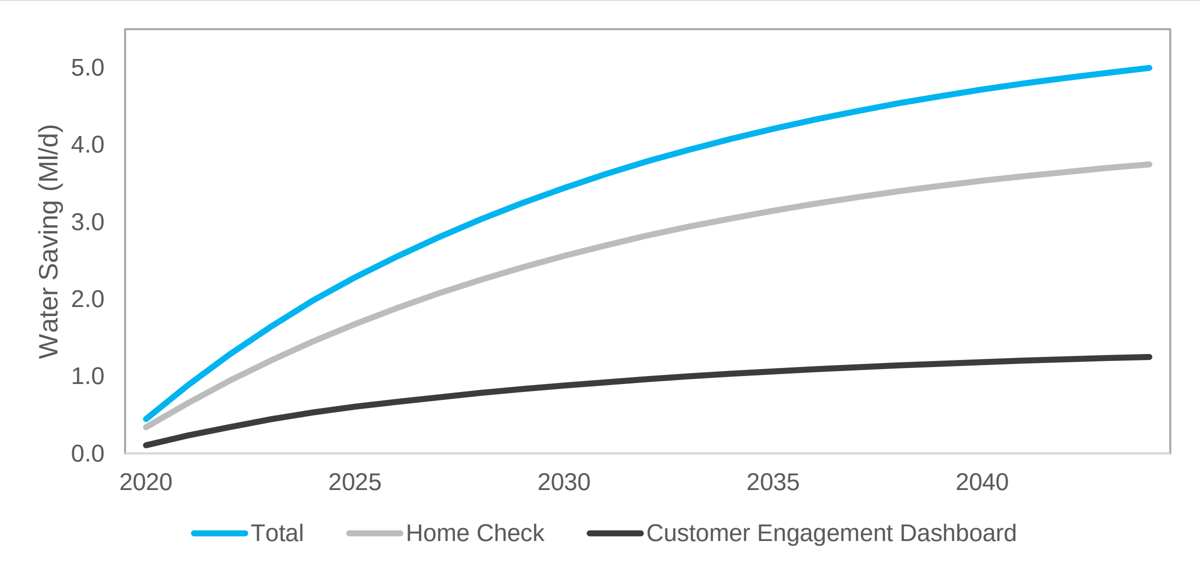


Table 9-3: Combined savings from water efficiency measures (Ml/d)

	2024/25	2029/30	2034/35	2039/40	2044/45
Dry year annual average	2.07	3.35	4.18	4.70	5.06
Dry year critical period	2.53	4.05	5.00	5.59	5.98

Water efficiency costs, benefits and customer preferences

A summary of the costs associated with the proposed water efficiency programmes are presented in Table 9-4, for further details see the technical appendix on the water efficiency options[93] that supports this Plan.

[93] Wessex Water (2017) Water efficiency options report for WRMP

Table 9-4: Summary of cost information for the water efficiency options

Option	2020-25 Totex (£m)	AIC (p/m³)	AISC exc. WTP (p/m³)	AISC inc. WTP (p/m³)
Home Check	3.2	47	3	-100
Customer Engagement Dashboard	0.3	0	-44	-76
Total	3.4	-	-	-

The willingness to pay research conducted to support this Plan indicated that customers are prepared to pay ~£530,000[94] for every 1% of households to whom we provide water efficient devices. Cumulatively this equates to being over twice as much as it costs to provide this service in the form of Home Check. The willingness to pay research also indicates that customers are prepared to pay £58,300 in order to increase the number of customers (households) engaged in water efficiency by 1% (of the customer base).

9.7.2 Metering

It is well understood that households with a meter tend to use less water than those without. Our own 6,000 household tariff and metering study shone a light on how metering particularly reduces water wastage – customers that pay for the volume they use are more likely to fix dripping taps and leaky toilets and adopt water saving behaviours.

Having a meter is the new norm for our customers. Over 61% of the households we supply pay for their water services by metered volume. In the last 7 years nearly 60,000 customers have opted to switch to metered services. In 2016 we introduced a change of occupier policy to support greater increases in the proportion of metered households and this proposal was a key element of our last Water Resources Management Plan.

Our baseline planning scenario assumes a continuation of the current optional metering and change of occupier policies. Customer research has shown that there is support for increasing the proportion of households on a meter and some modest interest in smarter metering. On this basis we considered the following metering options:

- An enhanced strategy to uplift the current optional programme through promotion
- Smarter metering using automatic meter reading technology
- Smarting metering using advanced metering infrastructure technology
- Compulsory metering.

Metering option descriptions

Table 9-5 states the key features of the alternative metering options.

[94] Total aggregated willingness to pay

Table 9-5: Metering option specifications

Code	Option name	Description
M1	Current strategy (baseline)	Policy: optional and change of occupier Meters installed: 38.3k between 2020 and 2025 Meter type: Standard
M1a	Enhanced metering	Policy: optional with promotional uplift and change of occupier Meters installed: 48.3k between 2020 and 2025 Meter type: Standard
M2	Smarter metering - AMR	Policy: optional and change of occupier Meters installed: 38.3k newly metered households between 2020 and 2025 plus 103.5K meter replacements between 2020 and 2025. Meter type: Smarter – Automatic Meter Reading (AMR) that will allow meters to be read using walk or drive by technology. The meters can be set with leak alarms for continual use.
M3	Smarter metering - AMI	Policy: optional and change of occupier Meters installed: 38.3k between 2020 and 2025 plus 103.5K meter replacements between 2020 and 2025 Meter type: Smarter – Automatic Meter Infrastructure (AMI) technology that will allow remote meter reading. The meters would send back data from the meter on a regular basis using smart communication infrastructure allowing daily usage to be recorded and viewed on a semi-live basis.
M4	Compulsory metering	Policy: all households to be metered by 2025 (assumes 7.5% of all households will be unmeterable). Meters installed: 129K between 2020 and 2025. Meter type: Standard

Compulsory metering is not an option that is actually available for us to implement – we are not in an area designated as in Water Stress and so we do not have powers to systematically install a meter on every household. We have included it in our option analysis for comparative purposes.

Metering impacts on demand

We included a change of occupier policy in our last Plan off the back of our study that found households that became metered through change of occupier use 15% less water than those without a meter.

The savings associated with (standard) optional metering are less per household (6%) because the customer's primary intention is usually to save money, and not necessarily water – i.e. they tend to be lower water users before they opt.

The enhanced metering option (M1a) will see us encourage an additional 10,000 household opt to become metered by 2025 – this represents a significant uplift (26%) on the baseline strategy 38,300. The enhancement will bring forward the growth in meter penetration and mean that by 2025 the average consumption of a meter optant household before they opt would be 244 litres a day, compared to the baseline scenario of 238 litres a day.

Encouraging higher water using households to become metered will require enhanced promotional activities and strengthened links with our water efficiency and behavioural engagement programme. Option M1a would involve targeted mailshots to segments of our customer base most likely to benefit from (and therefore take up) metering. Social media campaigns that make use of behavioural techniques (such as social norming) would also be used to encourage take up.

Our **'cashback guarantee'** scheme gives customers a risk free trial of metering – they can opt for a meter safe in the knowledge that if, after two years, they have paid more than if they had stayed on an unmeasured tariff, they can choose to revert to unmeasured charges and we will refund or credit the money back to them. 90% of customers who currently opt for a meter save money; this scheme will encourage households that are on the margins of cost saving (i.e. higher water users than current average optant households) to switch to a meter. The scheme will also pro-actively engage with households that are paying more after one year to offer water efficiency services like Home Check (Section 9.7.1) to help reduce their water usage and therefore manage their bill. With this approach, we will persuade more people to try a water meter, and also persuade households that use more water than those that typically opt for a meter.

We have reviewed two options for **'Smarter metering'**: M2 automated meter reading (AMR) technology and M3 automated meter infrastructure (AMI).

- AMR meters use a short range radio signal to enable automated drive-by or walk-by meter reading. The benefits of AMR metering (compared to standard metering) include reduced data collection costs and improved data accuracy. Some models include other features such as leak alarms that can allow early identification of supply pipe leaks and household plumbing losses, depending on the frequency at which AMR meters are read (in this option analysis we have assumed the meters would be read once every 6 months).
- AMI meters use a communication system (GPRS, radio signal, internet connection) to enable automated data collection. Data can be recorded at up to 15 minute intervals and can be collected at varying frequencies. The benefits of AMI metering (compared to AMR metering) are a significant increase in data and manual data collection is virtually eliminated. There would be expected to be a small reduction in demand due to earlier identification of leaks and, if consumption data is integrated with a customer-facing portal, householders can come to understand their water usage better.

For both options we have assumed that the smarter technology would be used for all new meter installations and would be used to replace existing meters when they fail or when they are due for replacement (our policy is for proactive age related replacement of small revenue meters is at 15 years). This means that by 2025 approximately 36% of our meter stock would be read with smarter technology, increasing to 70% by 2030 and 90% by 2035.

The potential for AMR to help us manage demand is not clear, and at this time we have only included a small reduction in demand associated with this option. Whilst we recognise the potential benefit of having a leak alarm, we are already proactive with our customers and inform them of their high consumption, and we offer a leak allowance once a leak has been fixed. We also offer supply pipe leak repairs. As a result our assessment of metered households supply pipe leakage is already lower than the industry average. Material impacts on demand from AMR would likely require the frequency of meter reads to be increased from once every six months to say once every month. This would significantly increase the costs and reduce meter battery life.

The benefit of reduced meter reading costs from using AMR only occurs when there are sufficient AMR meters installed to deliver the economies of scale work (i.e. the cost saving from more efficient meter reading outweighs the additional cost of purchasing the AMR unit). In the short to medium term (up to 2030) AMR does not offer advantages over our current metering strategy using standard (manually read) meters as the cost estimates suggest that AMR and standard metering costs are broadly equivalent for the first 15 years of the plan.

AMI coupled with investment in a customer-facing water use portal offers greater potential to help our customers understand and manage their own water use. It would also allow us identify leaks earlier because of more real time analysis of water use data. We estimate that there could be up to 10% demand saving associated with this option.

Metering costs, benefits and customer preferences

Our metering cost benefit analysis followed the methodology and spreadsheet model developed by the 2012 UKWIR study on smart metering[95].

The costs of the alternative approaches to metering in 2020-25 are summarised in Table 9-6. The costs are additional to the cost of the baseline strategy (which itself is £9.2m Capex and £0.2m per year Opex for 2020-25).

Table 9-6: The costs of the alternative approaches to metering (2020-25)

Option	2020-25 Potential demand reduction (Ml/d)	2020-25 Capex (£m)	2020-25 Opex (£m/ year)	AIC (p/m3)	AISC exc. WTP (p/m3)	AISC inc. WTP (p/m3)
M1a – enhanced metering	0.5	2.4	0.01	208	-20	-227
M2 – smarter metering – AMR	0.1	6.0	0	1,427	1,439	1,073
M3 – smarter metering – AMI	0.62	47.0	-0.4	2,539	2,418	2,302
M4 – compulsory	17.3	24.3	0.3	19	6	-7

The willingness to pay survey (Section 9.2) indicated that our customers are prepared to pay for standard metering to become more widespread. There was less support from customers for smart metering however where their preparedness to pay was less than the costs associated with current smarter metering technology.

95 UKWIR (2012). Smart Metering in the Water Sector Phase 3 – Making the Case.

Smarter water metering is an evolving technology. Many current 'smart' water meters still rely on manual walk/drive-by operational data collection, or deliberate infrastructure installations such as a radio network. Data is generally not collected and presented back to customer, or analysed by the company, in real time and the transmission rate is reliant on battery capacity and mobile phone network coverage. Smarter meters and logging devices may have limited battery life due to the power demands from the modem or radio transmission and the weight of the communication protocol. To make the devices last longer modems can be configured to communicate less frequently but this reduces the 'smart' element of the device.

With the growth in the Internet of Things[96] (IoT) the capability of connected devices that are becoming ever more cost and energy efficient is growing at a fast pace. New light weight protocols based around Narrow Band IoT such as Message Queue Telemetry Transport (MQTT) will enable higher frequency information transmission for a longer period of time, current estimates are around 10 years.

Within the next few years we expect that there will be significantly better options to collect nearer real time water use information from newer smarter devices and provide this information to our customers, rendering many current 'smart' meters obsolete.

The capital and operational costs associated with the currently available smarter metering technology are significant when compared to the potential benefits. Experience from our smart meter trials suggests that personalised online water use engagement through social norming and self-reported water use habits may deliver comparable water savings to smart metering programmes and it is our intention to focus on this in the short term.

Smarter forms of metering will undoubtedly feature in our future strategy but at the present time, with a surplus of water resources over water demands, the benefits do not outweigh the costs. As technology improves, costs come down and the water resource situation across the UK evolves we anticipate a transition towards smarter metering in the next 10 years, and we will learn from the experience of others as we develop our approach.

Based on the above information on costs, benefits and customer preferences our metering strategy for the 2020-25 period will include the delivery of option M1a that involves the additional promotion of optional metering to increase the proportion of households with meters.

Total cost of the metering programme

The total cost of the domestic metering programme between 2020 and 2045 is ~£76million. Table 9-7 shows the capital and operational costs of the programme in 5-year periods. These costs take account of baseline optional and change of occupier metering, and enhanced metering programme included as an option in our final planning scenario.

[96] i.e. embedding electronics, software, sensors etc. in everyday objects to enable them to be controlled via internet connections

Table 9-7: Total cost of the metering programme (millions of pounds)

	2020-25	2025-2030	2030-2035	2035-2040	2040-2045
Capital Cost (£m)	11.2	5.7	4.1	3.0	2.3
Operating Cost (£m)	8.0	9.4	10.2	10.8	11.3
Total Cost (£M)	19.2	15.1	14.2	13.8	13.6

9.7.3 Leakage

Since the mid-1990s we have halved the amount of water that leaks from our network this is around 15% more than the industry average reduction over the same period.

Leakage is consistently rated by customers as one of the top priorities for our business. It can be a complex issue and so we undertook in-depth with our customers in June 2017 on the core issue of leakage and efficient water-use, and found that:

- leakage has no direct negative impact on customers. Many could not recall ever having seen a leak and most have higher water priorities than leakage
- there is little appetite to see us invest to bring about further reductions in leakage over the next five years if this means that bills will rise for little overall leak reduction
- most customers are keen to see modest investments in innovation to help bring down leakage in the longer term
- there is interest in investment in education services with children and collaboration with customers to fix plumbing leaks in homes and improve awareness of water efficiency. Many customers recognise the role they can play in helping to manage the amount of water we take from the environment.

After the completion of our June 2017 leakage research with customers, Government and regulators (Defra, Ofwat and the EA) set an expectation that companies will reduce leakage by 15% by 2025 and continue to reduce leakage thereafter. In 2018 we therefore undertook further research to gauge our customers' priorities for our wider business plan submission. We found that, once leakage was set in the context of all the other service improvements we were proposing and the overall bill impact, customers accepted paying for further leakage reductions.

We welcome the regulatory appetite for setting stretching performance commitments for leakage, providing these are: aligned with customer preferences; take account of the savings already delivered by current available technologies; and complement strategies to help customers reduce demand. We are committed to further leakage reduction in the short, medium and long term and to finding new ways to achieve this without significant impact on customer bills.

While we are ourselves in a surplus position for water resources it is clear from the draft Water Resources Management Plans of some neighbouring companies that they would value this water more highly. Continued leakage reduction should enable greater resource to be traded with these companies in future, and this could help reduce bills for our own customers, further improving the cost-benefit ratio.

We selected a range of leakage options to appraise, these are listed in Table 9-8.

Table 9-8: Leakage reduction options (grey rows indicate individual options which collectively comprise option ALY)

Code	Option name	Description
ALC1	Active Leakage Control innovation programme 2020-25 (1 Ml/d)	To include a number of small evolutionary improvements across our active leakage control, and continuous monitoring and pressure management activities. To be delivered on a 'spend to save basis' i.e. this option will require no funding.
ALC2a	Increased Active Leakage Control (2 Ml/d)	Additional staff to find more leaks.
ALC2b	Increased Active Leakage Control (5 Ml/d)	Additional staff to find more leaks.
ALC3	Active Leakage Control – data optimisation (2 Ml/d)	In contrast to ALC1 (gradual evolution) this option involves a step change in the adoption of new technology and processes to include steps towards 'big data' analytics.
AM1a	Leakage driven asset renewal (first 2 Ml/d)	Replacement of service pipes and/or water mains, strategy optimised by ranking of most cost effective areas. Leakage saving to be achieved by 2025.
AM1b	Leakage driven asset renewal (further 2 Ml/d)	Option AM1a would be to be delivered first (costs and savings are additive for these options). Replacement of service pipes and/or water mains, strategy optimised by ranking of next most cost effective areas. Leakage saving to be achieved by 2025.
AM1c	Leakage driven asset renewal (further 5 Ml/d)	Options AM1a and b would be to be delivered first (costs and savings are additive for these options). Replacement of service pipes and/or water mains, strategy optimised by ranking of next most cost effective areas. Leakage saving to be achieved by 2025.
AM2	Subdivision of district metered areas (DMAs) (2 Ml/d)	Subdividing DMAs into smaller units enables better night flow analysis. Investment required to reconfigure pipework and install new meters etc.
AM3	Real time monitoring and decision support (2 Ml/d)	Adoption of software systems that allow more sophisticated 'big data analytics'. Scheme costed to include systems that could be delivered within 5 years including – more meters, pressure and acoustic points, IT infrastructure, knowledge management and data visualisation. This area is likely to experience significant innovation in the coming years.
PM1	Pressure management optimisation (2 Ml/d)	This would be a mixture of further optimisation of existing pressure management and new installations, together with calm network operational improvements.
ALY	15% reduction by 2025 (10.5 Ml/d of distribution leakage)	This scale of leakage reduction would be achieved by a combination of multiple individual options (which are highlighted as grey rows in this table) including infrastructure renewal, increased active leakage control, pressure management and improved data analysis and DMA improvements.
ALZ	15% reduction by 2045	The leakage reduction would be achieved using a number of different strategies. For the period 2020 – 2025 we would reduce the leakage figure by increasing meter penetration which assists in finding customer supply pipe leakage and using the existing active leakage control resources and which is our current baseline policy

In addition to these specific leakage options, any progression towards greater metering (whether standard or smarter) will bring about leakage benefits as it will allow earlier identification of leaks on customer supply pipes.

Our current level of leakage is significantly below the ‘sustainable economic level of leakage’ (78 Ml/d compared to a SELL of 104 Ml/d) meaning that reducing leakage further will cost more than the cost of producing the water, this is in part related to our surplus situation.

Our willingness to pay values shows that customers are willing to pay ~£2,000,000[97] for a percentage reduction in the proportion of total water that leaks from our network.

Table 9-9 shows a summary of the cost information for the leakage options assessed for the 2020-25 period.

Table 9-9: Summary of cost information for leakage options for 2020-25

Option	Reduction by 2025 (Ml/d)	2020-25 Capex (£m)	2020-25 Opex (£m/ year)	AIC (p/m3)	AISC exc. WTP (p/m3)	AISC inc. WTP (p/m3)
ALC1	1	0	0	-9	-9	-91
ALC2a	2	1.6	0.26	96	104	22
ALC2b	5	4.7	0.8	145	158	90
ALC3	2	1.8	0.3	70	77	29
AM1a	2	15	0	186	189	30
AM1b	4	35	0	210	214	67
AM1c	9	110	0	272	278	189
AM2	2	4.6	0.28	96	103	25
AM3	2	3.9	0.82	280	289	222
PM1	2	6	0.4	107	108	24
ALY	10.5	19.8	1.10	76	80	54
ALZ*	2.4	0*	0*	56	60	14

* ALZ - There is zero capex, opex and as option is the same as ALC1 for the first 5 years i.e. we don’t do anything over and above our current leakage operation apart from improving efficiency and effectiveness to continue reducing overall leakage

Our final planning leakage strategy for the next 5 years will see us implement option ALY to deliver a 15% reduction in leakage by 2025.

This will require a step change in our activities, as well as innovation and continued customer support and engagement. The package of individual options we will deliver will include:

- reducing losses from our distribution network through additional active leakage control (options ALC1, ALC2a and ALC2b), improved data collection and

[97] This is the aggregated willingness to pay

analytics (ALC3), further sub-division of district meter areas (AM2), innovative pressure management (PM1)
- reducing losses from customers' pipes through our enhanced metering programme as it is easier to identify leaks on properties that are metered (M1a)
- plus promoting ways in which customers can contact us to report a leak via our leak stoppers telephone hotline or our website.

Our longer term strategic vision is for continued leakage reduction beyond 2025 that is in line with the expectations of our customers and the Government's 25-year environment strategy – our final planning scenario assumes that by 2045 leakage will be 27% lower than it is at the start of this plan.

We are confident that we will continue to innovate and find better methods for predicting and detecting leaks and new technologies for fixing leaks quicker and at lower cost will be developed – see box on the next page which outlines some of our current innovative approaches and the box on our lift and shift case study in section 5.7.1.

We participate in a number of industry steering groups associated to leakage reduction to ensure that we are aware of the latest improvements and innovation in leakage management. Groups such as the Pressure Management Forum enable water companies to come together to discuss the latest technologies and equipment to manage leakage into the future whilst suppliers have a platform to present their latest innovations. We participate in the Isle Utilities run, European Water Technology Approval Group, which is a global innovation forum that highlights technologies in the pre-commercialisation stage.

<u>Leakage innovation</u>

For us, innovation is the introduction of new technologies, products or ways of working that offer a clear benefit – a better service to customers, a healthier environment, lower costs or reduced risk. The things we introduce can range from small modifications to a completely different way of addressing an issue. Some examples of recent innovations in leakage control that we have adopted are:

<u>Fixed remote acoustic loggers</u>

We have a 9" cast iron main which runs under a key commuter route an major A road. Any unplanned repairs or maintenance to the main causes significant disruption. To mitigate the risk, we have a network of correlating loggers fitted along the length of this pipeline which alert us of any potential leaks. The loggers transmit data through radio repeaters and GPRS. Any indication of a growing problem is investigated at the earliest opportunity, in a planned approach to prevent a burst and an unplanned emergency response.

<u>Aerial trunk main survey</u>

Locating leakage on trunk mains is inherently difficult due to many factors, but in large part because the large diameter pipework and lack of fittings makes traditional leak detection technologies (leak noise correlators etc.) ineffective. In January 2018 we will be working with a specialist service provider to undertake leak detection by a drone mounted infrared camera technology to deliver thermographic surveys. We intend to trial this innovative approach on six trunk main systems to pinpoint areas of loss that we haven't previously been able to identify. Other predicted benefits of using a mounted thermal imaging camera is that it allows survey of large areas in a short space of time and area where access is difficult.

Calm networks

Limiting the number and scale of pressure surges or transients in our distribution network will reduce the chance of burst mains, leakage occurrence and impact of service to our customers. Pressure transients can be introduced by fixed network assets, such as pumps, or through our manual operation of fittings such as valves and hydrants. We are introducing a 'calm networks' approach, which involves modifying the way in which we operate our supply network to avoid pressure surges. This has begun through undertaking training at specialist facilities and plans to upgrade our in-house training rig. New equipment has been purchased for Inspectors to use, and we deploy a set of very high resolution transient detection and reporting loggers.

9.8 Supply demand balance options

The supply side options that we have reviewed for this Plan are summarised in Table 9-10.

Table 9-10: Resource option descriptions

Code	Option	Yield	Comment
R1.a	Desalination (large)	30 Ml/d	A large desalination development on the South coast with the water transferred across the Wessex Water supply system.
R1.b	Desalination (small)	10 Ml/d	Small desalination development on the South coast with water used locally.
R2	New reservoir (south of Yeovil)	22 Ml/d	Development of a new reservoir close to Yeovil with enhanced pump storage from the River Yeo.
R3	River Avon abstraction near Saltford	30 Ml/d	A new river abstraction from the River Avon just upstream of Saltford (involving modification and transfer of existing abstraction licence for River Avon near Bath). Bankside storage would be provided along with an advanced water treatment works.
R4	Avonmouth effluent reuse	11 Ml/d	Use of treated effluent for non-potable supplies using treated effluent from Avonmouth STW.
R5a	Mothballed sources– south	2.6 Ml/d	Treatment processes upgraded enabling groundwater and spring sources in the south of our region to be brought back in to use that have been mothballed.
R5b	Mothballed sources– north	3.8 Ml/d	Treatment processes upgraded enabling groundwater and spring sources in the south of our region to be brought back in to use that have been mothballed.

Table 9-11 presents a summary of the analysis of the resource options is presented. None of these options have been included in our preferred options list, they were analysed for comparison only.

Table 9-11: Summary of cost information for supply side options for 2020-25

Option	2020 -2025 Yield (Ml/d)	2020 -2025 Capex (£m)	2020 - 2025 Opex (£m/ year)	AIC (p/m3)	AISC exc. WTP (p/m3)	AISC inc. WTP (p/m3)
R1a*	0	152.8	0	196	220	220
R1b*	0	71.0	0	192	199	199
R2**	0	0	0	205	211	211
R3	30	142	3.75	141	151	151
R4	11	120	3.12	330	345	345
R5a (south)	2.55	11.6	0.14	116	119	119
R5b (north)	3.8	8.1	0.12	59	61	61

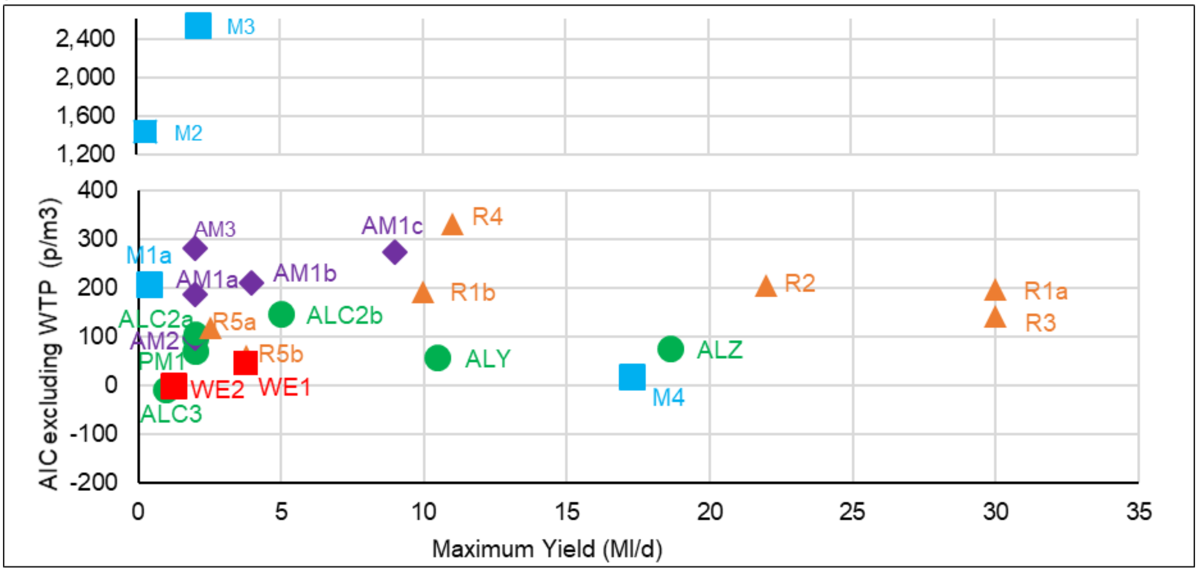
*R1 – this is the desalination plant and would not come online with in the 2020 – 2025 period so the yield is shown as zero

**R2 is the development of a storage reservoir. 2020 – 2025 would be part of the planning consent phase. Although there would be costs to develop this option with in the period these have been included in the construction costs which are beyond the period so costs are shown as zero

9.9 Comparison of options

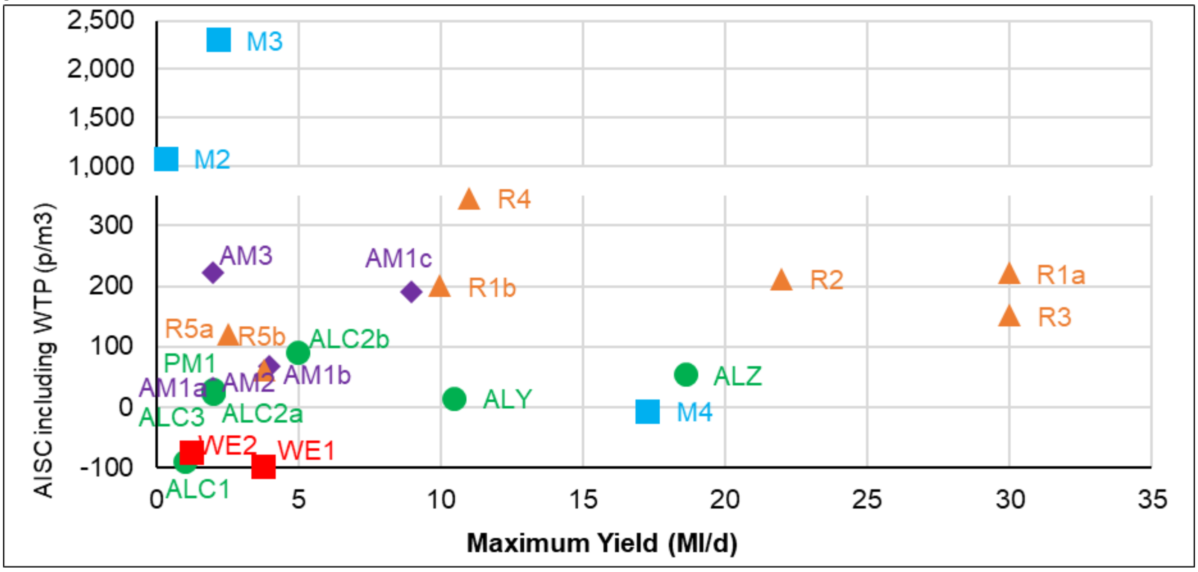
Figures 9-5 and 9.6 compares the average incremental social costs excluding and including willingness to pay respectively relative to the maximum yield of all the options we have considered.

Figure 9-5: Average incremental social cost excluding willingness to pay relative to option yield



For code definitions please see Table 9-1. Please note broken y-axis.

Figure 9-6: Average incremental social cost including willingness to pay relative to option yield



For code definitions please see Table 9-1. Please note broken y-axis.

These charts highlight that the water efficiency options are particularly cost beneficial with low or negative AISCs. Similarly, of the leakage and metering options considered, the active leakage control innovation option (ALC1) and the enhanced metering option (M1a) are the most favourable (given that compulsory metering, M4, is not a viable option as we are not water stressed).

9.10 Preferred options

Reducing demand in the short and long term delivers significant benefits for our customers, our local water environment and the operation of our business. Reduced demand leads to reduced abstraction. Demands and therefore abstraction has been declining in our region since the mid-1990s and we want to see this continue. The less we abstract the more that is left in the environment to support the precious rivers and ecosystems in our area.

Reduced demand provides more resilience to climate change. The impacts of a changing climate on water supplies are uncertain. Future climate projections are regularly updated and it is possible that while the current best available information suggests impacts are small it is possible that these estimates may be revised as climate science itself evolves. Reducing demand now and helping our customers understand the link between their water use and their local water environment enhances our adaptive capacity to deal with potential reductions in supplies or increases in demands in the future.

Reduced demand reduces carbon emissions and therefore lessens our contribution to accelerated anthropogenic climate change. Abstracting, treating and pumping water to serve our customers has associated ‘embedded carbon costs’. Lower demands therefore reduce emissions. The reduced use of hot water in customer’s homes also leads to lower carbon emissions as less energy is required to heat water.

Our stakeholders have been clear – they want to see a continued reduction in overall demand including reductions in household water use measured on a per capita basis and stretching reductions in leakage. They are also keen to see us increase participation in water services so that our customers understand the wider water system.

Our customers have been clear – they are keen to see greater activity to help them reduce their own use and are supportive of investment in leakage reduction. The affordability of bills is a high priority for most.

The preferred options that we have included in the final planning scenario are:

- WE1 – Home Check
- WE2 – Customer engagement dashboard
- M1a – Enhanced metering
- ALY – 15% reduction in leakage by 2025.

The ALY option to reduce distribution losses, in combination with our baseline and enhanced metering programme (M1a), will meet the challenge of reducing leakage by 15% by 2025. We are ambitious to reduce leakage further in the longer term beyond 2025, towards the National Infrastructure Commission’s recommendation to reduce leakage by half by 2050. Whilst we have ambition in the longer term, the exact means and costs are not yet known to achieve longer term reductions. We have therefore planned for a 27% total leakage reduction by 2045. Coupled with our own innovative work (Section 9.7.3), we believe that the stretching 15% leakage reduction challenge will lead to significant innovation across the industry over the next seven years to meet the target, that will lead to a greater

understanding of methods and costs to achieve greater savings. This will be addressed and incorporated into WRMP24.
Taken together our approach aims to deliver:

- A water neutral plan, where total water entering our supply network does not increase (subject to annual variations for weather) despite an increase in the population served.
- Declining water use per person.

The programme of options included in our final plan are consistent with the proposals included in our draft business plan that was tested with customers between January and June 2018.

The customer research was designed to test whether customers find the plan acceptable and affordable. The stimulus material covered our overall package of service improvements, statutory enhancements and bill impacts. We tested our plan with household customers, business customers, retailers, those in vulnerable circumstances and industry stakeholders. Results were triangulated across a variety of qualitative and quantitative methodologies to maximise the robustness of both the sample and conclusions.

Testing has shown that 96% of our customers find our business plan acceptable. Acceptability is above 90% across all demographic subgroups. Those in vulnerable circumstances were slightly less accepting of the plan than other groups, but still at a very high level.

A large majority of household customers (92%) consider our plans are affordable for them. Over 90% of businesses found the plan to be affordable. Vulnerable customers also found the plan acceptable and affordable, and were positive about the assistance that we provide to this group.

10 Stress testing and sensitivity analysis

Stress testing and sensitivity analysis is an important stage of the UKWIR decision-making framework (stage 7); its purpose is to help understand the assumptions and factors that have greatest influence on the plan, and to provide confidence that the plan is robust under a range of uncertainties.

In the first part of this section, we evaluate the performance of the proposed final plan options against other drought event scenarios, which is consistent with the risk composition 2 approach.

In the second part of this section, we test the impact of the preferred options on our baseline supply-demand balance against particular sensitivities. We have tested our supply-demand balance against uncertainties relating to:

- potential future sustainability reductions
- alternative household properties and population growth
- potential new bulk supply exports
- large source outages
- an extension to the forecast horizon (up to 2060).

10.1 Drought event scenario testing

As described in Section 3.2 outlining the approach we have taken in for developing our plan, we have generated a range of plausible drought events to evaluate the performance our supply system, consistent with a ‘resilience tested plan’. We initially developed the events to support the development of our recent drought plan, which meant these events were available in case they were required for more complex decision making process, to help determine between different investment portfolios, should our problem characterisation (Section 3.3.2) have identified larger issues for us to tackle.

We identified that our system will be in surplus under our design event (1975/76) for the baseline and final planning scenarios, and so have instead used these events to evaluate how well our final planning scenario performs under a range of droughts, and consistent with the UKWIR risk-based planning guidelines, have produced a severity-benefit table to demonstrate our supply-demand balance under these scenarios.

We used one of the generated plausible drought scenarios to calculate our 1 in 200 reference level of service – this showed we would be resilient to a drought event with an approximate severity of 1 in 200 years without the need for standpipes and rota cuts.

We used the drought scenarios to populate Table 10 of the water resource planning tables, to demonstrate how our supply system responds to a range of drought scenarios, and disaggregate the effects of drought measures from normal, non-drought supplies. In this section we describe the method used to generate our plausible drought scenarios (Section 10.1.1), how we have calculated the benefits of drought measures on the supply-demand balance (Section 10.1.2), and the results of the drought scenarios (Section 10.1.3).

10.1.1 *Plausible drought generation*

To generate plausible drought events more severe than those on the historical record, we followed the UKWIR guidance, WRMP 2019 methods: risk based planning. The key steps in the process are:

1. Create severity-duration plots of the historical rainfall record, or generate curves of climatological or hydrological metrics.
2. Use event analysis to generate artificial droughts and estimate return period range against the historic record.

The method we applied was based on the approach applied in the Water UK "Water Resources Long Term Planning Framework" project (Water UK, 2016) to be consistent with the severity of the 'plausible' drought events identified in this study beyond those in the historical record. We used an aridity index, which accounts for the balance between rainfall and actual evapotranspiration to generate more extreme events than observed on the historical record, by perturbing the rainfall and potential evapotranspiration of key historic drought events in the historic record: 1921, 1933, and 1976. More details of the methodology applied can be found in Annex I. The method we applied was peer reviewed by Atkins who confirmed that the method is fully adequate for the generation of 'plausible' drought events and aligns to the principles described as a 'resilience tested plan' in the guidelines. The peer review summary note is available as an appendix to this Plan[98]

The drought events generated are summarised in Table 10-1. They include the worst droughts from the historical record, including our design event, 1975/76, and more challenging droughts beyond those observed, which were generated by making the historic drought events worse in terms of rainfall deficit.

We have also included the 1933/34 drought event, as it is similar to our design event being a multi-season drought, which our water supply system is considered more vulnerable to, given that approximately 75% of our water is from groundwater sources.

Similarly we included the 1921 drought event, as it is of a different character to our design event, and consists of a dry summer going into a dry autumn-winter period. The event was also noted during pre-consultation conversations with two of our neighbouring water companies to be of particular relevance to their system vulnerabilities and so we felt it appropriate to consider given the potential for new bulk supply trading arrangements.

In our analysis of rainfall records to determine drought events, it was noted that, as shown in Figure 4-2, the periods ending in April and October 1976 were the worst in terms of rainfall deficit on the historical record of periods of between 4 and 5-year duration, in addition to being the worst 17 month drought period.

The drought events considered here are consistent with the drought planning guidance and the water resources and drought planning links supplementary guidance, wherein it is advised that the events should include: the worst drought on record (1975/76); a more

[98] Atkins (2017). Review of WRMP19 Resilience Analysis.

challenging but still plausible scenario than the worst drought on record (severe and extreme droughts); droughts of a different character to the design event (those based on the 1921 drought).

Table 10-1: Drought events used for testing drought resilience (note all events start on 1 April)

Event	Duration (months)	Rainfall (%LTA)	Indicative return period	Details
1975/76	17	64	1 in 100	Dry summer-winter-summer, with sudden end of drought in September 1976
1975/76 severe	17	56	1 in 200	1975/76 with drier April 1975 to September 1976
1975/76 extreme	17	54	1 in 500	1975/76 with drier April 1975 to September 1976
1921	9	48	1 in 100	Dry summer leading into dry autumn winter
1921 severe	9	44	1 in 200	1921 with drier period from April to December
1921 extreme	9	41	1 in 500	1921 with drier period from April to December
1933/34	24	73	1 in 100	Worst 24-month period on record. Consecutive dry years; dry summer following a dry winter.
1933/34 severe	24	68	1 in 200	1933/1934 with drier 2 year period from April 1933
1933/34 extreme	24	66	1 in 500	1933/1934 with drier 2 year period from April 1933

10.1.2 Calculation of drought demand and drought measure benefits

A drought measure is an additional operation or action taken by a water company to enhance yield/deployable output or reduce demand during a time of drought. These measures are set out in our drought plan; we submitted our draft final version and statement of response for our drought plan in October 2017.

For each plausible drought scenario, we have used our dry year annual average and critical period demand used in the supply-demand balance calculations as our unrestricted demand profile. Section 5.2 describes the process applied to calculate dry year demand, which is based on the 1995/96 period, which was our most significant (unrestricted) demand observed, including a significant increase in summer demand, relating to significant dry weather (Figure 5-6).

Our drought plan lists a number of actions we will take to reduce demand as a drought progresses, and also contains five supply-side drought permit options. Table 10-2 lists the drought actions, the calculated daily impact on supply or demand for each option, and the bands in which the options would be implemented, which are shown in Table 10-3. We operate on the basis of four drought bands, to reflect the continuum of actions and changes we can make to our water supply system as a period of dry weather develops. Table 10-4 provides some further detail of the derivation of demand side savings, and more detail can be found in the drought plan.

For the purposes of drought planning, we divide our single resource zone supply area into smaller units (drought management zones), which define the areas over which decisions will be made to manage resources. Within each zone the total amount of water available from reservoirs and for abstraction from key groundwater sources is used to define specific trigger levels. Once the amount of water available drops below a specific trigger level, certain actions are considered to either improve supply or reduce demand.

This approach provides a finer resolution of understanding of how resources within the system are evolving during an extended period of dry weather/drought, in comparison to calculating similar metrics at the resource zone level. This therefore provides more information on how the particular circumstances, and spatial variability of an individual drought situation are developing. Alongside the outputs of our system simulation model forecasts, this information allows us to trigger specific options within the system.

In order to calculate the potential benefit of each of these options on our supply-demand balance, the drought bands from the drought plan have been used to calculate the approximate length of time during each drought event we would expect to be in each band, and therefore the length of time over which each drought option might be applied.

The drought and water resource planning links document states that the assessment undertaken to calculate values for Table 10 of the water resource planning tables proportionate to the risks involved. Given our supply-demand surplus position, our system performance during the plausible drought events (Section 10.1.3) and the expected frequency of use of our drought measures, we believe the effort taken to calculating these values is proportionate.

Table 10-2: Drought supply and demand saving options

Measures		Calculated annual average volume (Ml/d)	Band applied
Supply	Use of standby source	6.5	4
	Pump storage from Bridgwater and Taunton Canal	4.5	
	Clatworthy compensation reduction and Hele Bridge pumped storage	2.88	
	Sutton Bingham compensation reduction and Clifton Maybank pump storage	2.13	
Demand	Increased leakage reduction – Phase 1	0.5	3
	Water efficiency campaign – Domestic	0.4	
	Water efficiency campaign – Business	0.005	
	Water efficiency campaign – Domestic and business	0.83	4
	Increased leakage reduction – Phase 2	1	

Measures		Calculated annual average volume (Ml/d)	Band applied
	Temporary water use restrictions	8.5	
	No-essential use bans	2.46	

Table 10-3: Drought management bands

Band	Strategy
1 Normal operation	Follow a cost optimal strategy for water abstraction and distribution, and undertake regular demand management activities such as water efficiency and metering campaigns, alongside leakage management
2 Initial dry weather actions	Proceed with a normal spring/summer water efficiency campaign and switch from a cost optimal strategy to a resource saving strategy.
3 Further dry weather actions	Implement a higher profile water efficiency campaign, leakage reduction, and additional water transfers and resource saving
4 Drought actions	Launch an intensive media campaigns potentially progressing to temporary use restrictions ('hosepipe bans') and the possible use of drought permits to conserve and increase water availability

Table 10-4: Demand side savings

Band	Demand saving option	Demand saving
3	Increased leakage reduction – Phase 1	We estimate that demand savings of a maximum of 0.5 Ml/d could be achieved by increased staff overtime and night working and undertaking more work in the highway as same day emergency works under the Traffic Management Act 2004.
	Water efficiency campaign - Domestic	The campaign would be focussed in the summer months and include both educational messages to promote behavioural change and the promotion of water efficient devices. Savings are estimated to amount to 0.4Ml/d. While these savings may seem small they rely on engaging with between 46,000 and 70,000 customers in addition to the business as usual level of engagement.
	Water efficiency campaign - Business	The campaign would be focused in the summer months and include both educational messages to promote behavioural change and the promotion of water efficient devices. Savings are estimated to amount to 0.005Ml/d
4	Water efficiency campaign – Domestic and Business	The campaign would be focused in the summer months and include both educational messages to promote behavioural change and the promotion of water efficient devices. Savings are estimated at 0.83Ml/d, which requires engaging with over 100,000 additional customers to business as usual activity.
	Increased leakage reduction – Phase 2	We estimate that demand savings of a maximum of 1.0 Ml/d could be achieved by further active leakage control activities utilising additional external staff resources and more active pressure management, i.e. reducing pressures at night or in specific areas below company standards.

Band	Demand saving option	Demand saving
	Temporary water use restrictions	Savings are difficult to quantify as we have no direct evidence of likely reductions for our own supply area as we have not imposed restrictions for over 40 years. We would estimate an annual average benefit of 8.5Ml/d (17Ml/d) peak, based on 5% saving of distribution input following the UKWIR (2011) code of practice.
	Non-essential use bans	Non-essential use bans have been estimated as 3% of our non-household demand.

10.1.3 Drought scenario results

Table 10-5 to Table 10-8[99] show drought severity-benefit tables of annual average and critical period planning scenarios at the start (2020/21) and end (2044/45) of the planning period. Each column of the table is a different drought event, and for each event the supply-demand balance with and without the inclusion of drought measures and actions is shown.

To recap, each drought event is based on a design event, which was the worst drought event within the historical record for the given drought duration (and hence a return period of 1 in 100 years). The severe (1 in 200) and extreme (1 in 500) droughts are then derived based on these design events but are more severe droughts.

There are a series of uncertainties that can affect the accuracy of the calculations, which are acknowledged in the guidelines we have followed and described in the pop-out box – key uncertainties in drought scenario assessment – below.

Under the annual average planning scenario, the analysis shows no supply-demand deficits based on our baseline supply-demand balance across our planning period, even without the inclusion of supply-side and demand-side measures. This is consistent with our stated levels of service, which we expect to be resilient to a repeat of the events observed within the historical record without the need to impose drought restrictions.

Under events more extreme than those observed in the historical record, we have listed the potential benefits of drought measures that may be used under those events, even though the calculation suggests we would not necessarily be in deficit. This is because the triggers to implement drought measures are based on the resource position as a drought progresses (as detailed in our drought plan), and not triggered by the overall event supply-demand balance, which of course cannot be known until an event has ended.

[99] The indicative return periods shown are based on the methodology outlined in the Water UK long-term planning framework project, and related to return periods of a given magnitude of aridity index (balance between rainfall and evapotranspiration) over a given duration drought event.

Table 10-5: Drought severity-benefit table for 2020/21 annual average supply-demand balance

Indicative return period	1 in 100			1 in 200			1 in 500		
Design event	**1921**	**1975/76**	**1933/34**	**1921**	**1975/76**	**1933/34**	**1921**	**1975/76**	**1933/34**
Duration (months)	9	17	24	9	17	24	9	17	24
Severity	historical			severe			extreme		
TWAFU	403	392	404	403	384	394	403	379	394
Demand (DI)	345	345	345	345	345	345	345	345	345
Target Headroom	30	30	30	30	30	30	30	30	30
Supply-demand balance	**29**	**17**	**29**	**28**	**9**	**19**	**28**	**4**	**19**
Benefit of supply-side measures	0	0	0	11	7	9	11	8	9
Benefit of demand-side measures	0	0	0	5	5	5	5	6	5
Balance including measures	**29**	**17**	**29**	**45**	**21**	**33**	**44**	**17**	**33**

Table 10-6: Drought severity-benefit table for 2044/45 annual average supply-demand balance

Indicative return period	1 in 100			1 in 200			1 in 500		
Design event	**1921**	**1975/76**	**1933/34**	**1921**	**1975/76**	**1933/34**	**1921**	**1975/76**	**1933/34**
Duration (months)	9	17	24	9	17	24	9	17	24
Severity	historical			severe			extreme		
TWAFU	396	384	396	395	376	386	395	371	386
Demand (DI)	324	324	324	324	324	324	324	324	324
Target Headroom	28	28	28	28	28	28	28	28	28
Supply-demand balance	**43**	**32**	**44**	**42**	**23**	**34**	**43**	**18**	**34**
Benefit of supply-side measures	0	0	0	11	7	9	11	8	9
Benefit of demand-side measures	0	0	0	5	5	5	5	6	5
Balance including measures	**43**	**32**	**44**	**58**	**35**	**48**	**58**	**32**	**48**

Under the critical period scenarios without the benefits of any drought measures, the supply-demand balance is in surplus under all scenarios in both 2020/21 and 2044/45, the latter surplus in the critical period as a result of the growing surplus over the planning period. The benefits of supply and demand measures is greater than the annual average scenarios.

Table 10-7: Drought severity-benefit table for 2020/21 critical period supply-demand balance

Indicative return period	1 in 100			1 in 200			1 in 500		
Design event	1921	1975/76	1933/34	1921	1975/76	1933/34	1921	1975/76	1933/34
Duration (months)	9	17	24	9	17	24	9	17	24
Severity	historical			severe			extreme		
TWAFU	483	471	466	479	457	456	476	460	456
Demand (DI)	413	413	413	413	413	413	413	413	413
Target Headroom	30	30	30	30	30	30	30	30	30
Supply-demand balance	**40**	**27**	**23**	**35**	**14**	**13**	**32**	**17**	**13**
Benefit of supply-side measures	0	0	0	16	16	16	16	16	16
Benefit of demand-side measures	0	0	0	13	13	13	13	13	13
Balance including measures	**40**	**27**	**23**	**64**	**43**	**42**	**61**	**45**	**42**

Table 10-8: Drought severity-benefit table for 2044/45 critical period supply-demand balance

Indicative return period	1 in 100			1 in 200			1 in 500		
Design event	1921	1975/76	1933/34	1921	1975/76	1933/34	1921	1975/76	1933/34
Duration (months)	9	17	24	9	17	24	9	17	24
Severity	historical			severe			extreme		
TWAFU	477	464	460	472	451	456	469	451	453
Demand (DI)	382	382	382	382	382	382	382	382	382
Target Headroom	28	28	28	28	28	28	28	28	28
Supply-demand balance	**67**	**54**	**50**	**62**	**41**	**46**	**59**	**41**	**43**
Benefit of supply-side measures	0	0	0	16	16	16	16	16	16
Benefit of demand-side measures	0	0	0	13	13	13	13	13	13
Balance including measures	**67**	**54**	**50**	**91**	**69**	**75**	**88**	**69**	**72**

Key uncertainties in drought scenario assessment

Drought return periods

Reliable estimates of drought return period are difficult because:

1. The length of the historical record from which to estimate return periods should ideally be much greater than the frequency of the event occurring. The historic drought record is too short (approximately 100 years) to estimate the return period of events with frequency of 1 in 100, 1 in 200 and 1 in 500 with accuracy. The methodology used to estimate drought return periods* assumes the worst drought on the 100 year historic record has a return period of 1 in 100.
2. Drought severities, particularly for conjunctive use systems, should only be views as estimates due to the many non-linear processes in water resources systems models†.
3. Drought severity does not also relate directly back to levels of service, as some droughts may be more severe, but not require drought restrictions†.

Uncertainties in deployable output assessment†

- The performance of a supply augmentation scheme may vary significantly between droughts.
- Behaviour of 3rd party abstractors or dischargers may be significantly different to assumed.
- Extrapolation of rainfall-runoff models to worse droughts may be non-linear, and models may fail to capture fully important processes.
- Uncertainties in Deepest Advisable Water Pumping Level (DAWPL) for GW sources or performance at water levels lower than those experiences in historic operation.
- Possible outage events for which no data exists for severe droughts.
- Additional outage to that used in the WRMP assessment such as water quality related treatment constraints.
- Loss of transfer from a neighbouring zone or company, which is assumed reliable.

Demand uncertainties

- Uncertainty in the effectiveness of customer drought restrictions (temporary use bans and non-essential use drought orders).

Drought order uncertainties‡

- Uncertainty in the time taken for drought permits/orders to be approved, and if they will be approved, given the requirement to demonstrate need and environmental assessment, such that their full intended benefit might not be realised.

*Water UK Water resources long term planning framework project.
†EA drought plan and WRMP links supplementary guidance.
‡UKWIR risk-based planning guidelines.

10.2 Stress-testing scenarios

10.2.1 Potential sustainability reductions

As discussed in Section 4.4, we have a number of potential sustainability changes – reductions to abstraction licences – that, pending the findings of the water resource investigations in the period 2020-25 may need to be implemented. The planning guidelines states that we should assess the impact of possible future sustainability changes through scenario testing.

We have reviewed the potential for future sustainability changes that could arise from the investigations planned between 2020 and 2025, and made an assessment about what a 'low', 'likely' and 'high' sustainability reduction volume could be for each of the thirteen sources, as shown in Table 4-4. For the dry year annual average scenario, we estimate the potential reduction volumes as 0 Ml/d, 4.87 Ml/d and 11.11 Ml/d for the low, likely and high scenarios, respectively. Figure 10-1 shows the impact of the likely and high scenario on our surplus from 2025, the earliest potential time that the reduction might be required.

Figure 10-2 shows the same reductions for the critical period, which for the low, likely and high scenarios are 0 Ml/d, 5.74 Ml/d, and 13.21 Ml/d, respectively. Under both planning scenarios, we remain in surplus under both the likely and high reduction scenarios.

Figure 10-1: Impact of sustainability reduction scenarios on the annual average surplus

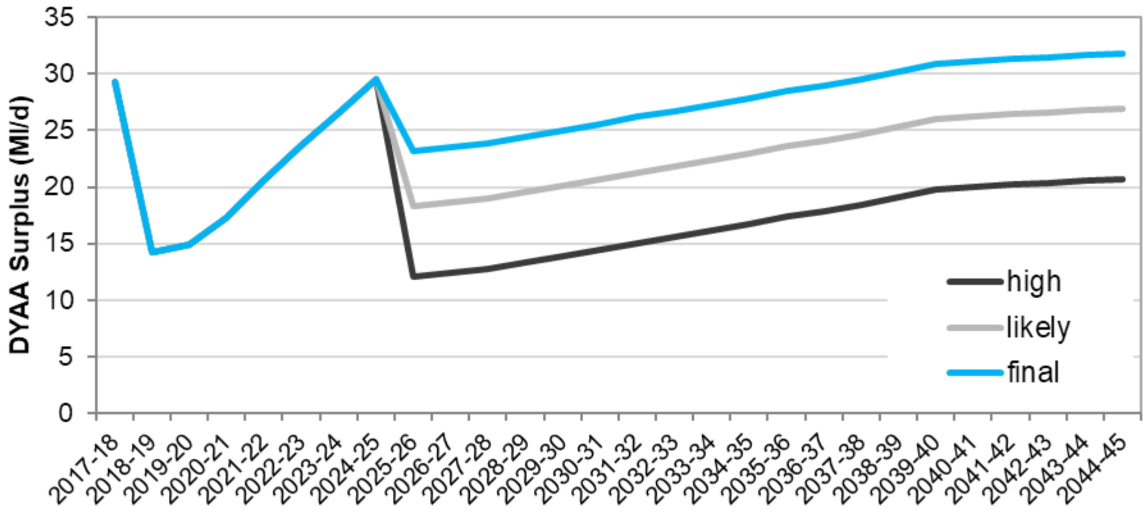
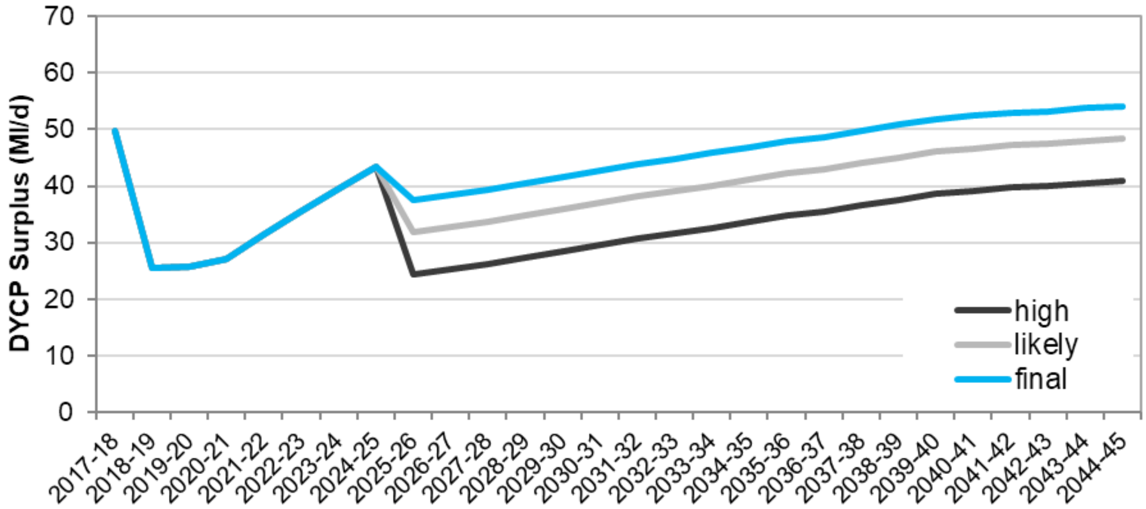


Figure 10-2: Impact of sustainability reduction scenarios on the critical period surplus



10.2.2 Household and population growth

As presented in Section 5.3, we have based our plan on what we view is the most likely household growth forecast for our region, that meets the annualised housing requirements set out in Local Authority plans for the region, but is smoother in delivery compared to the combined housing trajectory produced by local councils.

We have a statutory duty to provide water for new development, and are required to accommodate the growth plans set out by local and national government for our area. We have therefore considered the impact on our supply-demand balance if household growth rates are higher in the short-term and match those of local authority housing trajectories (see Figure 5-11). It should be noted that the combined local authority housing trajectory results in an additional 7,000 households over the planning period in comparison to the annualised requirements based on the local plans themselves. For this scenario, we have maintained household occupancy assumptions, and uplifted population accordingly.

Figure 10-3 and Figure 10-4 show that higher housing delivery early on in the planning period, in combination with an overall increase in housing, leads to a small reduction in our surplus of ~1.5Ml/d in 2020/21 and ~2.5Ml/d in 2044/45, approximately 10% of surplus in the respective years. The difference is therefore not material in either the annual average or critical period scenarios, and given the surplus remaining, suggests we could accommodate a higher household growth rate than the additional 7,000 households.

It should be noted that we considered the impact on our supply-demand balance of population uncertainty, as shown by the 90% population forecast uncertainty bounds shown in figure 5-13. This uncertainty was included in our headroom analysis when calculating the supply-demand balance.

Figure 10-3: Impact on surplus of additional household scenario on annual average surplus

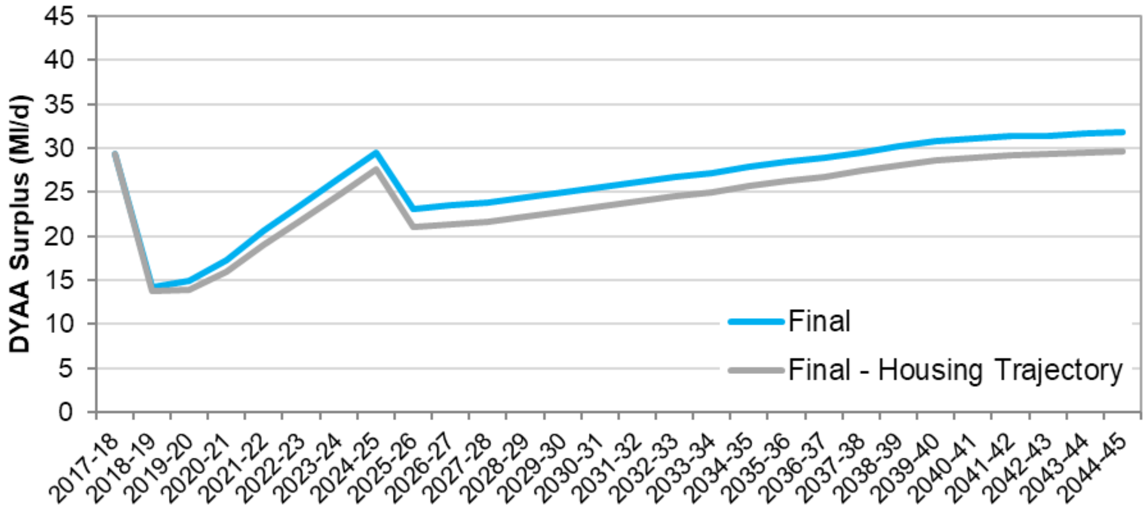
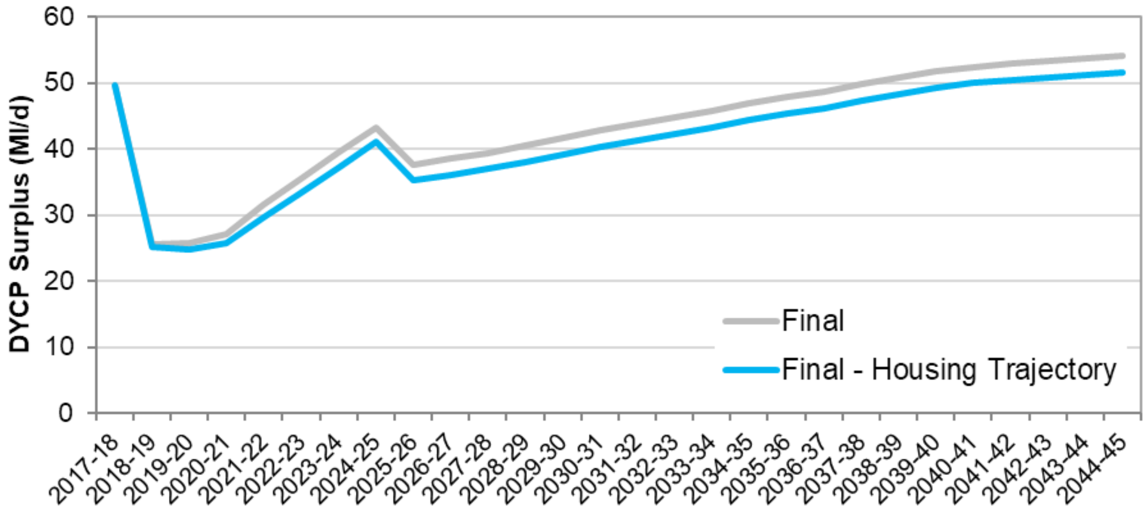


Figure 10-4: Impact on surplus of additional household scenario on critical period surplus



10.2.3 Extended forecast horizon – 2060

We have developed our plan on the basis of a 25 year forecasting horizon, up to 2045, which indicates a growing surplus over the planning period. Towards the end of the plan-period, however, we see a slight decline in the growth rate of the surplus, and also the rate of metering slows to 90% as we approach metering saturation.

We have therefore extended our forecast horizon by a further 15 years to 2060, by making simple assumptions about future trends, to gain a provisional understanding of future surplus. This provides helpful insight in the context of the potential for developing new bulk supply transfers.

To extend the forecast, we have assumed the following:

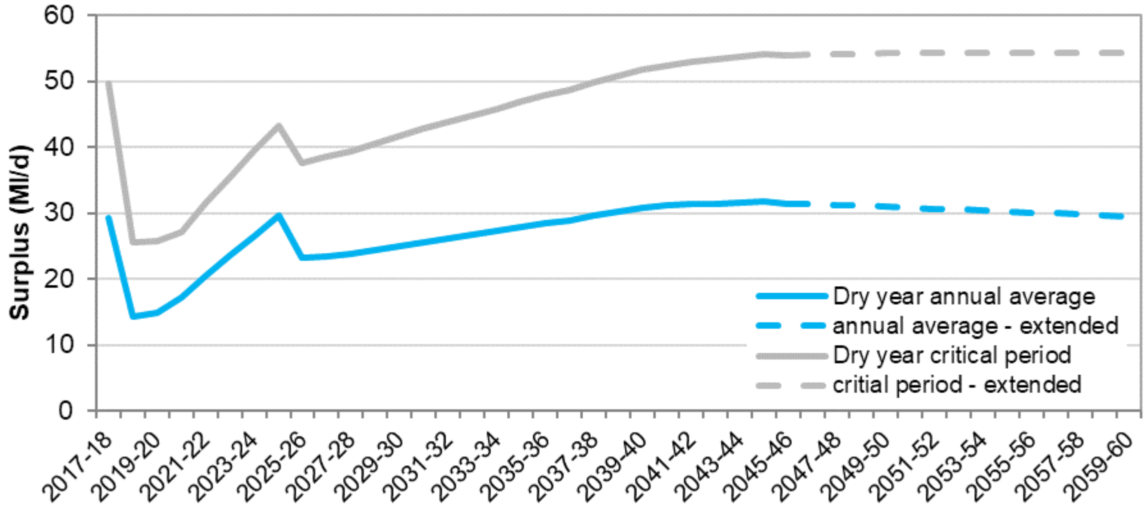
- Population (0.37%) and household growth rate (~4000 properties per year) at same rates as in 2045.

- Extrapolate trend in rate of metering (increase to 93% by 2060), distribution losses (declining by further 6 Ml/d), and water efficiency scheme savings (further 1.3 Ml/d saving).
- Climate change reduction by an additional 0.5 Ml/d annual average and 0.15 Ml/d peak, using same climate change methodology back calculated from 2080s.
- Continued declining trend in weighted average per capita consumption (an additional 0.7 litres per person per day over extended horizon to 122 litres a day by 2060.

Figure 10-5 shows the extended forecasting horizon to 2060, which indicates that, based on a continuation of existing trends, our growth in surplus would plateau at approximately 26 Ml/d annual average and 30 Ml/d critical period. Beyond 2045 the decline in the rate of metering leads to a decline in savings (both in demand and supply-pipe losses), which alongside smaller forecast savings in water efficiency, means increased demand associated with continued population and property growth will outweigh demand savings once we reach (close to) saturation of meter penetration.

It should be borne in mind, however, that this extended forecast is conservative in the sense that it does not include additional savings in water efficiency and leakage reduction that might come forwards over the next 40 years through innovation that could be delivered between 2045 and 2060.

Figure 10-5: Forecast surplus over planning period for annual average and critical period, extended to 2060



10.2.4 Potential new transfers to neighbouring water companies

<u>Southern Water</u>

Our pre-consultation discussion identified that Southern Water were expecting deficits to address during their planning period as a result of changes to key abstraction licences in their Hampshire water resources zone. On the basis of our baseline supply-demand balance, we indicated to Southern Water a potential surplus volume for trading of between 10 and 15 Ml/d from Poole region.

Figure 10-6 and Figure 10-7 show the impact of a 15 Ml/d bulk export on our surplus for the dry year annual average and critical period scenario. These figures show that we could accommodate such a transfer within our current surplus without reducing the level of service for our own customers.

We agreed with Southern Water to include this trading opportunity as a scenario test against our final plan supply demand balance for this draft final water resources management plan. Further detailed design work will be required from 2020-2025 to provide detailed cost and volume estimates, and also more undertake a detailed assessment of reliability under drought scenarios. In supporting such a transfer we also need to consider the potential sustainability reductions in supply that may result from the investigations scheduled for the 2020-25 period (Section 10.2.1).

Figure 10-6: Annual average surplus for final plan including new bulk export

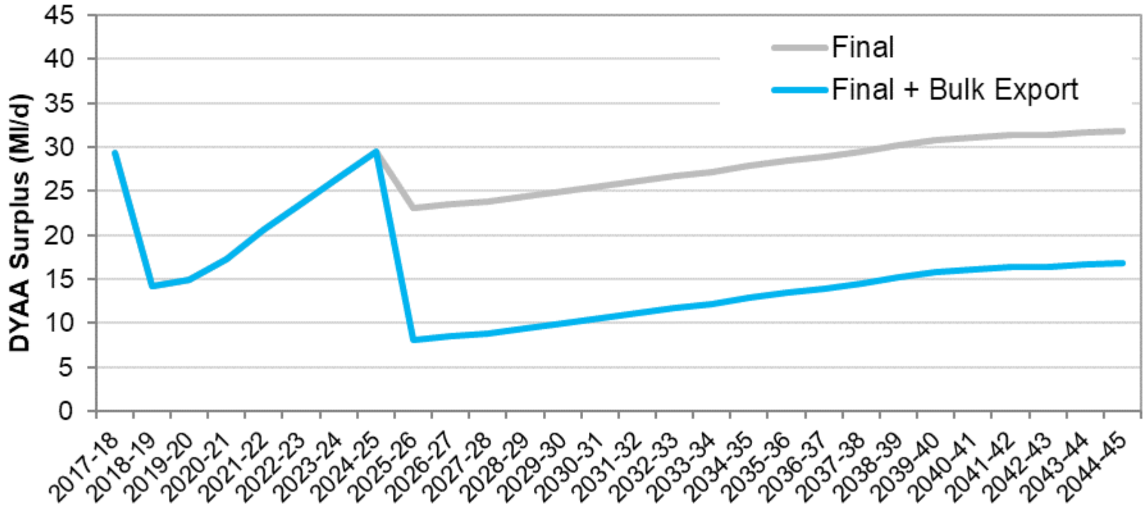
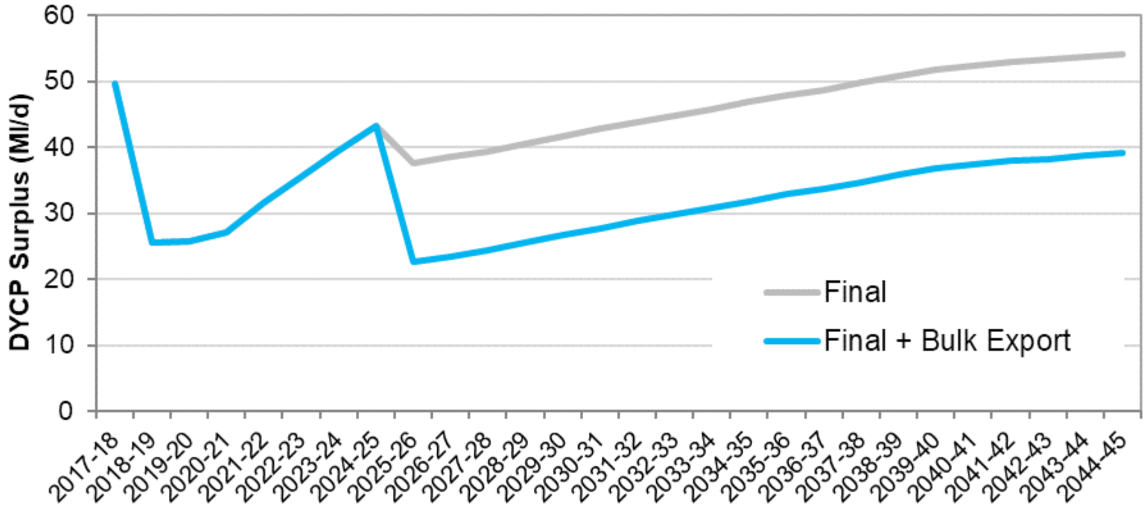


Figure 10-7: Critical period surplus for final plan including new bulk export



Thames Water

During pre-consultation, we discussed with Thames Water an option for a possible 2.9 Ml/d transfer from the north of our zone in the Malmesbury area into Thames Water's SWOX (Swindon and Oxfordshire) water resources zone. Thames Water has informed us that whilst the option has been selected in some of their stress test scenario runs, the option has not been selected in their preferred plan.

Whilst we indicate a growing regional surplus over our plan period (reaching 26 Ml/d in 2045), and a fairly stable surplus up to 2060 (Section 10.2.3), our analysis does not project up until 2071 and beyond, which is the time from which the option was included in our draft plan. If we assume that trends used to extrapolate up until 2060 continue towards the end of this century, then we can anticipate that we could support such a transfer; however, there is considerable uncertainty in forecasting beyond 60 years into the future.

The availability and need for this transfer can be reviewed with Thames Water in future water resource planning cycles.

Bristol Water

During the pre-consultation period, as we determined our relative resource requirements we discussed the potential for a number of potential bulk transfers between our supply areas. Potential transfers, and combinations thereof considered baseload requirement, drought resilience and outage resilience requirements.

These transfers included possible new connections from Wessex Water to Bristol Water in the Bridgwater and Frome areas of up to 10 Ml/d and the modification of existing transfer arrangements for the Bristol Water to Wessex Water Bath transfer to include a baseload reduction and mutual resilience options.

We have included in our baseline scenario a reduction in the Bath import from 11.3 Ml/d to 4.4 Ml/d annual average and peak period from 2025/26. Contractual terms are currently under discussion, and we will update our water resources management plan in due course accordingly.

10.2.5 Large outages

In Section 4.10, we presented our outage allowance, which is derived based on a stochastic analysis of our historical outage record. Such an approach is appropriate for deriving an allowance for smaller and more frequent outage events; however, is less appropriate for understanding the impacts of larger source outages on our supply-demand balance.

Our minimum surplus identified throughout the planning period is 14 Ml/d dry year annual average, and 25 Ml/d during the critical period. The majority of our sources have deployable outputs lower than these surpluses.

The effect of an outage of one of our reservoir sources, Sutton Bingham, is shown in Figure 10-8 and Figure 10-9. These indicate that while our surplus is reduced at the minimum it is still in excess of 6 Ml/d and this is a conservative estimate as in effect some elements of outage are double counted (as the outage allowance that is unchanged in this analysis will already accommodate a small volume associated with potential outages at Sutton Bingham). Whilst the outage volume is more significant during a critical period, the likelihood of these combined events is low.

Figure 10-8: Impact of Sutton Bingham outage on annual average surplus

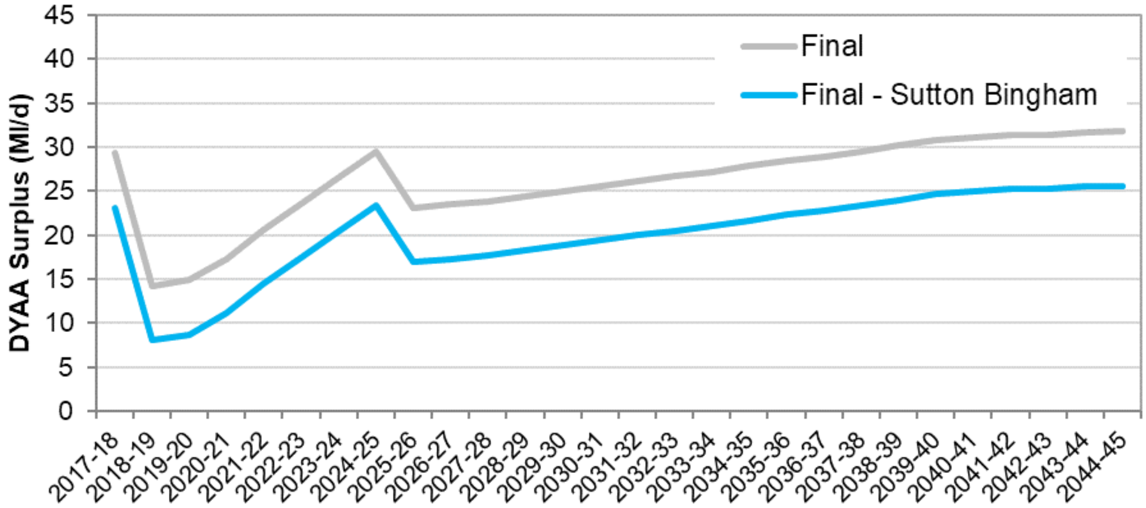
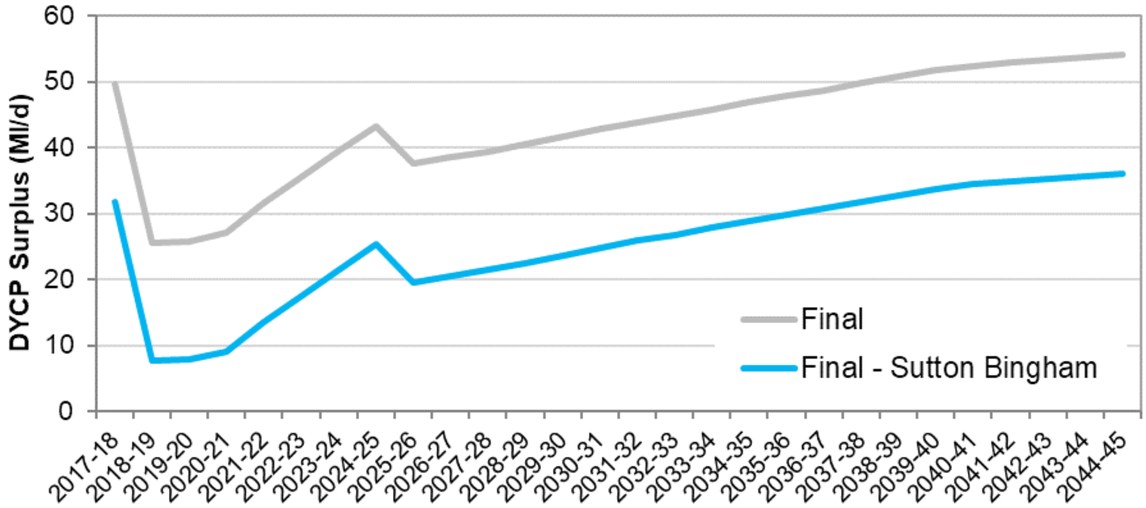


Figure 10-9: Impact of Sutton Bingham outage on critical period surplus



The resilience of our largest treatment works is considered in further detail in Section 7.

10.2.6 Reductions in household demand

In April 2018 Ofwat and Artesia published a report entitled “The long-term potential for deep reductions in household water demand”, which considered the potential for making deep reductions in household water consumption and supply pipe leakage up to 2065. The study modelled five potential scenarios of future demand, comparing a current ambition scenario with four other scenarios based on different assumptions about future drivers on demand including public perception and awareness, regulatory intervention and technology adoption.

The study found that the scenarios that led to the greatest reductions in demand were the technology and service innovation scenario, with market driven high-tech solutions, including smarter tariffs and pay-per-use, and the localised sustainability scenario, with greater competition for delivery of water resources and services, which positively influences consumer behaviour. Through these scenarios it was concluded that it is possible to achieve average household consumption of between 50 and 70 litres per person per day, but this will not be delivered by the industry working in isolation, and actions were required to move beyond the business as usual.

Through scenario testing, we have calculated the impact on our supply-demand balance of achieving per capita consumption of 50 and 70 litres per head per day in our region by 2065, which is shown in Figure 10-10 and
Figure 10-11 in comparison to our final plan scenario[100]. The analysis shows that such reductions could increase the dry year annual average surplus by 60 to 90 Ml/d and the critical period surplus by ~80 to 100 Ml/d.

Figure 10-10: Impact of a 50 and 70 l/head/day PCC reduction target by 2065 on the final plan supply demand balance (DYAA)

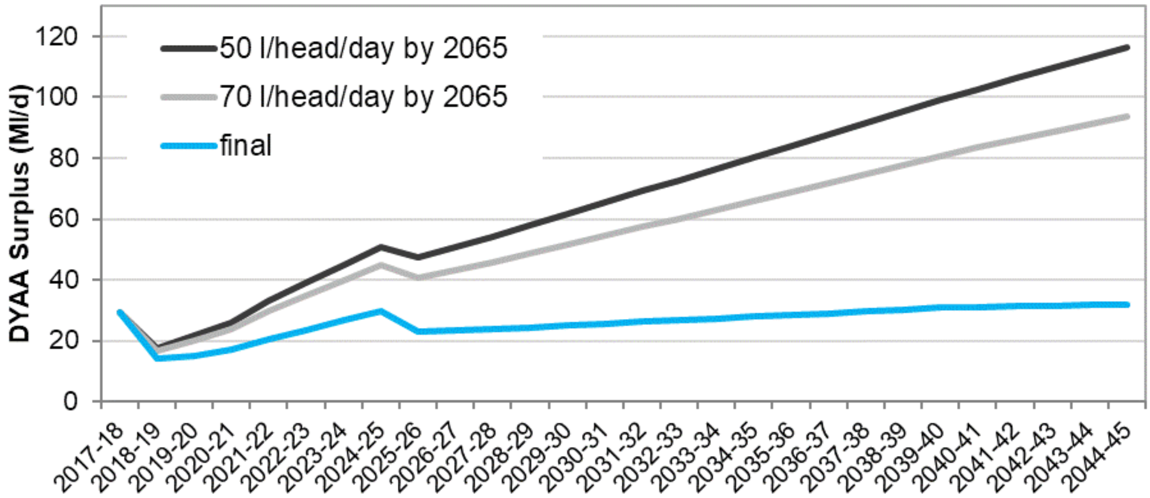
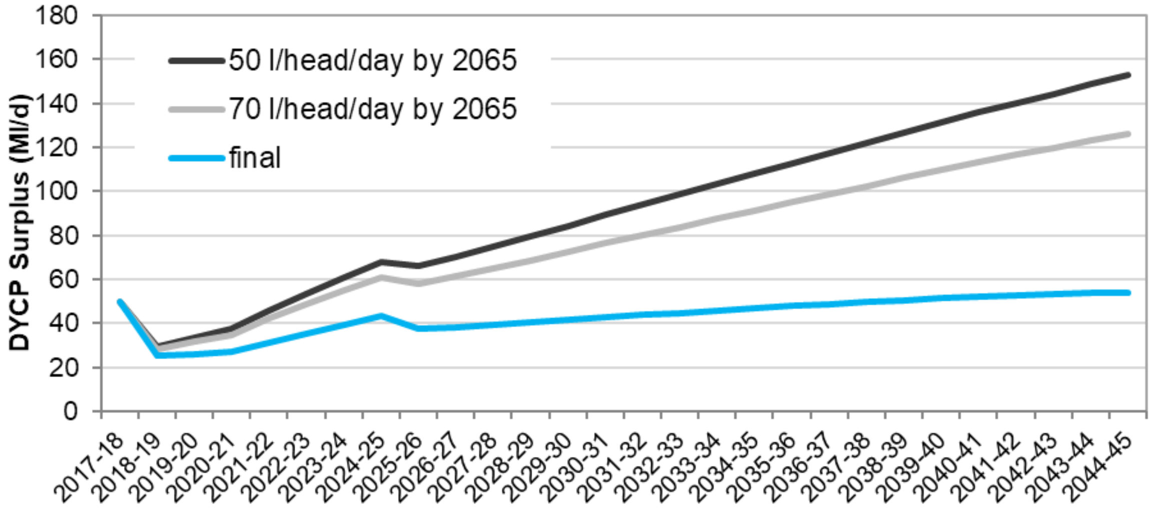


Figure 10-11: Impact of a 50 and 70 l/head/day PCC reduction target by 2065 on the final plan supply demand balance (DYCP)

[100] Our approach assumes a linear reduction in PCC from our base year value to the 2065 targets.



Our final planning scenario forecasts a modest decline in per capita demand across the planning period, in part through our increased metering and water efficiency activities. Our base year PCC is one of the lowest in the industry yet in recent years we have observed an upward trend in PCC (Figure 5-2). We believe our forecast is an accurate and appropriately conservative projection of future demand given our relative ability to influence consumer demand and the uncertainty surrounding future legislative changes and the pace of innovation.

To achieve deep reductions in household demand, the Ofwat report recommends a number of first steps, including:

- Stronger leadership to ensure coordination across industry stakeholders.
- Monitor progress towards deep reduction in demand.
- Metering all domestic properties to facilitate future savings through customer behaviour, utility services, water saving technologies, and further research on tariffs.
- Mandatory water labelling to help consumers select water efficient products.
- Tackle losses from leaky loos through product standards for new toilets, along with monitoring and fixing plumbing losses.
- Develop strategy to reduce customer supply pipe losses and maintain assets.
- Prioritise research into behaviour change relating to customer choice for products and water use practices.
- Update planning rules to require new developments to be water efficient – e.g. through community rainwater harvesting and water reuse.
- Make performance data openly available to encourage and facilitate innovation.

It is clear from this set of recommendations that the achievement of deep reductions in demand will require not only commitment from water companies but also from the Government and our regulators.

The greater use of markets is important for both scenarios evaluated by Artesia that deliver the greatest savings in water use. Section 12.2 of this plan sets out our plans to adopt an open systems approach to the future delivery of our core business outcomes and this has been set out in our Business Plan submission to Ofwat in September 2018. The Artesia study identifies that of the different measures that may be used to reduce household water demand, some of the greatest savings may be achieved through community rainwater and effluence re-use. We believe that possible market engagement in this area for new developments can help to deliver deeper household demand reductions (see Section 12.2).

Our ambition to explore the use of markets to help deliver resilience water supply and deeper reductions in demand, will we believe be most effective if delivered in concert with greater co-ordinated leadership across the industry, and clear commitments from government and regulatory bodies in some of the areas highlighted above, including compulsory metering of all domestic properties, and greater rules around water efficiency, in particular in new developments (Section 12.4

11 Final supply demand balance

Figure 11-1 shows the final planning dry year annual average supply-demand balance, and Figure 11-2 show the change in surplus between baseline and final resulting from the preferred options. The effect of the preferred options (Section 9.9) is to reverse the negative trend in our baseline surplus over the planning period, leading to a growth in surplus from ~14 Ml/d, the minimum in the plan period in 2018-19 to 32 Ml/d in 2045 (Table 3-1).

Figure 11-1: Final supply demand balance for the dry year annual average scenario

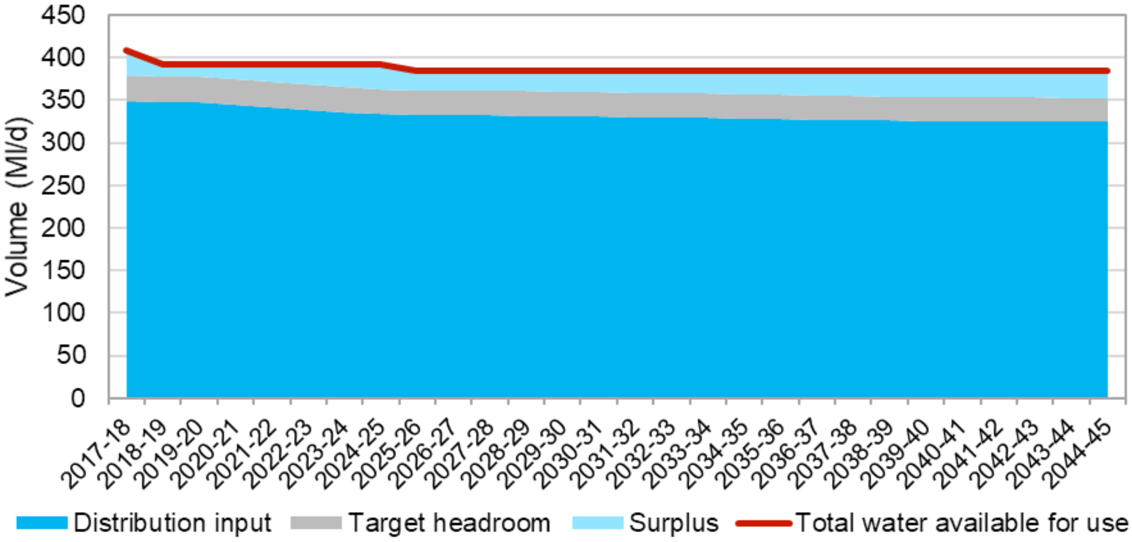


Figure 11-2: Change in surplus between baseline an final for the annual average scenario

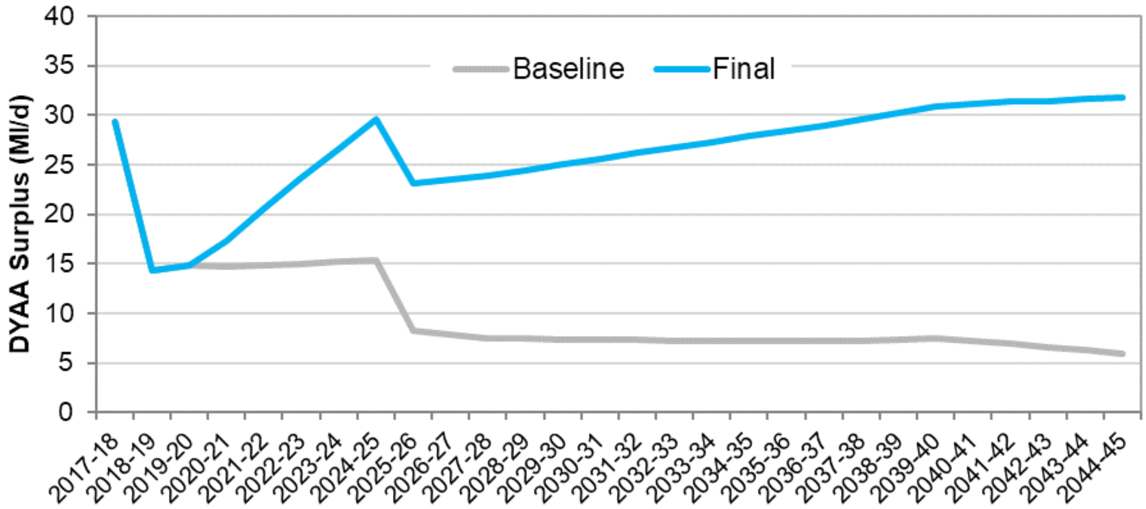


Table 11-1: Final supply-demand balance for the dry year annual average scenario

Dry Year Annual Average	2017/18	2019/20	2044/45
Distribution input (Demand)	349	348	324
Total water available for use (Supply)	409	393	384
Target headroom	30	30	28
Supply-demand balance	**+30**	**+15**	**+32**

Figure 11-3: shows the final planning dry year critical period supply-demand balance, and Figure 11-4 shows the change in surplus between baseline and final resulting from the preferred options. The effect of the preferred options is to increase the baseline surplus over the planning period, from a minimum of ~26 Ml/d in 2018/19 to ~54 Ml/d in 2045 (Table 3-1).

Figure 11-3: Final supply demand balance for the dry year critical period scenario

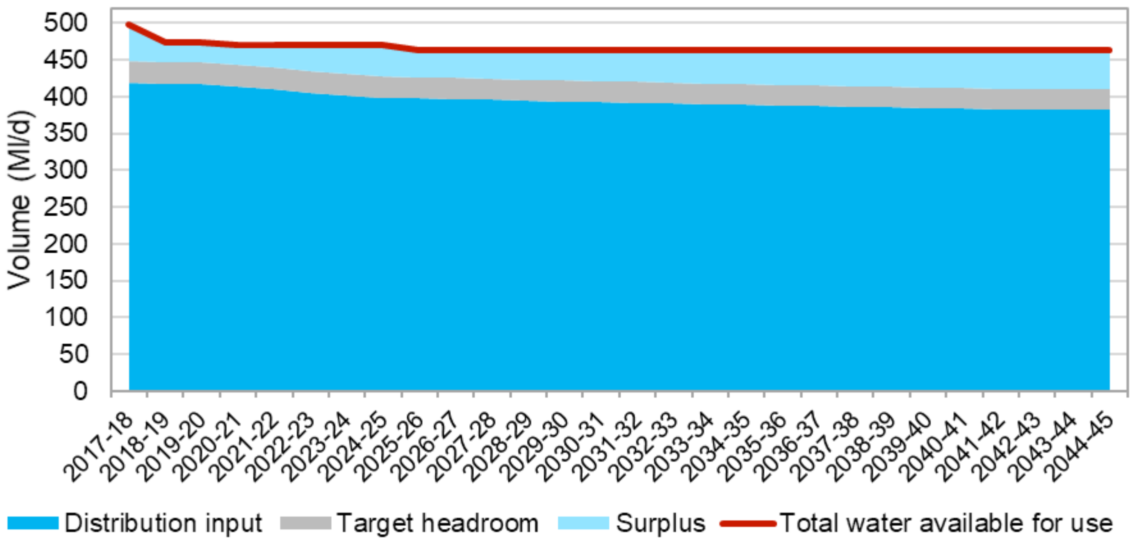


Figure 11-4: Change in surplus between baseline an final for the critical period scenario

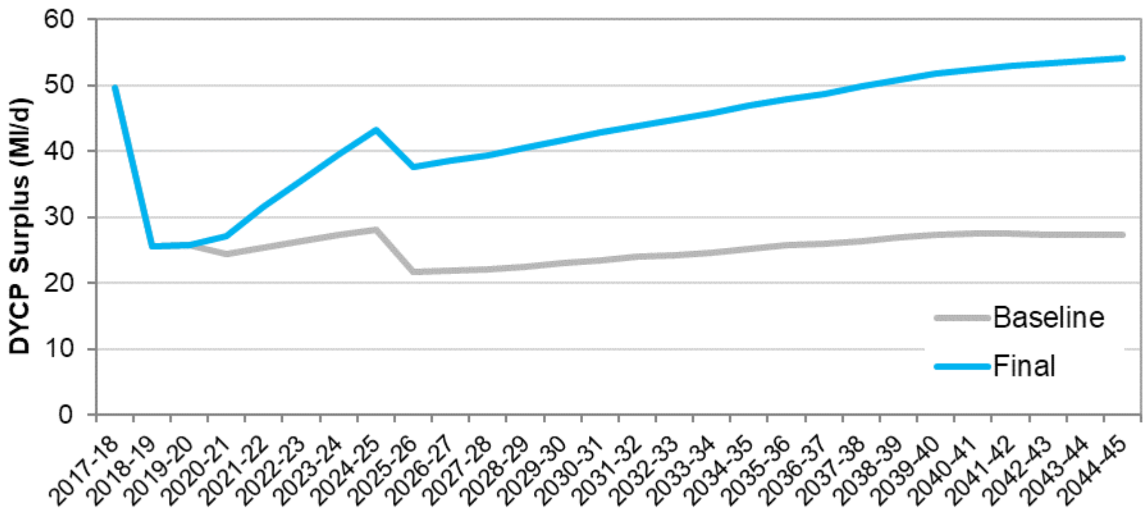


Table 11-2: Final supply-demand balance for the dry year critical period scenario

Dry Year Annual Average	2017/18	2019/20	2044/45
Distribution input (Demand)	418	417	382
Total water available for use (Supply)	498	473	464
Target headroom	30	30	28
Supply-demand balance	**+50**	**+26**	**+54**

We forecast to remain in surplus throughout our planning period under both dry year annual average and dry year critical period scenarios. We will therefore be able to achieve our planned level of service throughout the planning period.

11.1 Environmental screening of preferred options

11.1.1 Strategic Environmental Assessment and Habitats Regulations Assessment

We contracted consultants Ricardo to review our draft Water Resources Management Plan and determine the need to undertake a Strategic Environmental Assessment (SEA) on our final planning scenario and additionally undertake the Stage 1 Screening for the Habitats Regulations Assessment (HRA).

The purpose of the HRA screening is to assess whether any schemes in the preferred option list have the potential for a likely significant effect on the integrity of a European site including Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites.

Our final planning scenario consists of demand management schemes (e.g. metering and water efficiency measures) and as these will not result in any new development or water abstraction, and will be largely implemented within urban areas, the Plan is not likely to have a significant effect, alone or in combination, on the integrity of any European sites. Ricardo prepared a draft HRA Screening report to document and present the conclusion that that there is no need to progress to Stage 2 of the HRA process, Appropriate Assessment.

Similarly since the Plan does not involve any resource developments or significant construction activities the SEA screening identified that a full SEA on our Plan was not required. Ricardo prepared a draft SEA screening statement confirming this finding.

The HRA Screening report and SEA Screening Statements were sent to the statutory consultees (Environment Agency, Natural England and Historic England) for comment in October 2017.

The Environment Agency and Historic England responded that they agreed with the conclusion of the draft screening statement that it is not necessary to prepare a formal SEA.

We received comments back from Natural England raising some concerns in relation to water abstraction from Somerset rivers in relation to the water level management of the Somerset Levels and Moors Ramsar site. Natural England noted that the 2010 Environment

Agency Review of Consents for this location was conducted only in relation to the features of the Somerset Levels and Moors Special Protection Area (SPA) and not the Ramsar designation, which includes invertebrate and plant communities, and breeding wading birds, in addition to the SPA interest feature (wintering waterfowl). Through our Drought Plan we committed to liaise with the Environment Agency and the Canal and River Trust (CRT) to develop a better understanding of the transfer of water from the River Tone to the Bridgwater and Taunton Canal, and the potential wider environmental impacts. This commitment includes the continued collection of baseline monitoring data for ecological features to extend to a six year collection period, and working with the CRT to improve flow gauge data reliability. As this issue relates to existing water resource management arrangements, and not to any proposed option within this draft water resources management plan (which includes demand management options only) it is not considered material to the current screening decision.

The comments from consultees were incorporated into the final SEA Screening Statement[101] and final HRA Screening Report[102], which are available as a technical appendices to this Plan.

[101] Ricardo (2017) Wessex Water: Draft Water Resources Management Plan (dWRMP) 2019 - SEA Screening Statement

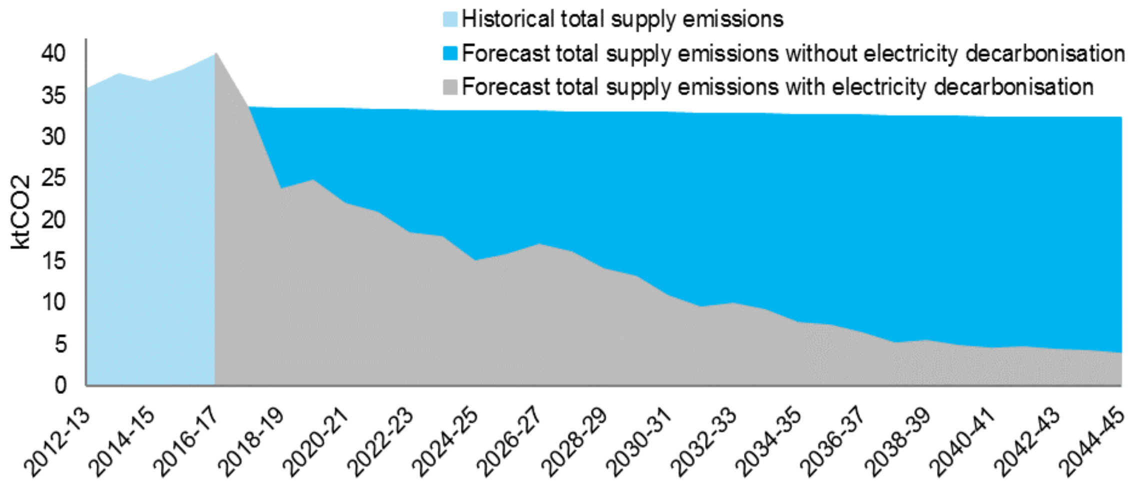
[102] Ricardo (2017) Wessex Water: Draft Water Resources Management Plan (dWRMP) 2019– Habitats Regulation Assessment, Stage 1 Screening

11.1.2 Greenhouse gas emissions

Figure 11-5 shows our forecast carbon emissions (tonnes of CO_2 equivalent) for our final planning scenario. The more steeply falling curve accounts for the projected reducing carbon intensity of grid electricity supplied to the industrial sector over the planning period. The flatter projection assumes the carbon intensity of the grid held at the 2016 level.

This demonstrates that our final plan, that includes the demand management options to enhance metering, water efficiency and deliver leakage reductions, results in a downward trend in carbon emissions associated with our activities, even without allowing for the effect of the decarbonisation of the national grid.

Figure 11-5: Carbon emissions projection for the final planning scenario



12 Summary and vision towards WRMP24

We have presented a plan, which ensures no overall increase in the amount of water abstracted from the environment, despite increases in population growth and climate change – a water neutral plan. Demand management is central to our strategy to minimise our impact on the environment, which alongside our integrated water supply grid, ensures we can provide a high level of service to our customers. This was demonstrated during the freeze-thaw conditions in March and the heatwave in June and July 2018, which did not impact on services to customers. Our grid investment has, in parallel, brought greater environmental protection to sources in the Bourne and Wylye catchments.

Customers are at the heart of this plan and their views and aspirations have been embedded into our plans for enhanced metering and water efficiency services, that will see average per capita consumption fall, and a leakage strategy that will deliver a 15% reduction in leakage by 2025. In combination these programmes will maintain high levels of resilience in the face of the pressures and uncertainties associated with a growing population and climatic change.

The Water UK Water resources long-term planning framework identified the significant and growing risk of severe drought impacts arising from climate change, population growth, and environmental drivers in the UK. We recognise the National Infrastructure Commission's report on Preparing for a drier future that recommends a twin-track approach of demand management, and supply investment through a national water network and increased water trading to address these issues.

Coupled with demand reductions in our region, we are actively pursuing opportunities to play our part in improving resilient water supplies across our region in areas where water is scarcer. We believe this can be achieved through regional planning and market-based opportunities, which alongside improvements in our planning methods, will provide a strong evidence base for identifying improved regional solutions.

12.1 Future regional water resources planning

In 2017 we were a founding member of the West Country Water Resources Group that seeks to undertake regional water resource planning to identify optimum solutions for the region and, in particular, explore new trading opportunities. Potential new or revised transfers include transfers to:

- **Southern Water:** to partially address their deficits due to sustainability reductions
- **Bristol Water:** for improved resilience.

We've already embraced an opportunity to enhance our resilience through a cross-border transfer arrangement in the south of our region near Poole. The arrangement provides resilience benefits to Wessex Water and South West Water (Bournemouth area) by maximising the use of existing assets. We have also identified potential effluent re-use schemes in the Poole area, and will be undertaking further work to understand their feasibility in helping to offset potable water demand to support a transfer, and provide part of a regional solution.

Our work in the next period as part of the West Country Water Resources Group will see us continue the regional analysis of water resources planning and exploration of cross-sector solutions, including new trading opportunities, and region wide optimisation, to develop a regional plan, that will inform the development of our Water Resources Management Plan for 2024. This work will also include widening the group membership to non-water company sectors and helping the publication of information to promote future water markets.

12.2 Embracing markets for Water Resources

Markets are key to delivering future water resilience, and we welcome Defra's call for greater use of markets and competition in the sector to deliver resilient water supplies[103]. We are adopting an open systems approach to future delivery of our core business outcomes and this has been set out in our Business Plan submission to Ofwat in September 2018. Our Open System Coordinator (OSC) concept proposes that a distinct process within Wessex Water will be tasked with pro-actively identifying opportunities for third party delivery of services, and ensuring that the most efficient / effective services are procured.

Our Open Systems approach builds on our track record of innovative approaches. Our business plan for PR19 sets out how we will progress this model to deliver efficiencies and better outcomes for customers, stakeholders and the environment. This is an approach that we have already taken with, for example, the creation of GENeco and EnTrade, but we see greater opportunities for other market solutions to be explored; see for example the case study in the box on new housing development. We have published a Bid Assessment Framework as part of our business plan that is consistent with our wider open systems strategy.

Possible market engagement for new housing developments

Wessex Water is supportive of the ambition to increase the provision of water efficient homes across the UK. Whilst forecasts that we will have enough water to meet demand for the next 25 years, challenges may be faced to meet peak demand for isolated new developments. Over the next investment period (2020-25) we will follow our open system principle, as supported by the bid assessment framework, to work with the market in such instances. We believe there may be market opportunities available to offset costly capital works in areas where new developments are placing additional demands on a network at capacity, or would result in an undesirable impact on the environment.

For example, through working with third parties to reduce peak potable water demand through on-site non-potable supplies, we may be able to identify a solution that reduces expenditure in the long-run, provides the upfront and ongoing contributions that allow a third party to create a water reuse scheme, and give a faster response to the developer than a wider asset upgrade.

An alternative solution could be provided by communities themselves, which would be an adaptation of the abstraction incentive mechanism (AIM) where currently we limit the use of a sensitive local source in favour of a more expensive alternative. Going forward, in exchange for financial support, local communities could commit to reducing their potable

[103] Building resilient water supplies – a joint letter, from Defra, the Environment Agency, the Drinking Water Inspectorate and Ofwat (9th August 2018).

water use of the sensitive source to create the additional capacity required; the housing developers themselves could even engage with this process and improve the water efficiency in their homes beyond the required per capita consumption figures.

12.3 Developing our planning methods

Our long-term approach to water resources planning is for the incremental adoption of more advanced methods, to avoid step-changes in methodology, and ensure a firm evidence base underpins our planning decisions. Adopting risk composition 2 therefore represented a proportional step forwards in our planning processes for this plan.

During and since the determination of our planning methods and the development of the draft plan however, there has been growing expectation on water trading with neighbouring companies to increase regional and national scale drought resilience, and as we move toward WRMP24, the need to produce regional plans that feed into individual company plans[104].

Our intention is to make iterative changes as we build towards WRMP24 through the development of our planning methods, both as a company, and also as part of the West Country Water Resources Group. However, the near future imposition of reductions in Southern Water's abstraction licences, relative to the 5-yearly WRMP planning cycle, means the issue for Southern Water is more pressing. To robustly support decision making relating to a potential new transfer and adequately assess uncertainties relative to other factors affecting our supplies (e.g. potential WINEP driven licence reductions), we are keen to make some step-changes in methodology. We will progress with work on this in the Autumn of 2018, to feed into our ongoing work as part of the West Country Water Resources Group.

We will expand our conjunctive use system modelling and investigate methods for better incorporating uncertainties into our system modelling. This will allow us to:

- Explore alternative metrics of system performance relating to system resilience. Moving towards a system-simulation approach will allow us to generate multiple metrics of system performance, for example, to calculate 'days of failure' to feed into the work required for the Drought Vulnerability Framework.
- Better explore system performance under a range of potential future scenarios.
- Explore better how the integrated grid, which sits at the centre of the South West region, can be used to support regional planning solutions, by using the model to explore potential import and export volumes.
- Incorporate better spatial uncertainties in future population and property growth in the region.
- Provide the technical basis to move to system simulation based planning methods for WRMP24 (e.g. robust decision making, Infogap analysis), as required by the outcomes of our system modelling, and the needs to identify regional solutions.

We are also working to improve our weather-demand modelling, which we will incorporate into our system simulation modelling through better representation of demand patterns

[104] Building resilient water supplies – a joint letter, from Defra, the Environment Agency, the Drinking Water Inspectorate and Ofwat (9th August 2018).

reflecting weather patterns of specific drought events, incorporating the work developed through our current academic partnerships. This work will also incorporate the latest demand data collected during the extended dry period of 2018.

12.3.1 Summary of current academic research partnerships

We have developed partnerships with world leading universities to enable us to bring the best academic research into our resource planning practice. We are currently supporting two research projects as part of the Water Informatics Science and Engineering (WISE) EPSRC[105] centre for doctoral training, with the Department of Civil Engineering at University of Bristol and the Centre for Water Systems at the University of Exeter. One of these projects is exploring the relationship between household water demand and weather to develop improved approaches for modelling weather-dependent demand. The other project is investigating the trade-off between water supply reliability and pumping energy costs under uncertainty, aimed at developing an improved water resource simulation model and optimisation tools to support reservoir operation.

We are also working with the Department of Civil Engineering, University of Bristol on a £700,000 EPSRC Environmental Change Challenge Fellowship project to improve the robust planning and operation of water resource infrastructure under droughts and future uncertainties, both to enhance short-term decision-making during droughts, and to improve long-term planning decisions under large future uncertainties.

Wessex Water also has an established relationship with the University of Bath, and collaborated with the university to launch to Water Innovation and Research Centre, which has eight water related research themes[106]

12.4 Co-ordinated leadership across the industry

We agree with our regulators that to meet the challenges of ensuring resilient water supplies in the future, we need ambitious and co-ordinated leadership across the industry, and we welcome their commitment to providing clear and joined up direction for the sector[107].

We are of course happy to continue to own this challenge, as reflected in our ambition for demand reduction strategies, the adoption of an open systems approach, and our commitment to regional planning. To support our ambition we would welcome clear commitments from government and regulatory bodies in the following areas:

- On metering – since we introduced the first social tariff in 2007 the industry has taken great strides in developing schemes that protect customers in more vulnerable circumstances. Government should now be able to commit to a statutory presumption in favour of household metering knowing that the adverse impacts will be mitigated. 15% average savings in demand can be achieved from metering, as found in our tariff trial, and replicated by Southern Water's universal metering

[105] EPSRC is the Engineering and Physical Sciences Research Council, which is the main UK government agency for funding research and training in engineering and the physical sciences.
[106] http://www.bath.ac.uk/research/centres/wirc/ - last accessed 26/11/2017
[107] Building resilient water supplies – a joint letter, from Defra, the Environment Agency, the Drinking Water Inspectorate and Ofwat (9th August 2018).

programme. Such savings are greater during critical summer periods. Making it possible for companies that are not classed as water stressed to implement universal metering has the potential to reduce abstraction in line with the Government's 25-year environment plan and/or free up capacity for greater water trading with water stressed areas.

- On building regulations and product standards – regulations to encourage new developments to install community level rainwater harvesting and water reuse schemes and changes to the product standards for toilets are required and could help foster greater innovation, and reduce internal water losses.
- Amending government guidance on charges for developers so that new entrants are not disadvantaged and that full costs are recovered will help the market deliver the best solutions.
- Transferring ownership of customer supply pipes to water companies would help reduce leakage further as demonstrated by the 2013/14 review.
- On consistency of environmental regulation – long term consistency in environmental regulation of abstraction licences, and closer incorporation of this regulation through regional planning, will remove a block to the regulatory ambition of greater water transfers, and help ensure that optimal regional solutions may be sought for both customers and the environment. Following a 5-year investigation programme in AMP4 and designing and constructing an integrated grid based on licenced volumes agreed following the Review of Consents process with the EA, the Common Standards Monitoring Guidance will now revisit some licences again. We recognise that as our climate changes the sustainability of licences may need to be reviewed again, but revisiting licences under such short timescales makes water resources planning and the identification of surplus resources available for regional trading more challenging. We also encourage our regulators to base licence changes on the evidence derived from localised scientific studies rather than indicator-based approaches that may fail to incorporate the best information into decision making.

12.5 Leakage planning ahead of WRMP24

The Environment Agency "Leakage in WRMPs" guidance noted updated in June 2017 reaffirmed that companies should follow the government's view as set outlined in the Guiding Principles that:

- a downward trend for leakage should continue throughout the planning period.
- all companies should take action to ensure total leakage (Ml/d) does not rise at any point in the planning period.
- water companies must fully consider and appraise leakage management as an option to balance supply and demand alongside other options
- all companies should compare their planned leakage forecast with other water companies and with suppliers in other similar countries, to demonstrate that its leakage forecast is appropriate and ambitious
- challenging leakage objectives should be informed by customers' views on leakage and also take account of the potential for future innovation.

Our WRMP24 planning will follow these Guiding Principles; and be fully compliant with the consistent approach to measuring and reporting leakage described in Consistency of Reporting Performance Measures (UKWIR 2017).

Our Sustainable Economic Level of Leakage (SELL) was recalculated for WRMP19 using the consistent reporting methodology as summarised below.

Table 12-1: SELL estimates by top down and MLE estimation methods

Leakage method	Leakage 2016/17 (Ml/d)	SELL central estimate (Ml/d)	SELL range (Ml/d)
Top down (former method)	68.3	94.1	73.3-97.5
MLE (new method)	78.3	104.4	83.3-107.5

* 2017/18 top down leakage was 67.8 Ml/d and the MLE method was 79.7 Ml/d.

As acknowledged in the "Leakage in WRMPs" guidance note, there is increased realisation that SELL may not be the most effective way to plan leakage levels.

This is certainly true for Wessex Water. At WRMP14 we were in surplus over the whole planning period, with a leakage level significantly below the SELL, but nevertheless offered a 5% reduction in leakage based on customer preference. Similarly, for WRMP19 we are offering a 15% reduction in leakage whilst in surplus over the whole planning period and operating significantly below our SELL.

In the "Leakage in WRMPs" guidance note, the Environment Agency stated "WRMP19 will be the final time that a leakage figure is derived by SELL. We expect water companies to evolve and move away from SELL for WRMP2024 and to innovate to help reduce leakage beyond the current levels. Government and regulators will work with water companies to consider the approach to setting leakage targets."

We look forward to working with Government and regulators in developing new approaches to setting leakage targets for WRMP24, informed by the latest view on the economics of leakage reduction and how innovation and new technology can move the frontier of efficiency.

Our leakage target to 2025 has been accepted by customers in the context of bills that are falling overall. We need to consider together where the burden of cost falls for further reductions, particularly where the resilience benefits may ultimately be received by customers in other regions where water-use is higher than our own.

13 Annex A: Leakage consistency project and base year changes to the water balance

13.1 Summary

Water UK Statement – November 2017
Water companies have been working together, co-ordinated by Water UK, to improve the consistency of reporting of definitions of key measures of performance, so that performance can be compared between companies more easily.

This work is supported by Ofwat, the Environment Agency, Natural Resources Wales and the Consumer Council for Water.

Companies need to make changes to their current reporting to align with the new, more consistent, reporting definitions, and for some of these changes it will take some time to have robust data.

One of the measures of performance this applies to is leakage. Each company's draft Water Resource Management Plan explains how the company is implementing the new reporting definition for leakage and the extent to which it might impact on their future plans for balancing supply and demand for water. The change in reporting of leakage is purely a change in reporting; it does not affect the actual amount of water lost through leakage.

Each company will be making different changes to their current reporting to come into line with the more consistent definition, and so the impact will be different for each company. For Wessex Water, the changes and their potential impact are explored below.

We adopted the Water UK final leakage methodology[108] to calculate leakage for the 2017/18 base year and used this for our baseline scenario, as recommended by the Environment Agency's supplementary guidance to the water resource planning guidelines. Applying the new guidelines has resulted in an increase of our estimate of leakage in the base year from 68 Ml/d to 80 Ml/d.

In parallel we have completed a comprehensive review of key components of our water balance, including household occupancy, meter under registration and supply pipe losses, to help reconcile the difference between the top down and bottom up leakage estimates. This review has resulted in changes to demand components of our water balance. Following the changes we have a water balance gap[109] of less than 2% which in is line with best practice.

The changes outlined below have been adopted in the base year for our demand forecast. This means that some of our base year demands, including leakage, and our base year per capita consumption (PCC), are different from the values reported in the 2017/18 Regulatory Returns (including the annual review of the WRMP). The changes that have been made

[108] OFWAT and Water UK (2018) Targeted review of performance commitments
[109] The water balance gap is the difference between the top down and bottom up leakage estimate as a percentage of distribution input.

were included in our report 'shadow leakage estimate' report to Ofwat in August 2017 and have been subject to review by our auditor Mott MacDonald.

This annex provides summary of how we have applied the new leakage reporting methodology along with an overview of the technical studies we have undertaken and the resultant impact to our water balance.

13.2 UKWIR leakage consistency project

The Water UK guidelines require water companies to calculate leakage using the maximum likelihood estimation (MLE)[110] to reconcile the difference between 'top down' and 'bottom up' leakage estimates. Wessex Water has always reported company leakage levels using the top down method[111] and the basic methodology has remained unchanged for over 20 years. This has provided a consistent and robust basis for reporting leakage.

Assessing leakage using the MLE method is a significant change in approach and this is the first year we have formally produced a bottom up leakage estimate[112] and an MLE adjusted water balance. We have invested further in the systems and processes required to estimate bottom up leakage, such as Waternet and our small area monitor (SAM); although these were initially set up to improve the efficiency of targeted leakage control activities, rather than to estimate total leakage volumes.

We are able to fully comply with the computational requirements of the new guidelines but at the time of writing are still working towards meeting all the data requirements. We have identified a number of key areas for data improvement, particularly around household and non-household night use allowances, and have put a data improvement plan in place to deliver these improvements by April 2019. Our bottom up leakage estimate is sensitive to these values, and until these improvements are made, some uncertainty over our reported leakage estimate will remain.

13.3 Sustainable economic level of leakage

We have recalculated our sustainable economic level of leakage (SELL) for both the top down leakage estimate (consistent with former reporting method) and the MLE methodology (new reporting method). The results are summarised in Table 13-1 showing that under either method our level of leakage is significantly below the SELL. We have prepared a separate SELL report[113] to support this Plan and it is available as a technical appendix.

[110] Both the top down and bottom up approach have inherent uncertainties. The two assessments of leakage can be reconciled using a statistical approach known as MLE (Maximum Likelihood Estimation).

[111] In the 'Top-down' Water Balance, leakage is the difference between the annual volume input to the distribution network (after allowing for volume exported) and the volume which is being legitimately consumed.

[112] The bottom-up' approach uses leakage derived from minimum night flow measurements in DMAs, adjusted for 24-hour pressure variations, and then aggregated with trunk mains and service reservoir leakage for the whole system

[113] Servelec (2017) Sustainable Economic Level of Leakage, Phase 2 Report.

Table 13-1: SELL estimates by top down and MLE estimation methods

Leakage method	Leakage 2016/17 (Ml/d)	SELL central estimate (Ml/d)	SELL range (Ml/d)
Top down (former method)	68.3	94.1	73.3-97.5
MLE (new method)	78.3	104.4	83.3-107.5

* 2017/18 top down leakage was 67.8 Ml/d and the MLE method was 79.7 Ml/d.

13.4 Uncertainty and impacts for the water resources management plan

There is some uncertainty in the MLE leakage estimate used for the 2017/18 base year that will be reduced as we complete the data improvement projects. This uncertainty is not material to the outcome of this Plan because it is not feasible that the scale of changes that might occur as we improve data inputs could change our position from being in surplus to being in deficit, and our final plan options are not dependent on our starting leakage position.

It is possible that future changes to the base year leakage estimate will impact other demand components in the water balance, including per capita consumption. This is because the MLE method will reconcile any difference between the top down and bottom up water balance, and adjust the demand components until a balance is achieved. The amount of adjustment is based on the size of the water balance gap and the uncertainty of an individual demand component relative to the other component (the higher the uncertainty the larger the adjustment).

We have assessed the uncertainty associated with each of the water balance components in the MLE analysis. The confidence intervals assigned to the large demand components are summarised in Table 13-2. The values are higher for the unmeasured components (such as total leakage and unmeasured household) because of the inherent uncertainty in estimating these values. The largest area of uncertainty remaining is 'Total Leakage' and we expect this to reduce to within the best practice range when the planned data improvements have been delivered.

Table 13-2: MLE uncertainty value used for the 2017/18 base year leakage estimate

Component	Volume (Ml/d)	Confidence interval (+/-)	Best practice range
Distribution input	342	2%	2-4%
Unmeasured household demand	81	9%	8-12%
Measured household demand	92	3%	2-5%
Measured non household demand	77	4%	2-5%
Total leakage	80	12%	8-12%

13.5 Water balance review

We seek to continually improve our understanding of the water balance and so regularly undertake projects to review and update the inputs to the various demand components. In preparation for this Plan, and in parallel to Water UKs leakage consistency project, we undertook a number of studies to augment our current analysis. This findings from these studies and the resultant impact to the water balance is summarised below.

13.5.1 Population and occupancy

For the Water Resources Management Plan, the base year population from which to forecast over the planning period, needs to be divided into key segmentations of the population: household and non-household population, and within each of these populations, into measured and unmeasured population. These figures have been derived from national datasets, and combined with survey data from Wessex Water customers to understand the measured/unmeasured household population split (as these figures are not available from national datasets).

To obtain customer occupancy for measured and unmeasured households, we collated and reviewed existing company datasets on occupancy for different segmentations of the household population, and also conducted an online household customer occupancy survey during the Spring of 2017. We combined the obtained information through a triangulation process with top-down national datasets, considering data uncertainty and bias in each of the data sources, to derive our final estimates of measured and unmeasured household occupancy. These estimates where then also compared to data published for other regions, as published through the Water Resources Market Information by companies across the UK, to sense check the results.

<u>Hidden and clandestine population</u>

We commissioned Edge Analytics to undertake a review of potential hidden and clandestine population in our region in November 2016. Their medium estimate suggests that an additional 15,900 people may be staying in the area each day that were not previously accounted for in the water balance. This population has been added to the regional household population.

<u>Household and Non-household population</u>

We have previously reported a non-household population of circa 130 thousand people. Whilst it is difficult to robustly estimate non-household population, the ONS estimate of communal population from census data is lower than this at around 38 thousand people.

For the updated 2016/17 data, we have reduced the non-household population to match the ONS communal population. Our confidence in this estimate for non-household population was strengthened through calculating the figure by taking the ONS-2014 based sub-national population projection for the base year 2016/17 and taking from this the DCLG 2014-based household population for 2016/17, which resulted in a figure of 34,000. The majority of this population has been re-allocated to measured households, reflecting the results of the customer occupancy survey.

Determining household occupancy

Data collection

Data on household occupancy was collated and evaluated from eight different sources (Table 13-3). We undertook a bespoke customer occupancy survey in the Spring of 2017 and supplemented this information with data collected from other business as usual activities such as customer research (e.g. Image Tracker), our water efficiency engagement programmes (e.g. Home Check and online calculator), and regular customer contacts (e.g. consumption monitor and switching reports). Given that occupancy data collection was not the primary purpose of some of these collection methods, recognition of bias in the sample is important owing to customer self-selection in providing the information, for example.

Table 13-3: Data sources used for measured and unmeasured occupancy estimation

Data Source	Description	Sample	Potential Bias
Customer occupancy survey	Online survey advertised on social media, and on source, with	2,335	Bias to online (social media) users. Small bias against +65. Survey targeted by postcode at times to reduce bias.
Image Tracker	Occupancy from telephone survey.	2,945	Telephone cold-call survey, so bias against mobile only households.
Willingness to Pay survey (Accent)	Online survey sent to emails of people previously contacting Wessex	719	Previous contacts with Wessex may introduce potential bias, and online customers only.
Home Check	Letter sent to Taunton postcodes, followed up by home visit to customers who sign up	6,347	Interested in saving water/money. Representativeness of postcodes compared to whole supply area.
Save Water Save Money calculator	Online calculator	6,414	Interested in saving water and money. Online only.
Consumption monitor	Occupancy from recent consumption monitor	1,719	Customers agreeing to be on monitor, so interested in saving water already?
Switcher Report	Occupancy reported by switchers since 2013	29,000	Switcher only, so a sub-sample of metered customers
New properties Survey	Occupancy data collected from survey of new property development	1,481	Not collated for occupancy survey, and of specific housing developments so not spatially extensive

From May to June 2017, we conducted an online household occupancy survey to understand how our total household population is divided between measured and unmeasured households. The survey was hosted on the Wessex Water website and promoted to our customers through social media channels. The survey was designed with specific additional questions about customers and their properties so what we could understand, and potentially correct for survey bias. Regular review of survey responses in comparison to company wide information during the survey, relating to ACORN category, number of bedrooms, and property type compared to census data, helped us to target social media advertising in certain areas to achieve as representative a sample as possible. For example, evaluating early respondents showed that the survey was under-representative in over 65s compared to the company wide population. As a result, social media advertising was targeted in certain areas (e.g. Poole) with higher over 65 populations. We received a total of 2,300 respondents.

Survey analysis

Alongside the raw figures for measured and unmeasured occupancy from each data source, occupancy estimates were also produced by weighting responses using additional survey information to correct for potential bias in individual surveys. From ONS census 2011 data, we calculated summary statistics for our supply area on property type (e.g. detached, terraced, etc), number of bedrooms, and ACORN category data. These statistics were then used to explore potential bias, and evaluate the overall representativeness of each individual survey, depending on the additional metadata collected by each survey. Table 13-4 summarises individual occupancy estimates alongside the data source, and comparison to the total household population.

Also in Table 13-4, we produced occupancy estimates for measured households, based on subsets of the measured population, by assuming all metered households are either new households or optant households. Therefore, occupancy estimates of both sub-categories can be combined with the total number of new households and total number of switcher households to derive an overall estimate of measured occupancy. All metered households were divided into new and optant properties based on historical annual return data. We derived optant occupancy from our switcher optant occupancy information (29,000 samples), and from the customer occupancy survey, and also new household information from both the customer occupancy survey and also a separate new household survey, to derive 4 estimates of measured occupancy for new households. The derived values when using the switcher optant survey was 2.07, and when using the customer occupancy survey data alone 2.26.

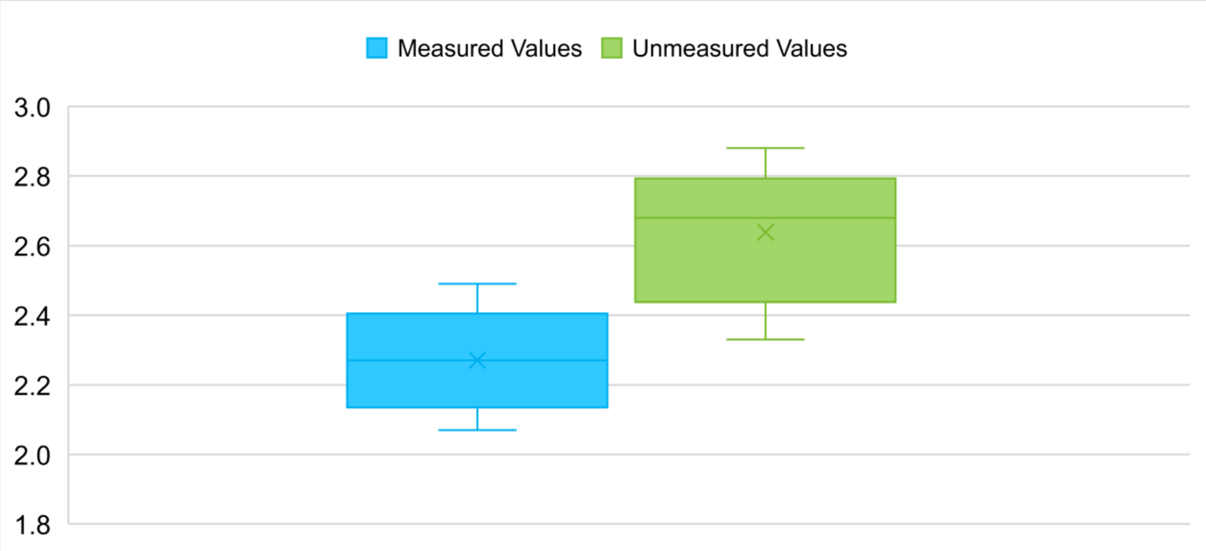
Table 13-4: Individual estimates of measured and unmeasured occupancy*

Data source(s)	Weighting	Occupancy		Household population estimate (000s)	Comparison to ONS total population (000s)
		Measured	Unmeasured		
COS	Raw results	2.41	2.86	1,416	+134 (110%)
COS	# Bedrooms	2.36	2.76	1,378	+96 (108%)
COS	Property Type	2.2	2.64	1,299	+17 (101%)
COS	Acorn	2.4	2.88	1,417	+135 (111%)
Image Tracker	Raw results	2.49	2.79	1,429	+147 (111%)
Image Tracker	Property Type	2.41	2.71	1,385	+103 (108%)
WTP Survey	Raw results	2.08	2.69	1,269	-13 (99%)
WTP Survey	Property Type	2.07	2.67	1,262	-20 (98%)
Home Check	Raw results	2.19	2.46	1,258	-24 (98%)
Home Check	# Bedrooms	2.27	2.62	1,319	+37 (103%)
WES	Raw results	2.41	2.36	1,311	+29 (102%)
WES	# Bedrooms	2.38	2.33	1,294	+12 (101%)
CM	Raw results	2.24	2.8	1,346	+64 (105%)
SR + COS	S + NP	2.08	-	-	-
COS	S + NP	2.28	-	-	-
CW + NPS	S + NP	2.26	-	-	-
COS + NPS	S + NP	2.07	-	-	-

*Household population estimate is derived by multiplying the respective occupancy estimate with number of measured and unmeasured household properties with the numCOS = customer occupancy survey; WTP = Willingness to Pay; WES = Water Efficiency Survey; CM = Consumption Monitor; SR = Switcher Report; NPS = New properties survey.

Figure 13-1 shows the distribution of derived occupancy values for measured and unmeasured households, which includes all samples, both raw figures and weighted figures. In nearly all cases, weighting adjustment of the samples led to a move in the occupancy figures closer to the estimate of the total population, as derived from national statistics. Comparing resultant population estimates, derived by combining occupancy figures with number of properties, to ONS data for household population, shows that most surveys over-estimate total household population, supporting the conclusion that surveys are biased to households with larger occupancy. The Accent Willingness to Pay survey had the lowest bias compared to national statistics, followed by the raw Home Check survey.

Figure 13-1: Distribution of results for occupancy for measured and unmeasured households in the Wessex supply area



Triangulations and data uncertainty considerations

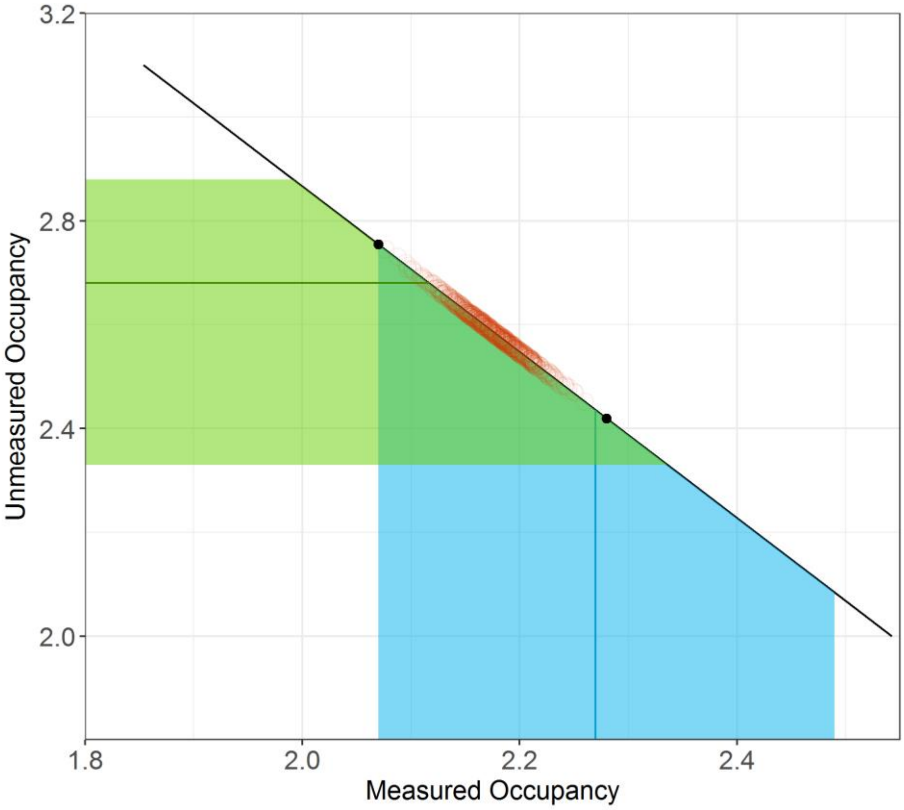
Estimates of measured and unmeasured occupancy could be determined individually for each segmentation. However, when combined with their respective number of properties for each segmentation, and summed, these values should add up to the total household population, which is derived from the base year population and DCLG household population forecasts. Therefore, the method applied to calculate household occupancy is to constrain the bottom-up estimates of occupancy for measured and unmeasured properties with the top-down estimate derived from national statistics.

Figure 13-2 shows a comparison of occupancy surveys to the top-down population estimation, and shows that the feasible values of measured and unmeasured occupancy, within each respective distribution of surveyed values, which also satisfy the total population constraint, are:

- **Measured** between 2.07 and 2.33 (central estimate: 2.22)
- **Unmeasured** between 2.34 and 2.75 (central estimate: 2.54)

In Figure 13-2 this range is where the green and blue shaded areas overlap on the diagonal black line.

Figure 13-2: Comparison of the distribution of measured and unmeasured occupancy to total household population derived from difference surveys*



* Comparison of distribution of unmeasured occupants (green ribbon = range, green line = median) to measured occupants (blue ribbon = range, blue line = median) from different surveys to all potential points on the black line, which represent all possible combinations of measured and unmeasured occupancies which give a total population equivalent to the DCLG household population of 1,282,000. Orange circles show the range of samples derived when using a property-type weighted customer occupancy survey approach, and sampling from the sample size uncertainty bounds, and black circles show points used when using a switchers occupancy to derive measured alongside a new household occupancy.

A number of factors support the plausibility of these ranges:

- Surveys with upper end occupancy for both measured and unmeasured occupancies (e.g. parts out of range of the total population estimate) were from unweighted samples, and it seems a number of surveys over-estimate total population, which suggested they are under-representative of lower occupancy households.
- The customer occupancy survey was under-representative of the over 65 population, despite attempts to correct for this bias through targeted advertising. Based on the customer occupancy survey, mean occupancy of properties with over 65s and over 65s only, was 1.91 and 1.61, respectively.
- Other online-based surveys also had total populations that were too high compared to the total DCLG derived total population, and these are also likely to be under-representative in an older age group category, which from the customer occupancy survey seem to have smaller households.
- Surveys that produced occupancy figures closest to total household population were the Accent Willingness to Pay survey, which used email addresses and also the

Home Check project, which sent letters and house calls to customers, so were not reliant on internet traffic derived from social media advertising.

In addition to estimating occupancy using the raw and weighted estimates from each survey, an additional approach was explored to consider sampling uncertainty. A Monte Carlo (random sampling) approach was applied to the property-weighted occupancy estimates derived from the customer occupancy survey. In this approach, random samples were drawn from the uncertainty ranges of population estimates for each sub-category (e.g. unmeasured occupancy for detached households), where the uncertainty range reflects uncertainty in the sub-category sample size. Samples were then chosen from each sub-category that produced the overall population estimate, and also satisfied constraints on the relative size of the population in each sub-sample. These are shown as orange circles in the centre of Figure 13-2.

Occupancy determination

Prior to the occupancy survey, the previous measured occupancy estimate was 1.8 (as used in 2016/17 annual reporting). All samples therefore support an increase in the previous value. It was felt that a measured occupancy uplift 0.3 taking the estimate to 2.1 people per household was appropriate for several reasons:

- The expected measured occupancy figure was between 2.07 and 2.33 (central estimate: 2.22), based on the estimates shown in Figure 13-2 when constrained by the total population.
- This value is to the lower end of the range produced from different occupancy surveys. However, as a result of the bias evaluation of different surveys, most surveys had a positive population bias compared to the true population.
- Under-representativeness of the older population was present in the customer occupancy survey, with households of over 65s, and those containing over 65s having a population of 1.91 and 1.61, respectively.
- When using the switcher occupancy survey combined with a survey of new household customers, we derived a measured occupancy estimate of 2.07. This was a large and robust sample size (29,000) of the switcher population.

Combining the calculated figure with the total population results in an unmeasured household population of 2.71, which represents no change to the figure previously used.

Comparison to other companies

Since the publication of the draft Water Resources Management Plans for consultation, the publication of accompanying Water Resources Market information has provided standard set of information enabling cross-company comparison of different metrics, including of occupancy. We have compared the occupancy estimates derived from our surveys and triangulation process with data from 111 other Water Resource Zones (WRZs)[114], for the year 2020-21, the first-year market information is available. These Water Resource Zones cover over 90% of the population of England and Wales.

[114] Information from Affinity water was not available at the time of the comparison.

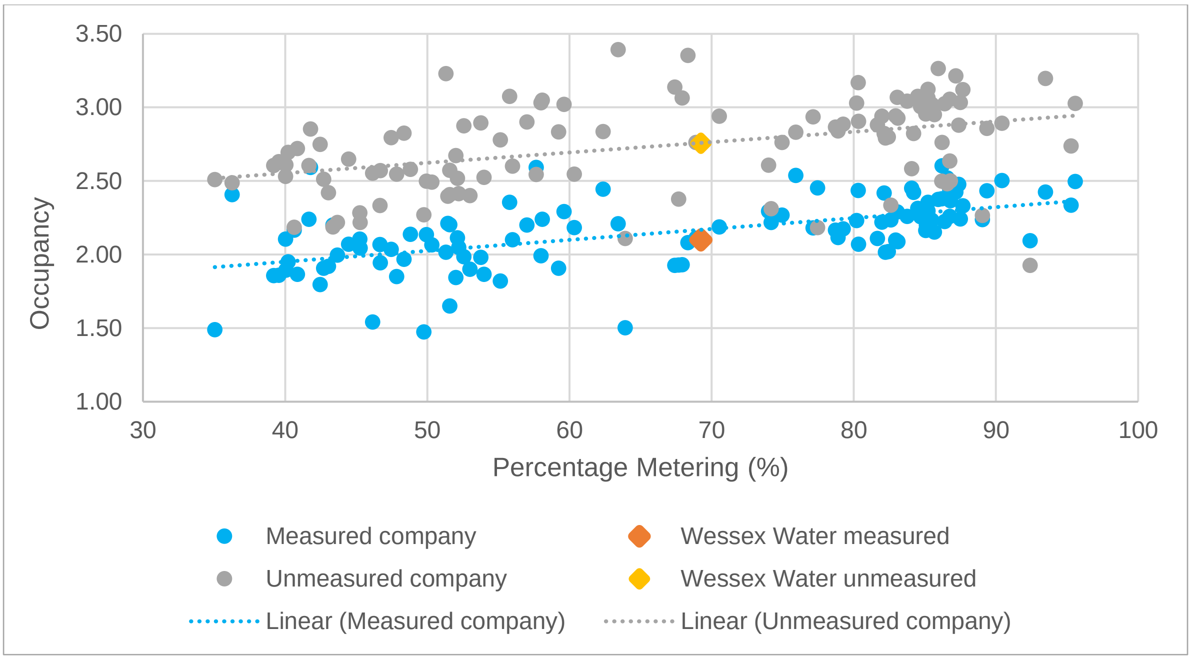
The mean occupancy[115] calculated across WRZs weighted by both population and properties in each WRZ, for measured and unmeasured properties is shown in Table 13-5. The figures derived for Wessex Water in the customer occupancy study are close to the average for all companies, and support the increase made to measured occupancy.

Table 13-5: Comparison of occupancy to other companies' water resources market information in 2020-21

	Measured	Unmeasured
Unweighted average	2.15	2.74
Weighted average (by pop)	2.22	2.74
Weighted average (by props)	2.21	2.73
Wessex Water occupancy calculations	2.10	2.71

Figure 13-3 shows a plot of measured and unmeasured occupancy as a function of meter penetration across company WRZs for 2020-21[116]. Both measured and unmeasured occupancy shows a positive trend as a function of meter penetration. Figures calculated for Wessex Water occupancy for 2020-21 are also plotted, and show that the occupancy estimates are consistent with overall cross-company trends of occupancy as a function of percentage metering.

Figure 13-3: Plot of occupancy as a function of percentage metering for company water resource zones



[115] A simple average of WRZ occupancies will over-estimate the importance of small and sparsely populated WRZs on the average that are often more typical of rural regions, and not representative of the country as a whole. Weighting by population and properties represent two approaches to overcome this problem. Both of course influence occupancy, but both allow a better understanding of "average" occupancy across the country, as it is a weighted according to where people live.

Summary of population changes

We have made the following changes to our population allocation:

- Incorporated the hidden and clandestine population into our household population
- Reduce the non-household population to the ONS communal population and reallocate this population to the household population.
- Increase the measured household occupancy from 1.8 to 2.1

Table 13-6: Summary of population changes made to 2016/17 data

Population (000s)	2017/18 as reported June 2017	2017/18 updated for WRMP base year
Households billed unmeasured water	532.7	546.3
Households billed measured water	642.4	745.8
Non-households billed unmeasured and measured water	139.7	38.6
Total population	**1314.8**	**1330.8**

13.5.2 Meter under registration

We completed a comprehensive review of meter under registration for households and non-households which included removing 400 passive displacement (PD) meters and getting these independently tested for accuracy at a range of flow rates by an accredited testing facility (WRc–NSF).

Figure 13-4 shows the meter under registration curve that was developed for our passive displacement meters. Figure 13-5 shows the age range of our meter stock in 2016.

Figure 13-4: Meter under registration curve for PD meters

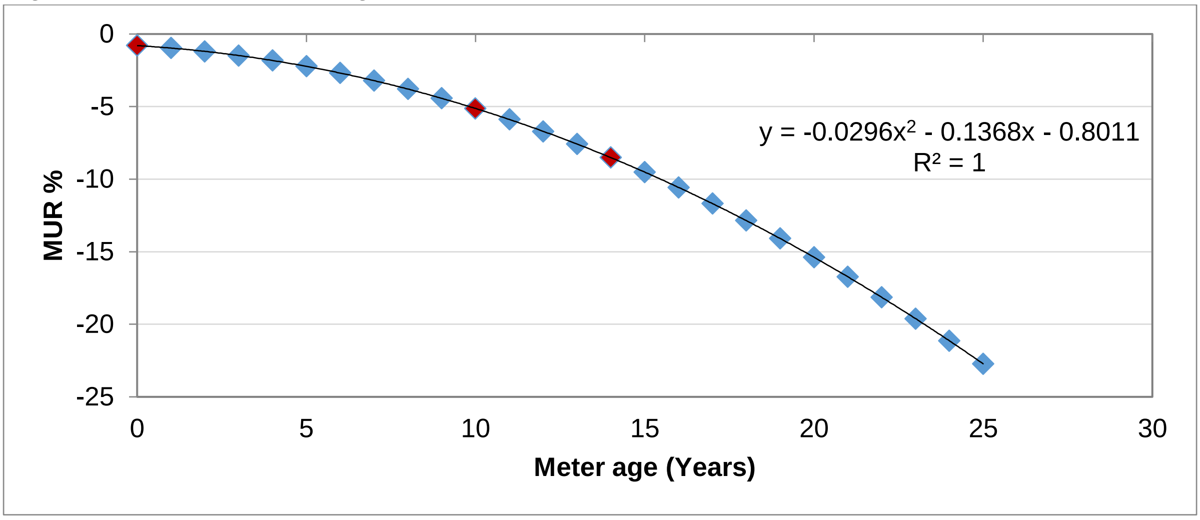
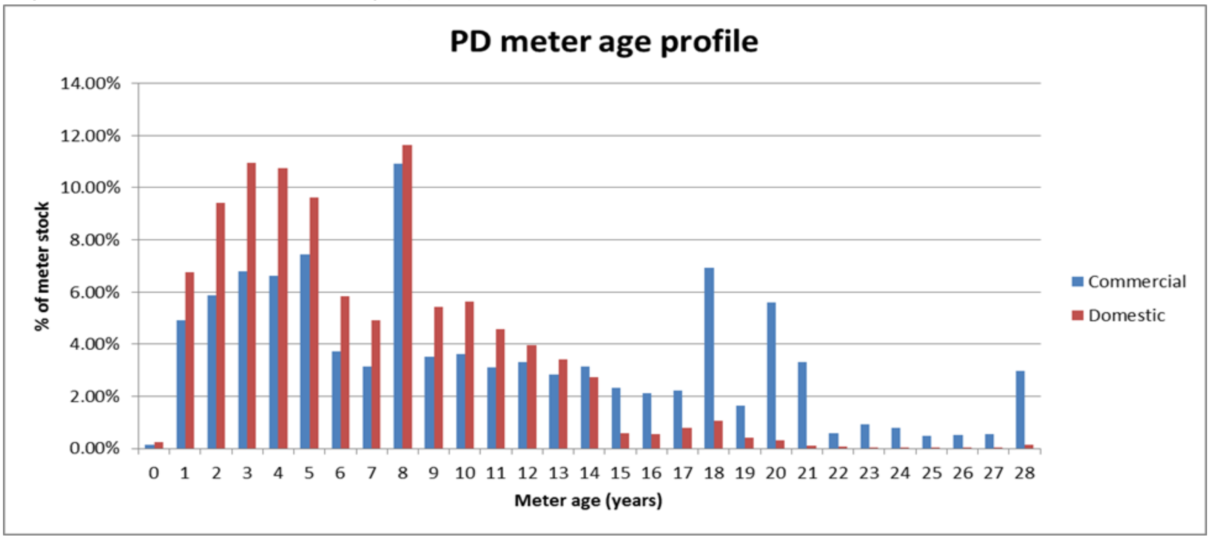


Figure 13-4: Current meter age profile



The results summarised in Table 13-5 suggest that it is appropriate to increase our meter under registration allowances.

Table 13-7: Meter under registration allowances

Property type	2017/18 as reported June 2018	2017/18 updated for WRMP base year
Households	2.6%	3.8%
Non-household	4.2%	4.6%

13.5.3 Unmeasured household water use

The leakage consistency guidelines recommend that best practice unmeasured household consumption monitors comprise at least 1000 households and that operability is at least 80%. We have delivered significant upgrades to the unmeasured consumption monitor over the past year and have taken the following steps to increase the sample size and improve the overall performance of the monitor:

- We recruited 300 additional households to the monitor in February 2017 and are in the process of recruiting a further 400 households in 2017/18
- We have procured new data loggers that we expect to perform better than our current stock and we are installing these on the new properties we are adding to the monitor.
- We have replaced the worst performing data loggers with new Hybrid meters that capture 15 minute data readings and are not reliant on GPRS signal.
- We are taking monthly manual meter reads at households in areas of poor GPRS reception to ensure we have the monthly consumption data.
- We completed an occupancy survey of all households on the monitor (72% response rate).

We currently have around 1300 monitors installed and achieve > 80% operability.

In 2016 we reviewed the meter under registration allowance for the consumption monitor meters to ensure the allowance we are using is appropriate for the meters and loggers installed in 2015/16 as part of the consumption monitor upgrade. This review included having 100 meters tested at the WRc–NSF facitility in Wales. The study recommended using an allowance of 2.2%.

13.5.4 Underground supply pipe losses (SPL)

We have recently reviewed our underground supply pipe loss (SPL) estimates in conjunction with consultants Servelec using data collected by our household consumption monitor and data on burst frequency and repairs.

The study estimated SPL of 40.5 l/prop/d for unmeasured and internally measured properties and 7.03 l/prop/d for externally measured properties. These are lower than the former SPL assumptions used, which are 46.4 l/prop/d for unmeasured properties and 16.4 l/prop/d for measured properties.

For void properties the unmeasured estimate of 40.5 l/prop/d is applicable unless the measured void properties are being actively read and checked, in which case a lower value would be applicable for these.

Table 13-8: Underground supply pipe loss estimates (litres/property/day)

Property type	SPL as reported for 2017/18	2017/18 updated for WRMP base year
Unmeasured households	46.4	40.5
Measured households - external meter	16.4	7.3
Measured households - internal meter	46.4	40.5

13.5.5 Unmeasured non-household water use

We have updated the per property allowance for unmeasured non-household properties using the approach described in the best practice guidelines. This data review suggested the allowance should be increased from 225 m^3 per property per annum to 354 m^3 per per property annum. Applying this allowance to the 2016/17 water balance increased demand by 1.34 Ml/d.

13.5.6 Impact to per capita consumption

Weighted average PCC for 2017/18 used for the base year of the water resources management plan is approximately 5% lower than the value reported in our annual regulatory return (131 litres/head/day compared to 143 litres/head/day). This reduction is due primarily to the increase in measured household occupancy as more people living in the same number of houses will reduce PCC. It was also impacted to a lesser degree by the update to supply pipe losses, meter under registration and the adjustments made through MLE (the confidence interval applied to unmeasured household demand is 9% and measured household demand is 3%). The 2017/18 PCC has also been normalised for weather effects which has led to a small reduction as 2017/18 was drier than normal.

Table 13-9: Changes to per capita consumption

Values in litres per head per day	2017/18 as reported June 2018	2017/18 updated
Measured PCC	137.3	123
Unmeasured PCC	150.4	148.1

Weighted average PCC	143.3	132.7

13.6 Leakage consistency data improvements

We have a programme of data improvements in place to enable us to become compliant with the new methodology. Significant improvements were delivered over the 2016/17 reporting year and the last few remaining projects are expected to complete by the end of 2018/19.

Our leakage estimate for 2017/18 calculated using the new method is 79.7 Ml/d. This is an increase to the shadow leakage estimate calculated for 2016/17 (78.3 Ml/d) despite a 0.5 Ml/d reduction in leakage over the year. This net increase in leakage is from the data improvement projects we have carried out rather than a real increase in leakage.

Our leakage performance last year was good and we managed to maintain 2 Ml/d headroom against our external leakage target for most of the year. The freeze thaw event in March 2018 was significant and resulted in a 1.5 Ml/d increase to our annual leakage level.

The data improvement projects completed over 2016/17 were:

1) Update of our hour to day factors (HDF) using hydraulic models. We completed this for around 70% of the network and used the average value for the remaining 30%. The update to the HDF was significant and resulted in a 2.7 Ml/d increase to our leakage which suggests that the night and day pressure differential in our network was higher than expected. We will be addressing this over the coming year.
2) We completed a detailed review of household plumbing losses using data from our IHM and also collected from customer data once plumbing losses had been repaired. The analysis suggests that plumbing losses are slightly higher than previously assumed at 0.57 litres/property/hour. We updated this value in our analysis which resulted in a 0.9 Ml/d net reduction to leakage.
3) During 2017/18 we began a significant project to improve our confidence in household night use estimates derived from our small area monitor (SAM) monitor network. The work consists of several elements, beginning with a review of the existing network, to ensure all components, such as property counts by ACORN category, are up to date and representative. We are also employing a SAM Technician to respond more quickly to meter and data issues to maximise the sample available for weekly leakage calculations. We are further looking to extend the coverage of the network by creating additional areas. These have been identified and will be constructed by the end of 2018/19. Having this improved sample, particularly for ACORN categories of currently low representation, will significantly improve resilience and confidence in calculated results.
4) We are improving our estimates of non-household night use (NHHNU) through two approaches: Firstly, we are increasing the number of directly monitored non-households (NHHs)by between 150 – 200 sites. These sites are being targeted by high annual average billed volumes and those likely to have an effect of night use. This will be complete by the end of the 2018/19. Secondly, through an extended temporary data logging project, we are enlarging and updating NHHs used

in the average billed volume to night use model. This we improve the stratified sample of industry groups, and will also be completed by the end of 2018/19.

5) Unmeasured household water use. We used the new Ofwat guidance to estimate unmeasured household water use which required us to calculate an average per household consumption for unmeasured properties and multiply by the average number of unmeasured properties. Previously we have calculated an average unmeasured per capita consumption and multiplied by the unmeasured household population. This change in method resulted in a circa 1Ml/d reduction to unmeasured volumes.
6) Unmeasured household water use. We continued to deliver improvements to our household consumption monitor and added over new households to the monitor and replaced 300 monitors that were not working. We ended the year with a sample of around 1300 households.

The improvements planned for 2018/19 include:

7) Further increase the sample size for the small area monitor.
8) Detailed review of unmeasured non-household water use.

14 Annex B: Water Resource zone integrity assessment

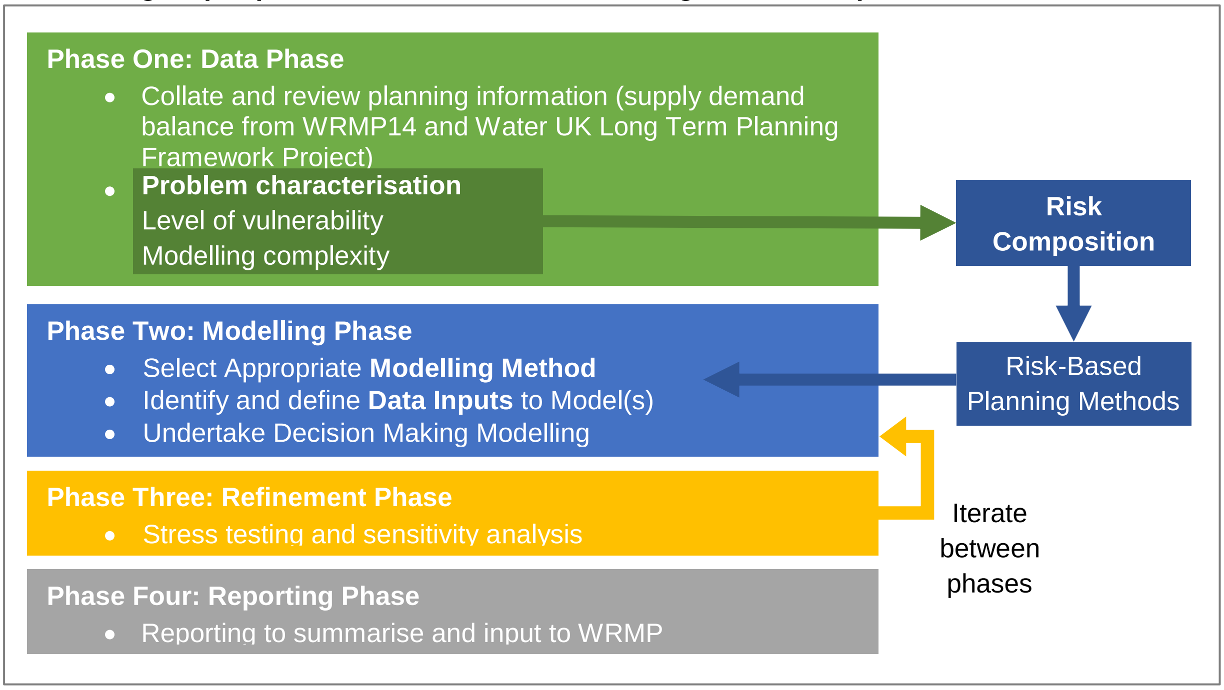
For security reasons this appendix is not available in the version of this Plan published on our website.

15 Annex C: Problem characterisation assessment

This chapter contains the 'problem characterisation' assessment for this WRMP. Its purpose is to capture and consider the vulnerability of our supply system to various strategic issues, risks and uncertainties over the planning period (up to 2045) in order to select the most appropriate analysis methods and investment/management options that are proportionate to the challenges we face.

Setting out the issues in this way is the logical starting point for developing a new or revised WRMP and is a formal requirement of the new joint regulator Water Resource Planning Guidelines[117]. In accordance with the Guidelines, the problem characterisation has been developed using the UKWIR Decision Making[118] and Risk-Based planning guidance[119]. These complementary guidance documents provide a clear, auditable and systematic framework, which has been followed in developing and applying tools for this WRMP. The framework is summarised in Figure 15-1, and consist of four phases. This Chapter covers Phase One and the justification for the methods selected in Phase Two and Phase Three.

Figure 15-1: Decision Making Framework for Investment appraisal and optimisation methodologies (adapted from UKWIR Decision Making Guidelines[99]).



The problem characterisation is the main output of Phase One, and consists of two elements:

- **Assessing Strategic Needs –** how big is the supply-demand balance problem over the planning period?

[117] EA Water Resources Planning Guidelines
[118] UKWIR WRMP19 Methods – Decision Making Process: Guidance
[119] UKWIR WRMP19 Methods – Risk Based Planning

- **Complexity Factors** – how difficult is this problem to solve?

We have answered these questions using planning information from our last WRMP, new information arising since the publication of our last Plan and also used where appropriate information from the Water UK Long Term Planning Framework Project[120]. This project explicitly looked at the impact of several factors, including drought events beyond those experienced historically, climate change impacts, and the impact of future growth scenarios upon water supply and demand for the Wessex Water region, and therefore provides additional useful information to inform the problem characterisation.

The answers to these questions are combined to define the **level of vulnerability** we face, and the complexity of **decision making tool** that is justified for application in Phase Two. In addition, the problem characterisation also informs the appropriate level of drought risk (**risk composition**) to consider when developing **data inputs** to the decision-making tools. Finally, this leads to a **method statement** that clearly describes the methods used in Phase Two and Three of this WRMP, which are subsequently described in chapters.

Key aspects of Phase One and Phase Two
Level of vulnerability – level of vulnerability faced in the water supply system that justifies the level of complexity of the decision making tool to be adopted: • low level of concern - ‘current’ EBSD approaches should be adequate; • Moderate level of concern - ‘extended’ approaches not widely used in existing WRMPs but tested at the ‘proof of concept’ stage for UK water resource systems. • High level of concern - apply more than one ‘extended’ or ‘complex’ approaches, not yet applied in the UK water resources context. Decision making tool - tool used for appraising investment options for WRMP19, that consists of four elements: • Objectives: what do we want to achieve? – e.g. least cost whilst maintaining SDB • Approach: Modelling approach – aggregated or system simulated. • Selection: how to choose a preferred solution – e.g. Expert Judgement or Ranking. • Solution: form of investment plan – e.g. schedule, adaptive strategy. Risk composition – either Conventional, Resilience Tested, or Fully Risk-Based, which indicates how drought risk and resilience are incorporated into the analysis by defining how uncertainty is dealt with in the Data Inputs. Also informs the links between the WRMP and Drought Plan. Data inputs – four required input components for the decision-making tool: supply forecast, demand forecast, outage assessment and option costs/benefits. Method statement – details the methods adopted in developing each component of the WRMP.

[120] WaterUK Water Resources Long-term Planning Framework (2015-2065)

15.1 Problem characterisation

Given the nature of risks posed to water supply, an individual problem characterisation is required for each Water Resources Zone (WRZ). The development of the integrated grid for the Wessex Water supply system is due to be completed in March 2018. Completion of the grid will result in improved interconnectivity between water sources and areas of deficit, providing greater supply resilience. As a result the Wessex Water supply zone will be considered as a single water resource zone for the problem characterisation, and resultant Water Resources Management Plan (WRMP).

15.2 Strategic needs assessment

Table 3-1 details the strategic needs assessment for the problem characterisation, and identifies no significant concerns for supply, demand and investment.

Table 15-1: Strategic WRMP risks

Strategic WRMP risks	No significant concerns (0)	Moderately significant concerns (1)	Very significant concerns (2)	Don't know	Comments
Supply: Level of concern that customer service could be significantly affected by current or future supply side risks, without investment.	0				The baseline supply demand balance prepared for WRMP14 projected a surplus of resources over demands throughout the 25 year planning period (see Table 3-2). Nevertheless our final planning scenario for WRMP14

Demand: Level of concern that customer service could be significantly affected by current or future demand side risks, without investment	0				sought to strengthen this position by implementing a group of demand management options under what was then known as 'do the right thing'. This approach was supported by customers and Ofwat and has seen us launch an enhanced metering programme, expanded water efficiency services and further reductions in leakage in AMP6. A update of our supply demand balance situation for the WRMP14 planning period (2015-2040) in March 2016 leads us to reconfirm our expectation of a supply demand balance surplus until at least 2040. In addition, the WaterUK long term planning project[121] identifies that Wessex Water is very resilient to the risk of severe drought (~1/200 year events).
Investment: Level of concern over the acceptability of the cost of the likely investment programme, or that the likely investment programme contains contentious options (including environmental/planning risks)	0				Expectation for PR19 is that affordability will remain a key issue for many of our customers which will influence the overall scale of the investment programme.
Total score	**0**				

Table 15-2: Supply demand balance from WRMP14

Scenario	Supply demand balance (Ml/d)	2014/2015	2019/2020	2039/2040
Baseline	Dry Year Annual Average	57	29	41
	Dry Year Critical Period	49	27	60
Final plan	Dry Year Annual Average	57	36	50
	Dry Year Critical Period	49	36	69

15.3 Complexity factors assessment

Table 3-3 to Table 3-5 detail the complexity factors assessment and identifies a moderate level of concern for supply side factors, resulting from uncertainty in supply system performance under different or more severe droughts than those contained in the historic

[121] WaterUK Water Resources Long-term Planning Framework (2015-2065)

record, and potential step changes in supply associated with licence reductions resulting from the ‘no deterioration’ driver. On the demand side, there are no significant concerns about changes and uncertainties in demand forecasts associated with demographic, economic, or behavioural changes, but there is moderate concern regarding the sensitivity of demand to drought conditions.

Table 15-3: Supply side complexity factors

Supply side complexity factors	No significant concerns (0)	Moderately significant concerns (1)	Very significant concerns (2)	Don't know	Comments
S(a): Are there concerns about near term supply system performance, either because of recent Level of Service failures or because of poor understanding of system reliability /resilience under different or more severe droughts than those contained in the historic record? Is this exacerbated by uncertainties about the benefits of operational interventions contained in the Drought Plan?		1			Supply system performance under more severe droughts than those contained within the historic record was explored to a limited extent for the 2014 WRMP. However, The Water Resources Long Term Planning Framework Report evaluated the impact of more severe droughts (1/200 and 1/500 year events) for the Wessex Water region, and identified modest reductions in deployable output, suggesting up to 8Ml/d reduction, or ~2% reduction in DO compared to the WRMP14 baseline. This evaluation suggests a moderate level of concern is appropriate.
S(b): Are there concerns about future supply system performance, primarily due to uncertain impacts of climate change on vulnerable supply systems, including associated source deterioration (water quality, catchments etc.), or poor understanding?	0				The last WRMP identified that deployable output for Wessex Water has a low vulnerability to climate change.
S(c): Are there concerns about the potential for ‘stepped’ changes in supply (e.g. sustainability reductions, bulk imports etc.) in the near or medium term that are currently very uncertain?		1			Concern about forthcoming potential sustainability reductions and capping of licence limits to ensure ‘no deterioration’.
S(d): Are there concerns that the ‘DO’ metric might fail to reflect resilience aspects that influence	0				Given the SDB surplus identified by the last WRMP, no new supply side investment options

the choice of investment options (e.g. duration of failure), or are there conjunctive dependencies between new options (i.e. the amount of benefit from one option depends on the construction of another option). These can both be considered as non-linear problems.					were put forward (investments schemes focussed on demand management).
Total score	**2**				

Table 15-4: Demand side complexity factors

Demand side complexity factors	**No significant concerns (0)**	**Moderately significant concerns (1)**	**Very significant concerns (2)**	**Don't know**	**Comments**
D(a): Are there concerns about changes in current or near term demand, e.g. in terms of demand profile, total demand, or changes in economics/demographics or customer characteristics?	0				Overall demand in the Wessex Water region has been falling since the mid-1990s despite population growth owing to the reduction in leakage, reduced commercial demands and the increasingly efficient use of water by our customers largely driven by metering. Given the rurality of our supply zone in which over 60% of households are now metered, the dominance of established agricultural businesses and (low water using) service industries, it is unlikely we will experience any sudden and/or unexpected changes in demand in the near term.
D(b): Does uncertainty associated with forecasts of demographic / economic / behavioural changes over the planning period cause concerns over the level of investment that may be required?	0				There is some uncertainty about future growth, however given the SDB from WRMP14 it is unlikely that such growth will cause significant concerns for level of investment required.

D(c): Are there concerns that a simple 'dry year/normal year' assessment of demand is not adequate, e.g. because of high sensitivity of demand to drought (so demand under severe events needs to be understood), or because demand versus drought timing is critical.		1			There are naturally some uncertainties around the impact of drought conditions on demand - for our last WRMP we undertook detailed analysis of peak factors using data from our Tariff Trial project. It is appropriate however to consider further analysis to understand weather drivers of demand.
Total score	1				

Table 15-5: Investment programme complexity factors

Investment programme complexity factors	No significant concerns (0)	Moderately significant concerns (1)	Very significant concerns (2)	Don't know	Comments
I(a): Are there concerns that capex uncertainty (particularly in relation to new or untested technologies) could compromise the company's ability to select a 'best value' portfolio over the planning period?	0				Investments being delivered in AMP6 are demand management focussed driven by customer preferences rather than a need to deliver a best value solution to a SDB deficit. We anticipate a similar programme to be put forward by this WRMP.
I(b): Does the nature of feasible options mean that construction lead time or scheme promotability are a major driver of the choice of investment portfolio?	0				There are no investment options with significant construction lead times or promotability concerns in either our existing Plan (2014) or anticipated for this Plan.
I(c): Are there concerns that trade-offs between costs and non-monetised 'best value' considerations (social, environment) are so complex that they require quantified analysis (beyond SEA) to justify final investment decisions.	0				Investments being delivered in AMP6 are demand management focussed driven by customer preferences rather than a need to deliver a best value solution to a SDB deficit. We anticipate a similar programme to be put forward by this WRMP.
I(d): Is the investment programme sensitive to assumptions about the utilisation of new resources, mainly because of large differences in	0				No supply side options are anticipated to be included in the final plan for this WRMP.

variable opex between investment options?					
Total score	**0**				

15.4 Level of vulnerability and modelling complexity

The total strategic needs score is 0 as there are no significant supply, demand or investment risks. The total Complexity Factors score is 3, resulting from moderate concern in some supply and demand components. Combining these scores together results in a **Low Level of Concern** (Table 3-6). Overall, the Decision Making Guidance[122] therefore suggests that current EBSD approaches should be adequate in terms of modelling complexity for the decision-making tool, and that any specific complexities can be examined through steps recommended in the Risk Based Planning Methods project.

Table 15-6: Final Problem characterisation combining strategic needs and complexity factors scores

		Strategic Needs Score ("How big is the problem")			
		0 (none)	**2 (small)**	**4 (medium)**	**6 (large)**
Complexity Factors Score ("how difficult is the problem")	**Low (<7)**	**X**			
	Medium (7-11)				
	High (11+)				

[122] UKWIR WRMP19 Methods – Decision Making Process: Guidance

16 Annex D: Miser model schematics

For security reasons this appendix is not available in the version of this Plan published on our website.

17 Annex E: Deployable output modelling adjustments

For security reasons this appendix is not available in the version of this Plan published on our website.

18 Annex F: Treatment works operational use schematics

For security reasons this appendix is not available in the version of this Plan published on our website.

19 Annex G: Water Resources Management Plan Direction

Defra published the Water Resources Management Plan (England) Direction 2017, which came into force on 22nd April 2017. This table documents where within this plan each statement in the direction is addressed.

Direction Statement	Section where this is addressed
A water undertaker must prepare a water resources management plan for a period of at least 25 years commencing on 1st April 2020.	Section 3.2.2
In accordance with section 37A(3)(d), a water undertaker must include in its water resources management plan a description of the following matters:	
the appraisal methodologies which it used in choosing the measures which it has identified in accordance with section 37A(3)(b) and its reasons for choosing those measures	Section 3.3
for the first 25 years of the planning period, its estimate of the average annual risk, expressed as a percentage, that it may need to impose prohibitions or restrictions on its customers in relation to the use of water under each of the following— section 76; section 74(2)(b) of the Water Resources Act 1991(b); and (iii) section 75 of the Water Resources Act 1991,	Section 3.3
and how it expects the annual risk that it may need to impose prohibitions or restrictions on its customers under each of those provisions to change over the course of the planning period as a result of the measures which it has identified in accordance with section 37A(3)(b);	Section 3.3
the assumptions it has made to determine the estimates of risks under sub-paragraph (b), including but not limited to drought severity;	Section 3.3
the emissions of greenhouse gases which are likely to arise as a result of each measure which it has identified in accordance with section 37A(3)(b), unless that information has been reported and published elsewhere and the water resources management plan states where that information is available;	Section 11.1.4
the assumptions it has made as part of the supply and demand forecasts contained in the water resources management plan in respect of—	
the implications of climate change, including in relation to the impact on supply and demand of each measure which it has identified in accordance with section 37A(3)(b);	Sections 4.9 and 5.6
household demand in its area, including in relation to population and housing numbers, except where it does not supply, and will continue not to supply, water to domestic premises; and	Section 5
non-household demand in its area, except where it does not supply, and will continue not to supply, water to non-domestic premises or to an acquiring licensee;	Section 5.6
its intended programme for the implementation of domestic metering and its estimate of the cost of that programme, including the costs of installation and operation of meters;	Section 9

its estimate of the number of premises which will become subject to domestic metering during the planning period as a result of— (i) optant metering; (ii) change of occupancy metering; (iii) new build metering; (iv) compulsory metering; or (v) selective metering, and its estimate of the impact on demand for water in its area of any increase in the number of premises subject to domestic metering;	Sections 5.5.4 and 5.5.5
its assessment of the cost-effectiveness of domestic metering as a mechanism for reducing demand for water by comparison with other measures which it might take to meet its obligations under Part III of the Act;	Sections 9, 5.5.4 and 5.5.5
its intended programme to manage and reduce leakage, including anticipated leakage levels and how those levels have been determined; and	Sections 5.8 and 9
if leakage levels are expected to increase at any time during the planning period, why any increase is expected.	Leakage will not rise during the planning period – Sections 5.8 and 9.
Except where the Secretary of State otherwise permits, a water undertaker must send its draft water resources management plan to the Secretary of State in accordance with section 37B(1) before 1st December 2017.	Complete, submitted on 30 November 2017.
Except where the Secretary of State otherwise permits, a water undertaker must publish its draft water resources management plan in accordance with section 37B(3)(a) for consultation within 30 days beginning with the date on which the Secretary of State directs it to do so.	N/A for draft Plan
Except where the Secretary of State otherwise permits, a water undertaker must publish its final water resources management plan in accordance with section 37B(8)(a) within 30 days beginning with the date on which the Secretary of State directs it to do so.	N/A for draft Plan
Except where the Secretary of State otherwise permits, a water undertaker must publish the statement required by regulation 4(2)(a) of the Water Resources Management Plan Regulations 2007(a), and send a copy of the statement to the persons specified in regulation 4(2)(b), within 26 weeks beginning with the date of publication of the draft water resources management plan.	N/A for draft Plan

20 Annex H: WRMP Environment Agency checklist

2.1 The legal requirements

No.	Action or approach	WRPG ref.	Section
1	You have considered and taken into account links between your WRMP and River Basin Management Plans.	S2.1, Page 3	4.4.2
2	You have considered and taken into account links between your WRMP and your Business Plan.	S2.1, Page 3	1.2.2;
3	You have considered and taken into account links between your WRMP and your Drought Plan.	S2.1, Page 3	1.2.1; 8.2
4	You have considered and accounted for links between your WRMP and the Environment Agency's drought plans and/or Natural Resources Wales' drought plans as appropriate.	S2.1, Page 3	1.2
5	You have considered and taken into account links between your WRMP and flood risk management plans.	S2.1, Page 3	8.8
6	You have considered and taken into account links between your WRMP and any local plans produced by Local Authorities.	S2.1, Page 3	5.4
7	You have considered and taken into account the requirements of the relevant legislation listed in section 2.1, including the WRMP Direction 2017 for water companies in England and WRMP (Wales) Directions 2016 for water companies in Wales.	S2.1, Page 3	1.1

2.2 Early engagement with regulators, customers and interested parties

No.	Action or approach	WRPG ref.	Section
8	You have followed the principles of UKWIR's 'Decision Making Process' and 'Risk Based Planning' frameworks to: • characterise the problem you need to solve • choose the best decision making process for appraising the options available to you • determine your approach for dealing with risks in your plan • determine methods for supply, demand, outage and headroom calculations that are consistent with your chosen options appraisal method and risk composition.	S2.2, Page 4	3.2, 3.4

No.	Action or approach	WRPG ref.	Section
9	You have prepared a method statement which clearly explains the choice and justification of methods, and communicated your statement to statutory consultees including the Environment Agency and/or Natural Resources Wales, Ofwat, licensed suppliers in your area that operate through your supply system any other relevant parties.	S2.2, Page 4	3.4
10	You have engaged with the Environment Agency and/or Natural Resources Wales to discuss the approaches laid out in your method statement and have appropriately recorded the outcomes of this engagement.	S2.2, Page 3	2.1
11	You have engaged with your Board, customers and other parties to discuss the approaches laid out in your method statement. You have appropriately recorded and incorporated the outcomes of this engagement.	S2.2, Page 3	2.2

2.3 Hold a pre-consultation

No.	Action or approach	WRPG ref.	Section
12	You have held pre-consultation discussions with statutory consultees including the Environment Agency and/or Natural Resources Wales, Ofwat and licenced water suppliers that operate through your supply system, revising your proposed approach accordingly.	S2.3, Page 5	2.1
13	You have accounted for outcomes of pre-consultation discussions with other consultees (including consumers, companies with which you share supply or have bulk supply) and have revised your proposed approach accordingly.	S2.3, Page 5	2.1
14	You have indicated how consultee feedback has been incorporated into the methods and approaches you will use to produce your draft plan.	S2.3, Page 5	2.1

2.4 Write a draft plan

No.	Action or approach	WRPG ref.	Section
15	You have accounted for pre-consultation outcomes and followed any written Directions received from the Secretary of State and/or Welsh Ministers. For water companies in England, follow the WRMP Direction 2017. For water companies in Wales, follow the WRMP (Wales) Direction 2016.	S2.4, Page 5	2.1 and Annex J

No.	Action or approach	WRPG ref.	Section
16	You have used a logical structured layout for your draft WRMP and included a separate non-technical overview, and supported the main technical document with appendices.	S2.4, Page 5	Summary for consultation and Annexes

2.5 Send your draft plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
17	You have appropriately flagged national security information or data within the draft WRMP, ready for redaction if necessary following security checking.	S2.5, Page 5	Complete – see security statement appendix
18	You have flagged commercially confidential or sensitive information or data that you prefer should not be published.	S2.5, Page 5	See Annexes B, D, E, F, K

2.6 Publish and distribute your draft plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
19	You have not published your draft plan until instructed to do so by the Secretary of State or the Welsh Ministers and have followed the WRMP Regulations 2007 in making your plan publically available.	S2.6, Page 6	To be completed at publication
20	You have redacted sensitive information prior to publication.	S2.6, Page 6	To be completed at publication
21	You have prepared a statement for issue with the draft plan, which explains where commercially sensitive information has been redacted and clearly explains the process for making representations on the draft plan.	S2.6, Page 6	2.3
22	You have taken appropriate steps to advertise the publication of the plan and to explain its contents to key stakeholders at the start of or during the consultation period.	S2.6, Page 6	To be completed at publication

2.7 Carry out a public consultation on your draft plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
23	You have allowed for a consultation period appropriate for the complexity of the plan, and that gives you adequate time to prepare a response to consultation feedback by the specified deadline (26 weeks after publication).	S2.7, Page 6	N/A for dWRMP

2.8 Publish a statement of response

No.	Action or approach	WRPG ref.	Draft WRMP ref.
24	You prepared and published your statement of response by the specified deadline.	S2.8, Page 7	N/A for dWRMP
25	You have considered all consultation responses in your statement and have explained whether/how you have acted on them and why.	S2.8, Page 7	N/A for dWRMP
26	You have set out any changes due to other factors during the consultation period (for example, external influences).	S2.8, Page 7	N/A for dWRMP
27	You have clearly set out the main changes you have made for the final plan and have accompanied your statement with an updated version of the draft plan if changes are substantive.	S2.8, Page 7	N/A for dWRMP
28	You have notified any party that responded to the consultation as you publish the statement of response (and revised draft WRMP if necessary).	S2.8, Page 7	N/A for dWRMP
29	You have considered the impact of any changes to your draft WRMP that might affect your Drought Plan, Business Plan or other plans.	S2.8, Page 7	N/A for dWRMP

2.9 Send your draft final plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
30	You have submitted your statement of response and final draft plan (if different to the draft WRMP) to the Secretary of State or Welsh Ministers, repeating the checklist steps as given in Section 2.6. The final draft plan should take account of any additional works required by Defra or the Welsh Government or advised by the Environment Agency or Natural Resources Wales following your statement of response.	S2.9, Page 7	N/A for dWRMP
31	You have undertaken any additional works as required by the Environment Agency or Natural Resources Wales following their review of your final draft plan, and have fully checked all changes.	S2.9, Page 7	N/A for dWRMP
32	You have completed and submitted the WRMP tables alongside the final WRMP.	S2.9, Page 7	N/A for dWRMP

2.10 Publish your final plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
33	You have accounted for any relevant Directions with regards to publishing your final plan and the appropriate permissions from the Secretary of State or Welsh Ministers have been given.	S2.10, Page 7	N/A for dWRMP
34	You have notified any party that responded to the consultation as you publish the final plan.	S2.10, Page 7	N/A for dWRMP

2.11 Revise and review your final plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
35	You have planned for annual review of the published plan in line with the Annual Review guidelines.	S2.11, Page 8	N/A for dWRMP
36	You will consult with the Environment Agency and/or Natural Resources Wales on any material changes that you wish to make to your plan in future.	S2.11, Page 8	N/A for dWRMP

3.1 Developing your plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
37	Your plan consistently complies with relevant government policy documents/publications.	S3.1, Page 9	1.1
38	You have provided a full explanation of the planning period assumed in the plan, which covers, as a minimum, the statutory period from 2020 to 2045.	S3.1, Page 9	3.3.2
39	You have included a robust forecast of the water you have available to supply customers with for each year within the planning period, accounting for climate change, and demonstrating that supply is both efficient and sustainable. You have achieved this by following the steps in Section 4 of this checklist.	S3.1, Page 9	4; 4.1.2
40	You have included a robust forecast of customers' demand for water during each year within the planning period, accounting for climate change. You have achieved this by following the steps in Section 5 of this checklist.	S3.1, Page 9	5; 5.10
41	You have allowed for uncertainties in your calculations and forecasts for both supply and demand over the planning period, and have used best practice methods to quantify uncertainty.	S3.1, Page 9	6

No.	Action or approach	WRPG ref.	Draft WRMP ref.
42	You have compared supply and demand to determine whether there is a surplus or deficit in any of your resource zones.	S3.1, Page 9	7
43	If you are in surplus in any of your resource zones you have flagged to other water companies that water is available for trading.	S3.1, Page 10	2.1.2
44	If you are in deficit in any of your resource zones, you have considered all reasonable options for addressing the deficit, including options for increasing supplies, reducing demand and cross-company/third party options	S3.1, Page 9	NA
45	Where new options are required, you have given opportunity for neighbouring companies or third parties to bid into your plan.	S3.1, Page 10	NA
46	You have adopted options that support the environmental objectives set out in RBMPs and if required, have carried out a Habitats Regulations Assessment including appropriate assessments, and a Strategic Environmental Assessment (SEA).	S3.1, Page 10	9
47	If you supply customers in Wales or your plan affects catchments in Wales, you have worked with Welsh Government and Natural Resources Wales with regards to understanding implications of the Environment (Wales) Act and Wellbeing of Future Generations (Wales) Act in developing your plan and how your plan contributes to Nature Recovery Plans.	S3.1, Page 10	NA
48	If you supply customers in England, you have adopted options that support the well-being of future generations, are compatible with Defra's long term plans for the environment including Biodiversity 2020, and whose social and environmental benefits/costs are properly understood and taken account of.	S3.1, Page 10	9.1.1
49	You have included confirmed or likely sustainability changes that you have been informed about.	S3.1, Page 9	4.4.3
50	You have demonstrated a system that can cope with droughts of a magnitude and duration that you reasonably expect to occur in your area over your chosen planning period and have considered contingencies for challenging but plausible droughts beyond the capabilities of your supply system (with relevant links to your Drought Plan) including whether they require options to provide additional resilience.	S3.1, Page 9	10.1
51	You have documented the impact of drought interventions on supply and demand and links with your Drought Plan.	S3.1, Page 9	10.1

No.	Action or approach	WRPG ref.	Draft WRMP ref.
52	You have accounted for the views of customers, other interested parties, statutory and non-statutory consultees in developing your plan.	S3.1, Page 10	2.1; 2.2
53	You have produced a flexible and adaptive plan that allows for risks and uncertainties in decisions, calculations and forecasts undertaken as part of the development of the plan.	S3.1, Page 10	6
54	You have gained Board buy-in with respect to the cost and long-term sustainability of proposals.	S3.1, Page 10	1.3
55	You have provided all the necessary supporting information at WRZ level and entered this in the water resources planning tables.	S3.1, Page 9	Annex B.

3.2 Defining a water resource zone

No.	Action or approach	WRPG ref.	Draft WRMP ref.
56	You have defined your Water Resource Zones (WRZs) using the Environment Agency's WRZ assessment methods (Water Resource Zone Integrity, 2016).	S3.2, Page 10	3.1.2; Annex B
57	You have demonstrated that, for each WRZ: • the abstraction and distribution of supply is largely self-contained (excepting agreed bulk transfers). • the majority of customers experience the same risk of supply failure and same level of service for demand restrictions. You have explained and justified any deviations from the above.	S3.2, Page 10	3.1.2: Annex B

3.3 Problem characterisation

No.	Action or approach	WRPG ref.	Draft WRMP ref.
58	You have applied the problem characterisation step of the *WRMP 2019 Methods – Decision Making Process: Guidance* (UKWIR, 2016) to determine the nature of the planning problem (including scale and complexity) as well as related issues, risks and uncertainties.	S3.3, Page 10	3.2.3
59	You have demonstrated that the effort and cost you have given to the selection of a decision-making process is proportional to the problem. You have described the significance of the choice of decision making method and its wider implications with respect to the plan outcomes.	S3.3, Page 11	3.2

No.	Action or approach	WRPG ref.	Draft WRMP ref.
60	You have adopted processes outlined in *WRMP 2019 Methods – Decision Making Process: Guidance* (UKWIR, 2016) using methods that are most appropriate for your company.	S3.3, Page 11	3.3
61	You have explained how/why the solutions(s) you have identified have been arrived at, and given assurance that uncertainties have not been double counted.	S3.3, Page 11	9.2
62	You have applied the *Economics of Balancing Supply and Demand [EBSD] method* (UKWIR, 2002) to determine a benchmark solution for comparison.	S3.3, Page 11	9.2
58	You have applied the problem characterisation step of the *WRMP 2019 Methods – Decision Making Process: Guidance* (UKWIR, 2016) to determine the nature of the planning problem (including scale and complexity) as well as related issues, risks and uncertainties.	S3.3, Page 10	3.2;
59	You have demonstrated that the effort and cost you have given to the selection of a decision-making process is proportional to the problem. You have described the significance of the choice of decision making method and its wider implications with respect to the plan outcomes.	S3.3, Page 11	3.3.3
60	You have adopted processes outlined in *WRMP 2019 Methods – Decision Making Process: Guidance* (UKWIR, 2016) using methods that are most appropriate for your company.	S3.3, Page 11	3.3
61	You have explained how/why the solutions(s) you have identified have been arrived at, and given assurance that uncertainties have not been double counted.	S3.3, Page 11	9.2
62	You have applied the *Economics of Balancing Supply and Demand [EBSD] method* (UKWIR, 2002) to determine a benchmark solution for comparison.	S3.3, Page 11	9.2
58	You have applied the problem characterisation step of the *WRMP 2019 Methods – Decision Making Process: Guidance* (UKWIR, 2016) to determine the nature of the planning problem (including scale and complexity) as well as related issues, risks and uncertainties.	S3.3, Page 10	3.2; Annex D
59	You have demonstrated that the effort and cost you have given to the selection of a decision-making process is proportional to the problem. You have described the significance of the choice of decision making method and its wider implications with respect to the plan outcomes.	S3.3, Page 11	3.3.3

No.	Action or approach	WRPG ref.	Draft WRMP ref.
60	You have adopted processes outlined in *WRMP 2019 Methods – Decision Making Process: Guidance* (UKWIR, 2016) using methods that are most appropriate for your company.	S3.3, Page 11	3.3
61	You have explained how/why the solutions(s) you have identified have been arrived at, and given assurance that uncertainties have not been double counted.	S3.3, Page 11	9.2
62	You have applied the *Economics of Balancing Supply and Demand [EBSD] method* (UKWIR, 2002) to determine a benchmark solution for comparison.	S3.3, Page 11	9.2

3.4 Drought risk assessment

No.	Action or approach	WRPG ref.	Draft WRMP ref.
63	You have explained how you have followed the processes outlined in *WRMP 2019 Methods – Risk Based Planning: Guidance* (UKWIR, 2016) to identify an appropriate design drought.	S3.4, Page 11	8.2
64	You have clearly set out and justified the risk composition you have selected for each WRZ and the reasons that lead you to select that option, including the availability of data where more complex risk compositions have been used.	S3.4, Page 11	3.3.4
65	Where different risk compositions are used in different parts of your supply system, you have explained this clearly and justified your reasoning. Also, where a more complex risk composition has been adopted but later abandoned to a simpler approach, this has been noted but your WRMP reflects the final risk composition adopted.	S3.4, Page 11	NA
66	You have included a drought resilience statement in your plan which is consistent with your chosen risk composition, and have explained how this reflects the hydrological risks that drought may impose on your supply system.	S3.4, Page 11	3.2

3.5 Planning scenarios

No.	Action or approach	WRPG ref.	Draft WRMP ref.
67	You have demonstrated that your plan is based on the dry year annual average for demand.	S3.5, Page 12	5.2; 5.10
68	You have reiterated the design drought you are basing your plan on for supply, and have based this on the drought risk assessment activities carried out under Section 3.4.	S3.5, Page 12	4.1

No.	Action or approach	WRPG ref.	Draft WRMP ref.
69	If you have chosen to consider how you will deal with a period of peak strain (critical period), you have set out which WRZs this applies to, the reasons for this and have described the underlying factors that impact on the supply-demand balance during the critical period.	S3.5, Page 12	3.2.2
70	You have explained the assumptions made when assessing your baseline figures for your demand forecast. Your documentation includes assumptions about mains renewal and capital maintenance, your baseline forecast of consumer need, losses through leakage and operating losses. You have demonstrated that the baseline case represents what happens excluding any changes in operations or company policy.	S3.5, Page 12	5
71	You have described how/where you have allowed for uncertainty in your demand forecast and how this is appropriate to your selected methods.	S3.5, Page 12	6.1
72	You have explained the assumptions made when assessing baseline figures for your supply forecast. You have demonstrated that the baseline case represents the supplies that can be maintained through a design drought as appropriate for your company area.	S3.5, Page 12	7; 4; 5;
73	You have reported the baseline figures for supply and demand in the water resources planning tables at WRZ level.	S3.5, Page 12	Annex B
74	For your final plan, you have explained any decisions related to developing options to manage or meet the forecast demand of your customers.	S3.5, Page 12	
75	You have documented each of the demand side options considered and the reason for choosing each option. If relevant, you have categorised your options as – change to existing policies, operations, infrastructure and resilience solutions (including drought measures and orders).	S3.5, Page 12	9.7
76	You have considered all available demand and supply side options in the process of developing your preferred plan. You have explained how you have done this, and demonstrated how third party and collaborative options with other companies have been evaluated. You have accounted for opportunities to improve resilience at regional level.	S3.5, Page 12	9.5; 2.1.2;
77	You have provided details of and explained your preferred programme of solutions to restore your supply-demand balance under a dry year average annual scenario.	S3.5, Page 12	NA

No.	Action or approach	WRPG ref.	Draft WRMP ref.
78	You have provided details of and explained your preferred programme of solutions to restore your supply-demand balance under a critical period scenario, if relevant.	S3.5, Page 12	NA
79	Where you are in deficit in dry year average annual or critical period scenarios, you have demonstrated how you have addressed these deficits and how your plan allows you to be compliant with your statutory duties.	S.5, Page 12	NA
80	You have indicated clearly if you have included resilience solutions for more challenging but plausible droughts beyond the capabilities of your final plan.	S3.5, Page 12	9.1
81	If you are in surplus, and you have still decided to include options in your plan, you have explained the benefits from this (such as more efficient supply of water, improvements in long-term resilience, demand reduction etc.)	S3.5, Page 12	9

3.6 Levels of service

No.	Action or approach	WRPG ref.	Draft WRMP ref.
82	For water companies wholly or mainly in England you have clearly set out your level of service as an annual percentage risk of restrictions, and set out if/how you expect it to change across the planning period as you implement supply-demand or resilience measures.	S3.6, Page 13	3.3.
83	You have presented evidence to demonstrate that your level of service is appropriate and have used appropriate assumptions and methodologies to develop your levels of service.	S3.6, Page 13	3.3.
84	You have engaged with your customers and stakeholders and their views have been considered when developing your level of service. You have communicated your level of service appropriately.	S3.6, Page 13	2; 3.3.
85	For water companies in England, you have set out a reference level of service that would mean resilience to an event of approximately 0.5% risk of annual occurrence (1:200 year drought event). You have presented this as a scenario and explained how you have modelled the drought event used.	S3.6, Page 13	3.3.
86	You have quantified the deployable output and incremental costs of your reference level of service scenario and explained how you have calculated these. You have set out if and how this could be achieved at any point in the planning period.	S3.6, Page 13	4.8.5

4.1 How to develop your supply forecast

No.	Action or approach	WRPG ref.	Draft WRMP ref.
87	Your approach to calculating your supply forecast is consistent with your risk composition choice, and the risk and uncertainty involved have been quantified using appropriate methods.	S4.1, Page 14	4.
88	You have discussed your approach to calculating your supply forecast as early as possible with the Environment Agency or Natural Resources Wales.	S4.1, Page 14	2.1
89	You have considered all individual components making up the supply forecast, and taken account of pressures on future supplies including (but not limited to): • climate change • abstraction licence changes due to abstraction reform or sustainability improvements • pollution or contamination implication for sources • development and new infrastructure • changes in contractual arrangements relating to transfers. You have clearly documented all assumptions made.	S4.1, Pages 14-15	4
90	You have recorded in the water resources planning tables the quantities for all baseline supply components as well as the amount of water that your analysis indicates you can reliably supply.	S4.1, Page 14	Annex B
91	As part of your supply assessment, you have determined and explained how your supply system behaves during the design drought.	S4.1, Page 14	4.11
92	You have explained links between your WRMP and your drought plan, including the likelihood of achieving planned levels of service and their impact on available supply.	S4.1, Page 14	1.2; 10.1
93	You have explained how drought interventions (drought permits and orders) that are contained within the drought plan have been dealt with in the WRMP in accordance with levels of service, and outlined any contingencies for extreme droughts that exceed the capability of your system to meet.	S4.1, Page 14	10.1
94	For water companies in England you have not included benefits drawn from supply drought measures (e.g. drought permits and orders) in your baseline supply forecast.	S4.1, Page 14	4
95	For water companies wholly or mainly in Wales, you should have discussed inclusion of supply drought measures in baseline forecasts with	S4.1, Page 14	NA

No.	Action or approach	WRPG ref.	Draft WRMP ref.
	Natural Resources Wales or Environment Agency.		

4.2 What should be included in your supply forecast?

No.	Action or approach	WRPG ref.	Draft WRMP ref.
96	You have provided a breakdown of your supply forecast for the dry year annual average scenario for all WRZs and presented this in the planning tables.	S4.2, Page 15	Annex B
97	You have explained your decision to include a critical period, if relevant, and have provided a supply forecast for it.	S4.2, Page 15	3.2.2
98	Where you abstract water for supply, your supply forecast for that WRZ sets out the deployable output, future changes to deployable output (e.g. from sustainability changes or climate change), transfers and future inputs from third parties, outage and other short-term losses, operational losses related to abstraction or treatments.	S4.2, Page 15	4.4; 4.3; 4.8; 4.6
99	Where you receive a raw or treated water import from a third party, your supply forecast reflects the contractual arrangements with this third party supplier.	S4.2, Page 15	4.6
100	You have demonstrated that your supplier will be able to maintain supply during your design drought and that levels of service can be achieved. You have demonstrated that your supplier has assessed that their statutory and policy obligations can be met.	S4.2, Page 15	4.6.1
101	You have expressed the supply forecast as the Water Available for Use (WAFU).	S4.2, Page 15	4.11
96	You have provided a breakdown of your supply forecast for the dry year annual average scenario for all WRZs and presented this in the planning tables.	S4.2, Page 15	Annex B
97	You have explained your decision to include a critical period, if relevant, and have provided a supply forecast for it.	S4.2, Page 15	4.1
98	Where you abstract water for supply, your supply forecast for that WRZ sets out the deployable output, future changes to deployable output (e.g. from sustainability changes or climate change), transfers and future inputs from third parties, outage and other short-term losses, operational losses related to abstraction or treatments.	S4.2, Page 15	4.4; 4.3; 4.8; 4.6

No.	Action or approach	WRPG ref.	Draft WRMP ref.
99	Where you receive a raw or treated water import from a third party, your supply forecast reflects the contractual arrangements with this third party supplier.	S4.2, Page 15	4.6
100	You have demonstrated that your supplier will be able to maintain supply during your design drought and that levels of service can be achieved. You have demonstrated that your supplier has assessed that their statutory and policy obligations can be met.	S4.2, Page 15	4.6
101	You have expressed the supply forecast as the Water Available for Use (WAFU).	S4.2, Page 15	4.9

4.3 What should be covered in your deployable output assessment?

No.	Action or approach	WRPG ref.	Draft WRMP ref.
102	You have explained which factors constrain deployable output, such as hydrological yield, licensed quantities/constraints, pumping constraints, transfer issues, water quality and treatment.	S4.3, Page 15	4.7; 4.8
103	You have identified where deployable output is constrained by licences that are time limited and due to expire in the period covered by the plan, and evaluated the risks of non-renewal.	S4.3, Page 15	6.1
104	You have checked that licenced volumes are sustainable and that their use will not cause deterioration.	S4.3, Page 15	4.4
105	Your method for deployable output determination is consistent with your risk composition and the methods outlined in *Handbook of source yield methodologies* (UKWIR, 2014) or *WRMP 2019 Methods – Risk Based Planning: Guidance* (UKWIR, 2016); you have fully explained and documented your choice of method and supporting techniques.	S4.3, Page 16	4
106	You have described how deployable output will be affected by demand side drought restrictions according to the level of service you have planned for.	S4.3, Page 15	10.1.3
102	You have explained which factors constrain deployable output, such as hydrological yield, licensed quantities/constraints, pumping constraints, transfer issues, water quality and treatment.	S4.3, Page 15	4.7; 4.8
103	You have identified where deployable output is constrained by licences that are time limited and due to expire in the period covered by the plan, and evaluated the risks of non-renewal.	S4.3, Page 15	6.1

No.	Action or approach	WRPG ref.	Draft WRMP ref.
104	You have checked that licenced volumes are sustainable and that their use will not cause deterioration.	S4.3, Page 15	4.4
105	Your method for deployable output determination is consistent with your risk composition and the methods outlined in *Handbook of source yield methodologies* (UKWIR, 2014) or *WRMP 2019 Methods – Risk Based Planning: Guidance* (UKWIR, 2016); you have fully explained and documented your choice of method and supporting techniques.	S4.3, Page 16	4
106	You have described how deployable output will be affected by demand side drought restrictions according to the level of service you have planned for.	S4.3, Page 15	8.2

4.4 Your role in achieving sustainable abstraction

No.	Action or approach	WRPG ref.	Draft WRMP ref.
107	Your proposals support WFD obligations and RBMP objectives in relation to sustainable abstraction.	S4.4. Page 16	4.4
108	You have determined if changes to your abstractions are required to meet RBMP objectives, and you have discussed the scope of changes with the Environment Agency or Natural Resources Wales as part of WINEP for PR19.	S4.4. Page 16	4.4.2
109	You have determined that all existing abstractions (including any planned increases to abstracted volumes with current licence limits, and any time limited licences) are compliant with RBMP objectives and any other legally binding environmental objectives.	S4.4. Page 16	4.4
110	You have liaised with Environment Agency and/or Natural Resources Wales to determine if you have any abstractions from water bodies that are at risk from deterioration.	S4.4. Page 16	4.4.2
111	You have reviewed potential mitigation measures for any waterbodies at risk and put into place plans to manage the risk of deterioration, or where deterioration has occurred because of your actions, you have put in place plans to restore the waterbody.	S4.4. Page 16	4.4.1
112	You have completed all investigations and options appraisals in your PR14 water industry NEP for AMP6 by the agreed dates and included any options needed to manage any sustainability changes in your plan.	S4.4. Page 16	4.4

No.	Action or approach	WRPG ref.	Draft WRMP ref.
113	You have considered any regulator measures to improve fish/eel passage or water quality and accounted for likely impact on supply forecasts.	S4.4. Page 16	4.4.7
107	Your proposals support WFD obligations and RBMP objectives in relation to sustainable abstraction.	S4.4. Page 16	9.3
108	You have determined if changes to your abstractions are required to meet RBMP objectives, and you have discussed the scope of changes with the Environment Agency or Natural Resources Wales as part of WINEP for PR19.	S4.4. Page 16	4.4.2
109	You have determined that all existing abstractions (including any planned increases to abstracted volumes with current licence limits, and any time limited licences) are compliant with RBMP objectives and any other legally binding environmental objectives.	S4.4. Page 16	4.4
110	You have liaised with Environment Agency and/or Natural Resources Wales to determine if you have any abstractions from water bodies that are at risk from deterioration.	S4.4. Page 16	4.4.2
111	You have reviewed potential mitigation measures for any waterbodies at risk and put into place plans to manage the risk of deterioration, or where deterioration has occurred because of your actions, you have put in place plans to restore the waterbody.	S4.4. Page 16	4.4.1
112	You have completed all investigations and options appraisals in your PR14 water industry NEP for AMP6 by the agreed dates and included any options needed to manage any sustainability changes in your plan.	S4.4. Page 16	4.4
113	You have considered any regulator measures to improve fish/eel passage or water quality and accounted for likely impact on supply forecasts.	S4.4. Page 16	4.4.7

4.5 Invasive Non-Native Species (INNS)

No.	Action or approach	WRPG ref.	Draft WRMP ref.
114	You have considered whether/how any current or future abstractions or operations might cause the spread of INNS and have determined measures to reduce the risk of this. You have liaised with Environment Agency and/or Natural Resources Wales to discuss the risk of INNS and reflected the outcomes of this in your plan.	S4.5. Page 17	4.4.7

No.	Action or approach	WRPG ref.	Draft WRMP ref.
115	For water companies in England, you have reflected the February 2017 position statement and its principles in your plan.	S4.5. Page 17	4.4.7

4.6 How to include changes to your abstraction licence in your plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
116	You have liaised with the Environment Agency or Natural Resources Wales to determine the likely impact of sustainability measures on abstraction licences and agreed a mutually acceptable timescale for the implementation of new licence conditions.	S4.6. Page 17	4.4.3
117	You have determined the impact of any sustainability reductions on your deployable output and included these in your plan appropriately.	S4.6. Page 17	4.4.3
118	You have assessed the impact of possible future sustainability changes on your plan through scenario testing and not included any uncertainty about sustainability changes within your plan.	S4.6. Page 17	10.2.1
119	Where changes to abstraction licences or new options threaten security of supply and there are no alternatives, you have considered and prepared evidence for exemption under Article 4.7 of the WFD.	S4.6. Page 17	NA

4.7 Abstraction reform – evidence needs

No.	Action or approach	WRPG ref.	Draft WRMP ref.
120	For catchments managed by the Environment Agency, you have not included any changes to DO from abstraction reform. You have identified sources having unused licence volumes that are required for emergency purposes and have explained how you define these (e.g. drought source or other purposes).	S4.7, Page 17	4.4
121	For catchments managed by Natural Resources Wales, you have included evidence to justify retaining any of your daily or annual licensed volumes within your plan. You have discussed the evidence requirements with Natural Resources Wales.	S4.7, Page 17	NA

No.	Action or approach	WRPG ref.	Draft WRMP ref.
122	If you operate using licences within the three cross-border catchments (Rivers Dee, Wye and Severn), you have included information in your plan that justifies retention of any unused volumes associated with those licences.	S4.7, Page 17	NA

4.8 Climate change

No.	Action or approach	WRPG ref.	Draft WRMP ref.
123	You have determined the impact of climate change on river flows and groundwater recharge using one of the three methods set out in the guideline.	S4.8, Page 18	4.10
124	You have assessed and clearly demonstrated the vulnerability and risks your sources and supplies face for each of your WRZs.	S4.8, Page 19	4.10
125	You have set out and justified your assessment methods, outlined any assumptions made and clearly presented your results, explaining any differences in methodology between your resource zones.	S4.8, Page 19	4.10
126	You have clearly explained whether and how climate change has been accounted for in your headroom assessment and have reported this separately.	S4.8, Page 19	6.1
127	You have set out if/how you have used scaling methods to account for climate change that has already happened, and how this has affected your supplies.	S4.8, Page 19	4.10
128	You have calculated the impacts of climate change on supply and have entered this into the water resources planning tables as changes to DO.	S4.8, Page 19	Planning Tables

4.9 Water transfers

No.	Action or approach	WRPG ref.	Draft WRMP ref.
129	You have quantified all water transfers including all raw and potable imports/exports and entered this in the water resources planning tables. You have noted the direction of transfers along with the potential to change the direction if needed.	S4.9, Page 18	4.6.1
130	You have documented agreed limits between supplier and recipient companies for all transfers, including any contractual variations that might apply (e.g. in times of drought).	S4.9, Page 18	4.6.1

No.	Action or approach	WRPG ref.	Draft WRMP ref.
131	You have documented the total volume available to you via transfer for each year of your plan (accounting for operational or infrastructure constraints that may reduce quantities).	S4.9, Page 18	4.6.1
132	You have assessed and documented the quality of transferred water and any impact of the transfer on the quality of receiving waters.	S4.9, Page 18	4.6.1

4.10 Drinking water quality

No.	Action or approach	WRPG ref.	Draft WRMP ref.
133	You have supported objectives for drinking water in protected areas.	S4.10, Page 20	4.5.1
134	You have checked that the drinking water arising from the water treatment regime applied meets the Standards of the Drinking Water Directive plus any other legislation.	S4.10, Page 20	4.5.1
135	You have abided by Section 68(1) of the Water Industry Act 1991 in terms of quality of supplied water, and applied this to water from your own sources as well as transfers.	S4.10, Page 20	4.5.1
136	You have considered appropriate measures to prevent deterioration of water quality in a protected area.	S4.10, Page 20	4.5.1
137	You have recorded how you have calculated treatment works losses and operational use for each WRZ.	S4.10, Page 20	4.3
138	You have provided diagrams and other supporting evidence for complex major works that can be used in pre-consultation discussions with the Environment Agency or Natural Resources Wales.	S4.10, Page 20	Annex D
139	You have considered options to reduce losses where possible, especially if your plan has a supply-demand balance deficit.	S4.10, Page 20	4.5.1.
140	You have considered measures to protect supplies against long term risks of pollution.	S4.10, Page 20	4.5.2
141	You have considered measures to reduce the treatment process whilst still complying with the requirements of the drinking water regulations.	S4.10, Page 20	4.5
142	You have demonstrated that all sources you may rely on have been correctly identified and measures taken to provide protection where necessary, e.g. SPZs around groundwater abstractions.	S4.10, Page 20	4.5

No.	Action or approach	WRPG ref.	Draft WRMP ref.
143	You have applied your approach consistently across all WRZs.	S4.10, Page 20	4.5

4.11 Outage

No.	Action or approach	WRPG ref.	Draft WRMP ref.
144	You have documented your outage allowance and your approach is in line with *WRMP 19 methods -Risk based planning* (UKWIR, 2016) or the *Outage allowances* (UKWIR 1995) approach.	S4.11, Page 20	4.11
145	You have entered outage calculations in the water resources planning tables.	S4.11, Page 20	Planning Tables
146	You have included details of options you propose for reducing outage, particularly in cases of a supply-demand balance deficit.	S4.11, Page 20	4.11
144	You have documented your outage allowance and your approach is in line with *WRMP 19 methods -Risk based planning* (UKWIR, 2016) or the *Outage allowances* (UKWIR 1995) approach.	S4.11, Page 20	4.11
145	You have entered outage calculations in the water resources planning tables.	S4.11, Page 20	Planning Tables
146	You have included details of options you propose for reducing outage, particularly in cases of a supply-demand balance deficit.	S4.11, Page 20	4.11

4.12 Water available for use

No.	Action or approach	WRPG ref.	Draft WRMP ref.
147	You have clearly set out the total WAFU, and demonstrated how changes in deployable output, transfers, operational use and outage impact on the calculated total.	S4.12, Page 20	4.11

5.1 What should be covered in your demand forecasts?

No.	Action or approach	WRPG ref.	Draft WRMP ref.
148	You have provided a demand forecast for the dry year annual average where demand is unrestricted, which includes adjustments for likely future changes in demand due to factors such as climate change, population growth,	S5.1, Page 21	5; 5.10

No.	Action or approach	WRPG ref.	Draft WRMP ref.
	household size, property numbers, and current company demand management policy/activity.		
149	You have provided a demand forecast for the critical period (if considered in your plan) that accounts for the factors you expect will drive demand during the critical period, such as seasonal changes or population growth.	S5.1, Page 21	5; 5.10
150	You have provided a demand forecast for the final plan dry year annual average which includes adjustments to reflect solutions identified through your options appraisal.	S5.1, Page 21	5.10
151	You have provided a demand forecast for the final plan critical period which includes adjustments to reflect solutions identified through your options appraisal.	S5.1, Page 22	5.10
152	You have explained how demand forecasts have been arrived at and documented any underlying assumptions, including how you have determined unrestricted demand.	S5.1, Page 22	5
153	You have explained your reconciliation of current best estimates of demand with other parts of the water balance.	S5.2, Page 22	Annex A
148	You have provided a demand forecast for the dry year annual average where demand is unrestricted, which includes adjustments for likely future changes in demand due to factors such as climate change, population growth, household size, property numbers, and current company demand management policy/activity.	S5.1, Page 21	5; 5.10
149	You have provided a demand forecast for the critical period (if considered in your plan) that accounts for the factors you expect will drive demand during the critical period, such as seasonal changes or population growth.	S5.1, Page 21	5; 5.10
150	You have provided a demand forecast for the final plan dry year annual average which includes adjustments to reflect solutions identified through your options appraisal.	S5.1, Page 21	5.10
151	You have provided a demand forecast for the final plan critical period which includes adjustments to reflect solutions identified through your options appraisal.	S5.1, Page 22	5.10
152	You have explained how demand forecasts have been arrived at and documented any underlying assumptions, including how you have determined unrestricted demand.	S5.1, Page 22	5

No.	Action or approach	WRPG ref.	Draft WRMP ref.
153	You have explained your reconciliation of current best estimates of demand with other parts of the water balance.	S5.2, Page 22	Annex A

5.2 Forecast household demand

No.	Action or approach	WRPG ref.	Draft WRMP ref.
154	You have demonstrated how you have arrived at your forecast of population and property numbers and the assumptions on which these are based.	S5.2, Page 22	5.4; 5.5
155	You have demonstrated an understanding of what is driving future household demand and how you have estimated this.	S5.2, Page 22	5.6
156	You have included forecast savings data for existing water efficiency initiatives in your baseline forecast.	S5.5, Page 22	5.6.3

5.3 Forecast population, properties and occupancy

No.	Action or approach	WRPG ref.	Draft WRMP ref.
157	For water companies supplying customers in England you have aligned your method for forecasting population and property growth with the most recent local plans published for your area(s), and accounted for potential changes in published figures if a local plan is not yet finalised.	S5.3, Page 22	5.4.2
158	Where no local plan project(s) exist to inform your plan, you have used other appropriate methods such as household projections for Dept. for Communities, Local Government, those produced for DCLG by the ONS or the methods outlined in *Population, household property and occupancy forecasting* (UKWIR, 2016). You have documented and explained assumptions and data sources used.	S5.3, Page 22	5.4.2, 5.5.2
159	You have provided evidenced justification if your property forecasts deviate from planned figures.	S5.3, Page 22	5.4.2
160	You have accounted for the planning period in your forecast property and population figures and have explained where/if different forecasting methods are applied for different time horizons, especially if your planning period is longer than 25 years.	S5.3, Page 23	5.4.2; 5.5.2

No.	Action or approach	WRPG ref.	Draft WRMP ref.
161	For companies supplying customers in Wales, you have based your forecast population and property figures on the latest Local Authority population and property projections published by the Welsh Government. Your analysis of the uncertainties in your forecast population and property figures has been informed by local development plans in your supply area.	S5.3, Page 23	NA
162	You have demonstrated that your plan does not constrain supply such that it may not meet planned property forecasts.	S5.3, Page 23	5.4.2
163	You have engaged with local planning authorities to inform your analysis and understand uncertainties in your forecast population and property figures.	S5.3, Page 23	5.4.2
164	You have properly communicated limitations in your forecast and uncertainty associated with your forecast.	S5.3, Page 23	5.4.2; 5.5.2
165	You have described assumptions and supporting information that you have used to develop property and occupancy forecasts, including uncertainties.	S5.3, Page 23	5.4; 5.5
166	You have explained how you have allocated unaccounted for populations for each WRZ, including your assumptions.	S5.3, Page 23	5.4
167	You have accounted for local council and neighbourhood plans, when calculating future demand.	S5.3, Page 23	5.4.2
No.	**Action or approach**	**WRPG ref.**	**Draft WRMP ref.**
157	For water companies supplying customers in England you have aligned your method for forecasting population and property growth with the most recent local plans published for your area(s), and accounted for potential changes in published figures if a local plan is not yet finalised.	S5.3, Page 22	5.4.2
158	Where no local plan project(s) exist to inform your plan, you have used other appropriate methods such as household projections for Dept. for Communities, Local Government, those produced for DCLG by the ONS or the methods outlined in *Population, household property and occupancy forecasting* (UKWIR, 2016). You have documented and explained assumptions and data sources used.	S5.3, Page 22	5.4.2, 5.5.2

No.	Action or approach	WRPG ref.	Draft WRMP ref.
159	You have provided evidenced justification if your property forecasts deviate from planned figures.	S5.3, Page 22	5.4.2
160	You have accounted for the planning period in your forecast property and population figures and have explained where/if different forecasting methods are applied for different time horizons, especially if your planning period is longer than 25 years.	S5.3, Page 23	5.4.2; 5.5.2
161	For companies supplying customers in Wales, you have based your forecast population and property figures on the latest Local Authority population and property projections published by the Welsh Government. Your analysis of the uncertainties in your forecast population and property figures has been informed by local development plans in your supply area.	S5.3, Page 23	NA
162	You have demonstrated that your plan does not constrain supply such that it may not meet planned property forecasts.	S5.3, Page 23	5.4.2
163	You have engaged with local planning authorities to inform your analysis and understand uncertainties in your forecast population and property figures.	S5.3, Page 23	5.4.2
164	You have properly communicated limitations in your forecast and uncertainty associated with your forecast.	S5.3, Page 23	5.4.2; 5.5.2
165	You have described assumptions and supporting information that you have used to develop property and occupancy forecasts, including uncertainties.	S5.3, Page 23	5.4; 5.5
166	You have explained how you have allocated unaccounted for populations for each WRZ, including your assumptions.	S5.3, Page 23	5.5.1
167	You have accounted for local council and neighbourhood plans, when calculating future demand.	S5.3, Page 23	5.4.2

5.4 Forecasting your customers' demand for water

No.	Action or approach	WRPG ref.	Draft WRMP ref.
168	You have selected a method for forecasting demand that is appropriate to each WRZ, based on the supply-demand situation, any problem characterisation approaches you have considered and the data available.	S5.4, Page 23	5

No.	Action or approach	WRPG ref.	Draft WRMP ref.
169	Your method for forecasting demand is aligned with the following guidelines: • *WRMP-19 Household demand forecasting - Integration of behavioural change into demand forecasting and water efficiency practices* (UKWIR 2016). • *Customer behaviour and water use – good practice for household consumption forecasting* (UKWIR, 2012).	S5.4, Page 23	5.5
170	You have documented your reasons for choice of method, including your assumptions and their associated uncertainties.	S5.4, Page 23	3.4
171	You have demonstrated a forecast demand for the critical period scenario (if appropriate) as well as the dry year annual average.	S5.4, Page 23	5.10
172	You have provided a breakdown of total consumption, per capita consumption and micro-components within the water resources planning tables.	S5.4, Page 23	Planning Tables
168	You have selected a method for forecasting demand that is appropriate to each WRZ, based on the supply-demand situation, any problem characterisation approaches you have considered and the data available.	S5.4, Page 23	3.4
169	Your method for forecasting demand is aligned with the following guidelines: • *WRMP-19 Household demand forecasting - Integration of behavioural change into demand forecasting and water efficiency practices* (UKWIR 2016). • *Customer behaviour and water use – good practice for household consumption forecasting* (UKWIR, 2012).	S5.4, Page 23	5.6
170	You have documented your reasons for choice of method, including your assumptions and their associated uncertainties.	S5.4, Page 23	3.4
171	You have demonstrated a forecast demand for the critical period scenario (if appropriate) as well as the dry year annual average.	S5.4, Page 23	5.10
172	You have provided a breakdown of total consumption, per capita consumption and micro-components within the water resources planning tables.	S5.4, Page 23	Planning Tables

5.5 Forecasting your non-household consumption

No.	Action or approach	WRPG ref.	Draft WRMP ref.
173	You have calculated a demand forecast for non-households.	S5.5, Page 23	5.7
174	You have described your assumptions about customer/property types that you have considered as non-household and demonstrated that your decisions are aligned with part 17C of the Water Industry Act 1991 and guidance on non-household customers as reported in *Eligibility guidance on whether non-household customers in England and Wales are eligible to switch their retailer*. You have consulted with retailers of water to non-household customers.	S5.5, Page 24	5.7
175	You have accounted for the likely other retailers to non-household sectors in your area following the changes introduced in April 2017 and have consulted with retailers of water to non-household customers.	S5.5, Page 24	5.7
176	You have determined non-household demand into different economic sectors, for example by using the UK SIC codes or applying a service and non-service split approach.	S5.5, Page 24	5.7.2
177	You have assessed the likely new uptake of public water from non-household customers / sectors that previously used private supplies.	S5.5, Page 24	5.7
178	You have examined and taken account of planned or existing water saving initiatives by both the wholesaler and retailer and have determined in the likely saving in non-household demand.	S5.5, Page 24	5.7
179	You have included forecast savings data for existing water efficiency initiatives in the baseline forecast that you have presented.	S5.5, Page 24	5.7

5.6 Forecasting leakage

No.	Action or approach	WRPG ref.	Draft WRMP ref.
180	You have determined baseline leakage over the planning period and explained your method in the WRMP	S5.6, Page 24	5.8.2
181	You have used *UKWIR Consistency of reporting performance measures (2017*) to forecast levels of leakage.	S5.6, Page 24	Annex A
182	If you are unable to use the guidance outlined in *Consistency of Reporting Performance Measures (UKWIR 2017),* you have explained why you have not used the revised approach for base year leakage, what steps you are	S5.6, Page 24	NA

No.	Action or approach	WRPG ref.	Draft WRMP ref.
	taking to comply with the new approach and when this data will be available.		
183	Where the revised approach to calculating base year leakage leads to uncertainty or significant changes in your base year or projected leakage, you have used scenarios to demonstrate how this affects your plan and any options you have selected.	S5.6, Page 25	NA
184	You have described how your approach to calculating base year leakage affects your ability to meet government aspirations to reduce leakage over the planning period.	S5.6, Page 25	5.8.1
185	You have accounted for any actions or policies that may reduce leakage (e.g. mains improvements) in your leakage forecast.	S5.6, Page 25	9.5
186	You have accounted for your customers' views on leakage reduction and their resulting willingness to participate in demand management activities.	S5.6, Page 25	9.2
187	You have included all feasible options for further leakage control, and any other options you are actively investigating with support from your customers.	S5.6, Page 25	9.2; 9.7.3
180	You have determined baseline leakage over the planning period and explained your method in the WRMP	S5.6, Page 24	5.8.2
181	You have used *UKWIR Consistency of reporting performance measures (2017*) to forecast levels of leakage.	S5.6, Page 24	Annex A
182	If you are unable to use the guidance outlined in *Consistency of Reporting Performance Measures (UKWIR 2017),* you have explained why you have not used the revised approach for base year leakage, what steps you are taking to comply with the new approach and when this data will be available.	S5.6, Page 24	NA
183	Where the revised approach to calculating base year leakage leads to uncertainty or significant changes in your base year or projected leakage, you have used scenarios to demonstrate how this affects your plan and any options you have selected.	S5.6, Page 25	NA
184	You have described how your approach to calculating base year leakage affects your ability	S5.6, Page 25	5.8.1

No.	Action or approach	WRPG ref.	Draft WRMP ref.
	to meet government aspirations to reduce leakage over the planning period.		
185	You have accounted for any actions or policies that may reduce leakage (e.g. mains improvements) in your leakage forecast.	S5.6, Page 25	5.8.1, 9.10
186	You have accounted for your customers' views on leakage reduction and their resulting willingness to participate in demand management activities.	S5.6, Page 25	2.2.2, 9.10
187	You have included all feasible options for further leakage control, and any other options you are actively investigating with support from your customers.	S5.6, Page 25	9.2; 9.10

5.7 Other components of demand

No.	Action or approach	WRPG ref.	Draft WRMP ref.
188	You have included details on other components of demand, the methods you have adopted for their calculation and your source datasets.	S5.7, Page 25	5.9

5.8 Metering

No.	Action or approach	WRPG ref.	Draft WRMP ref.
189	You have reported household metering figures in the water resources planning tables.	S5.8, Page 25	Annex B
190	For water companies in England, you have complied with the WRMP Direction 2017 with regard to household metering.	S5.8, Page 25	Annex O
191	If you are in an area of serious water stress, you have considered the costs and benefits of compulsory metering.	S5.8, Page 25	NA
192	You have assessed which tariffs are appropriate to your company as part of your options appraisal and included in your plan as appropriate.	S5.8, Page 25	9.5

5.9 Impacts of climate change

No.	Action or approach	WRPG ref.	Draft WRMP ref.
193	You have documented the allowance included in your plan for the impact of climate change on demand, including the assumptions on which this is based.	S5.9, Page 26	5.6.6

194	If your allowance is outside expected impact range (<3%), you have robustly demonstrated and justified the reasons for this.	S5.9, Page 26	NA

5.10 Allowing for uncertainty

No.	Action or approach	WRPG ref.	Draft WRMP ref.
195	You have reduced uncertainty by using the most up to date methods and data when determining supply and demand forecasts.	S5.10, Page 26	4.9; 5.6
196	You have analysed, quantified and discussed any uncertainties associated with your calculations of dry year annual average demand (and critical period scenarios if applicable).	S5.10, Page 26	6
197	You have used risk-based planning techniques to assess individual components of uncertainty, avoiding any double counting for (e.g. for target headroom components) or omission of uncertainties.	S5.10, Page 26	NA – (see 198)
198	Alternatively, if you have applied an older target headroom approach to assess individual components of uncertainty, you have justified why this is appropriate. You have evaluated target headroom with regards to risk appetite and have allowed risk to increase with time as adaptations will occur in practice.	S5.10, Page 26	6
199	You have documented all assumptions and information used in the assessment of uncertainties and have discussed the relative significance of uncertainties showing which impact most on each WRZ.	S5.10, Page 26	6
200	You have considered options for reducing uncertainty in the planning period.	S5.10, Page 26	6
201	You have communicated uncertainty such that customers can clearly understand the issues and risks.	S5.10, Page 26	6
202	You have explained where there are any uncertainties related to non-replacement of time-limited licences (TLLs).	S5.10, Page 26	6
203	You have not included an allowance for possible future sustainability changes in headroom, and where relevant you have explored this through scenario analysis.	S5.10, Page 26	6; 10.2.1

6.1 Considerations when choosing future solutions

No.	Action or approach	WRPG ref.	Draft WRMP ref.

204	You have considered all options that will address any deficit(s) between supply and demand in any WRZ at any time during the planning period. You have justified your preferred solution(s) in your final plan.	S6.1, Page 27	NA
205	You have distinguished whether options apply to the dry year annual average and/or critical period scenarios, and your final plan addresses deficits in all scenarios for all WRZs across the planning period.	S6.1, Page 27	11
206	You have considered options that will allow you to improve your service to customers, provide long-term best value, benefit the environment or collaborate with other water companies. You have justified your preferred solution(s) in your final plan.	S6.1, Page 27	9
207	You have documented all factors that have led you to consider options (whether in deficit or not) in your plan, including reasons.	S6.1, Page 27	9
208	You evaluated the environmental impacts of all possible and discarded options that could have unacceptable impacts that could not be overcome. You have further considered only those options that support achievement of RBMP objectives and would not result in deterioration.	S6.1, Page 27	9
209	You have considered the need to undertake an SEA or HRA for each option, and if appropriate undertaken them as a result.	S6.1, Page 27	9

6.2 Resilience options

No.	Action or approach	WRPG ref.	Draft WRMP ref.
210	You have evaluated whether options are needed to improve resilience to significant vulnerabilities which are not addressed within the planned level of service, and if needed explained this fully.	S6.2, Page 28	9
211	The hazards you considered when evaluating resilience options were those listed in *Resilience planning: good practice guide* (UKWIR, 2013), and you have also considered hazards other than drought.	S6.2, Page 28	8
212	You have considered the results of the *Water Resources Long Term Planning Framework* (Water UK, 2016), and WRSE and/or WRE as appropriate and incorporated the outcomes into your plan.	S6.2, Page 28	3.2
213	If resilience options have been considered, you have considered the costs and benefits and justified the solution.	S6.2, Page 28	NA

214	You have demonstrated customer support for the options you have proposed to improve resilience and the level of resilience the options will provide, and have a business case for the additional spending that resilience measures will involve.	S6.2, Page 28	NA
215	You have described the option(s) in detail and have conducted the appraisal of resilience options to the same standard as non-resilience options.	S6.2, Page 28	NA
210	You have evaluated whether options are needed to improve resilience to significant vulnerabilities which are not addressed within the planned level of service, and if needed explained this fully.	S6.2, Page 28	8.1
211	The hazards you considered when evaluating resilience options were those listed in *Resilience planning: good practice guide* (UKWIR, 2013), and you have also considered hazards other than drought.	S6.2, Page 28	8
212	You have considered the results of the *Water Resources Long Term Planning Framework* (Water UK, 2016), and WRSE and/or WRE as appropriate and incorporated the outcomes into your plan.	S6.2, Page 28	3.2
213	If resilience options have been considered, you have considered the costs and benefits and justified the solution.	S6.2, Page 28	9.4
214	You have demonstrated customer support for the options you have proposed to improve resilience and the level of resilience the options will provide, and have a business case for the additional spending that resilience measures will involve.	S6.2, Page 28	9.4
215	You have described the option(s) in detail and have conducted the appraisal of resilience options to the same standard as non-resilience options.	S6.2, Page 28	9.4

6.3 Third party options

No.	Action or approach	WRPG ref.	Draft WRMP ref.
216	You have considered options, where appropriate, that involve engaging with third parties to help deliver solutions at lower cost, such as upstream services, leakage detection and demand management. You have used the Market Information Platform to assess third party bids (when available).	S6.3, Page 29	NA
217	You have subjected options involving third parties to the same scrutiny and testing as other options.	S6.3, Page 29	NA
218	Where relevant, your plans clearly sets out which options within the final planning scenario are third party options.	S6.3, Page 29	NA

6.4 Upstream competition

No.	Action or approach	WRPG ref.	Draft WRMP ref.
219	For water companies in England, you have checked that there are no requirements with regards to reforms relating to competitive services for supply to/removal from your network following the Water Act 2014.	S6.4, Page 29	

6.5 Assessing solutions for your plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
220	Your appraisal of options follows the eight stage approach outlined in *WRMP 2019 Methods – decision making process guidance* (UKWIR, 2016). 1. Collate and review planning information. 2. Identify unconstrained options. 3. Problem characterisation and evaluate strategic needs/complexity. 4. Decide modelling method. 5. Identify and define data inputs. 6. Undertake decisions making modelling / options appraisal. 7. Stress testing and sensitivity analysis. 8. Final planning forecast and comparison to EBSD benchmark.	S6.5, Page 29	3.2
221	You have demonstrated that your final planning forecast is your best value plan, not necessarily the least cost solution, accounting for all criteria that sensitivity analysis has established are important to the plan.	S6.5, Page 29	9.8

6.6 Unconstrained list

No.	Action or approach	WRPG ref.	Draft WRMP ref.
222	You have developed an unconstrained list of all plausible technically feasible options, including drought measures, and have at least considered options presented in *WR27 Water resources tools* (UKWIR, 2012) and the EBSD method.	S6.6, Page 30	9.2
223	For water companies in England, you have included third party options (see 6.3) in the unconstrained list, and have demonstrated you have invited or considered third party collaborations or provide a clear explanation of why third party option have not been included.	S6.6, Page 30	9.2

6.7 Feasible list

No.	Action or approach	WRPG ref.	Draft WRMP ref.
224	Your feasible list is a subset of your unconstrained list and you have demonstrated that all options on your preferred list are suitable for promotion.	S6.7, Page 30	9
225	You have communicated your feasible list to the Environment Agency and/or Natural Resources Wales as soon as possible and discussed it with them.	S6.7, Page 30	9
226	You have clearly described the screening criteria you have used to identify feasible options and have applied these consistently to achieve a balance between the number of options included and availability of realistic choices.	S6.7, Page 31	9
227	You have provided a full description of all feasible options that you have considered, including main operational features, expected implementation extent, conceptual diagram etc.	S6.7, Page 31	9
228	You have compared each feasible option to the baseline case, and provided a profile of the extra water available over the 80 years from initial investment in the option.	S6.7, Page 31	9
229	Where you are transferring water / commissioning new sources and this increases the risk of non-compliance, you have included steps to mitigate those risks (e.g. INNS, discolouration, nitrates, pesticides).	S6.7, Page 31	NA
230	You have assessed the level of customer support for each option.	S6.7, Page 31	9.2
231	You have appropriately estimated the amount of time needed to investigate and implement the option and have proposed an earliest start date based on your review.	S6.7, Page 31	9
232	You have appropriately assessed and reported the risks and uncertainties associated with each option, including the likelihood of reduced yield due to factors such as climate change, environmental constraints and customer behaviour. You have considered the flexibility of the option to adapt to future uncertainty.	S6.7, Page 31	9
233	You have explained any factors or constraints specific to the option, and have highlighted any links or dependencies on other existing schemes, other options and any mutual exclusivity with another option.	S6.7, Page 31	9
234	You have described how the option will be utilised and the impact on costs.	S6.7, Page 31	9

No.	Action or approach	WRPG ref.	Draft WRMP ref.
235	You have assessed the environmental impacts of the option, including implications for RBMP objectives, and have undertaken and reported the outcomes of a Habitats Regulations Assessment (HRA) if the option has been found to potentially affect any designated site.	S6.7, Page 31	9
236	You have undertaken a cost-benefit appraisal of the option, including a cost breakdown over the 80 year period and covering capital, operating and financing costs. Your method is aligned to Ofwat's most recent guidance for PR19 and the WRPG, and gives Average Incremental Costs (AIC) based on maximum capacity costs divided by maximum capacity outputs expressed as net present value (NPV). You have explained how you arrived at your AIC figure.	S6.7, Page 31	9
237	As part of the cost-benefit appraisal, you have evaluated the environmental and social (including carbon) costs and benefits of the options and show either a monetised profile of Average Incremental and Social Costs (AISC), or a non-monetised assessment of impacts. You have stated your approach to calculation of AISC.	S6.7, Page 31	9
238	For supply options, as part of your cost-benefit appraisal you have determined supplementary costs required to distribute the new supply (e.g. service reservoirs, pumping stations, mains upgrades), excluding costs associated with local infrastructure enhancements.	S6.7, Page 31	NA
239	You have evaluated whole-life costs that include treatment, pumping, network, storage, maintenance and operation costs (the latter included control measures relating to water quality optimisation, fluoridation, chemical stabilisation, aesthetic impacts on consumers and control of disinfection by-products.	S6.7, Page 32	9

6.8 Environmental and social impacts

No.	Action or approach	WRPG ref.	Draft WRMP ref.
240	You have considered the environmental and social impact of each option of the feasible list.	S6.8, Page 32	9
241	You have assessed impacts using a method that is proportionate to the scale of the problem and have fully justified your approach.	S6.8, Page 32	9
242	You have applied an Ecosystem Services approach to environmental evaluation, if appropriate, and your method gives accountable and transparent outcomes that consider stakeholder needs.	S6.8, Page 32	9

No.	Action or approach	WRPG ref.	Draft WRMP ref.
243	You demonstrate that you have used the best available evidence and data in your assessment, and the conclusions you draw are robust, locally valid and justifiable.	S6.8, Page 32	9
244	You provide a clear audit trail of your appraisal of environmental and social impacts and explain the data you use, the results and recommendations from the appraisal.	S6.8, Page 32	9

6.9 Solutions driven by changes to existing abstraction licences

No.	Action or approach	WRPG ref.	Draft WRMP ref.
245	You have worked with the Environment Agency or Natural Resources Wales to understand the cost effectiveness of solutions that are driven by changes to existing abstraction licences.	S6.9, Page 32	NA
246	You explain how any solution driven by changes to existing abstraction licences meets the objectives of the Habitats Directive, Wildlife and Countryside Act and Water Framework Directive and prevents any deterioration of water bodies.	S6.9, Page 32	NA
247	You have considered whether measures needed to meet sustainability and environmental objectives (e.g. related to HD, WCA and WFD) are cost-effective and cost-beneficial, and are supported by customers.	S6.9, Page 32	NA
248	You have explained how the cost has been evaluated (where cost include non-monetised costs) and that the benefit outweighs the cost, the option is not disproportionately costly and has the lowest overall costs even when accounting for the need for customer support.	S6.9, Page 33	NA

6.10 Deciding on a solution

No.	Action or approach	WRPG ref.	Draft WRMP ref.
249	You have explained the approach you have taken to arrive at the best solution(s), making use, as appropriate, of the UKWIR Decision Making process to develop a decision-making framework and identify methods to determine which solution(s) is/are best.	S6.10, Page 33	9
250	You have used the EBSD method within the process of identifying best solution(s), e.g. to provide a benchmark against which outcomes of alternative methods can be compared.	S6.10, Page 33	9
251	You have explained which methods other than EBSD have been used within the process of identifying best solutions, including justification for their appropriateness, such as differences and improvements.	S6.10, Page 33	NA

No.	Action or approach	WRPG ref.	Draft WRMP ref.
252	You have clearly and transparently set out the economic, social and environmental justifications for your final choice of solution, and demonstrated why you have decided on this approach and discounted others. You have provided a clearly reasoned justification for how the decision has been made, as well as the decision. Your explanations are able to be clearly interpreted by customers, interested parties and regulators.	S6.10, Page 33	9
253	You have considered how future changes might affect the solution or whether any potential future changes might make it redundant.	S6.10, Page 33	9
254	You have considered the resilience of the solution against a range of possible futures.	S6.10, Page 33	9; 9
255	You demonstrate that the possible futures considered include potential future impacts of regional or cross sector demand.	S6.10, Page 33	9
256	You have assessed the costs and benefits of the chosen solution, and have set out your assessment of whether the benefits of implementing the solution are greater than the costs. Your preferred solution is best value.	S6.10, Page 33	9
257	You have described the steps you have taken to carry out a Strategic Environment Assessment and Habitat Regulations Assessment for your chosen solution, or demonstrated why this is not needed. Where relevant, you have incorporated any outcomes from the SEA and/or HRA into your final plan.	S6.10, Page 33	9
258	Where the option involves sharing resources, you have explained who will have ultimate rights to the water and why. You have also provided details of how the option will operate, funding mechanisms, legal arrangements, drought implications.	S6.10, Page 33	NA

6.11 Water Framework Directive

No.	Action or approach	WRPG ref.	Draft WRMP ref.
259	You have considered and prioritised solutions that promote the requirements of Article 7 of the WFD and are consistent with RBMP objectives and solutions, highlighting how you will or are working with others to achieve this.	S6.11, Page 33	4.4
260	You have described how the impact of changes to the operation of existing sources and / or the impacts of new sources on WFD water body status has been established, and that you have	S6.11, Page 33	4.4

No.	Action or approach	WRPG ref.	Draft WRMP ref.
	rejected sources that might cause deterioration or prevent the achievement of good status.		
261	You have described any intended actions that may cause deterioration of status/potential or prevent good status/potential being achieved. You have discussed this with the Environment Agency or Natural Resources Wales and made a clear statement in the plan of any potential impacts of any intended actions.	S6.11, Page 33	4.4
262	You have included targeted and cost effective restoration measures, and have considered how you will apply adaptive management measures solely or working in partnership with other relevant organisations.	S6.11, Page 33	4.4

6.12 Testing your plan

No.	Action or approach	WRPG ref.	Draft WRMP ref.
263	You have explained the scenario testing you have undertaken to evaluate the resilience of your plan to a range of risks.	S6.12, Page 34	10
264	Based on scenario testing, you have described the factors and risks having the most significant impact on your plan, and the possible timings of these impacts.	S6.12, Page 34	10
265	You have explained the scenario testing you have undertaken to show the plan is robust to minor changes to supply and demand forecasts in the near future and to more moderate changes as the plan progresses.	S6.12, Page 34	10
266	You have explained the scenario testing you have undertaken to compare your preferred plan with, or to identify, alternative options.	S6.12, Page 34	10.1; 10.2
267	Based on scenario testing, you have justified how you will manage risk and future uncertainties (e.g. in response to new evidence becoming available), and what you will monitor to help manage these risks.	S6.12, Page 34	10.3
268	Based on scenario testing, you have explained when and why important decisions should be made within the period of the plan.	S6.12, Page 34	10.3
269	You have explained how scenario testing demonstrates that you have not over-planned for a worst-case scenario that is very unlikely.	S6.12, Page 34	10.3

21 Annex I: Drought scenario generation

In order to generate plausible drought events more severe than those on the historic record, we followed the UKWIR "WRMP 2019 methods - risk based planning" guidance for development of 'Drought Events' for a 'Resilience Tested Plan'. The approach has been peer reviewed by Atkins; this can be found as an appendix. The key steps in the process are:

1. Create severity-duration plots of the historic rainfall record, or generate curves of climatological or hydrological metrics.
2. Use event analysis to generate artificial droughts and estimate return period range against the historic record.

The guidelines state than a number of simple methods may be used to generate drought events, but because of their simplicity, the second stage where the 'plausibility' of the droughts is tested, is critical to the robustness of the WRMP. Furthermore, for this level of analysis it is recommended that this second stage is based on analysis of both drought event severity and duration. Following these guidelines, we based our approach on that applied in the Water UK "Water Resources Long Term Planning Framework" project (Water UK, 2016) in an attempt to ensure consistency with the severity of the 'plausible' drought events identified in this study beyond those in the historic record.

In the long term planning framework project, to generate plausible synthetic drought events beyond those observed in the historic record, synthetic drought events derived from a stochastic weather generator were used. The aridity index for each of these events was calculated, and plotted against those from the historic record (Figure 1). For each drought duration, plausible worse-than-historic drought scenarios were then chosen from stochastic record for two different drought return periods, each with an aridity index corresponding to the chosen return period derived from the historic data:

- "Severe" drought (~1 in 200 year)
- "Extreme" drought (~1 in 500 year)

The report identified that the expected change in the aridity index is around 5% to 10% for a 'worst historic' to 'severe' event, and around 10% to 15% for a 'worst historic' to 'extreme' event.

In the absence of drought events derived from stochastic weather generators, we generated plausible droughts as follows:

- For different drought durations (using April as a starting month) aridity indices were calculated from the historic record (Table 1). As input to the calculation, actual evapotranspiration was calculated using hydrological models for representative catchments in the Wessex Water area (Section ref);
- We then evaluated the historic record and chose three different events, based on the worst drought events in the historic record, to give three drought events of different duration, which were then used as "design events" for generating plausible, more severe droughts:
    - 1921, 9-month drought
    - 1975/76 17-month drought
    - 1933/34 24-month drought
- For each of these drought durations, the aridity index of the worst drought on the historic record was identified;

- For each duration drought (9, 17 and 24 month), we chose as the magnitude of the severe “1 in 200” drought an aridity index 7.5% worse than the worst historic on record (as per the expected change identified in the Water UK study), and for the extreme “1 in 500” drought, an aridity index 12.5% worse than the worst historic drought, and compared these indices to those produced through extreme value curve fitting, where we fitted normal, log-normal 2- and 3- parameter Weibull distributions, and also fitting the 3-parameter Weibull distribution also to the tail-ends of the distributions.
- To calculate inflow sequences for our Miser model runs and DO assessment (section ref), we then ran a set of hydrological models with a range of rainfall and associated potential evapotranspiration (PET) multipliers, applied to the input rainfall/PET sequence for each design event, and combined with the modelled actual evapotranspiration, calculated the aridity index for each model run.
- The rainfall multiplier that produced the required aridity index for the severe and extreme droughts of each event duration was then used to generate inflows from our hydrological models that are then fed into the system simulation model (Miser).

Table 1 summarises the results of the derived 9, 17, and 24-month duration drought events. For the 1921 and 1975 drought events these were the worst droughts on record for 9 and 17 month duration, whereas for the 24 month event, the period from April 2010 to April 2012 was the worst 24 month duration period. However, we chose the 1933/34 drought as the 24-month design event, given the nature of the deficits during this period focussing more in the summer period. Table 1 also shows the rainfall multipliers associated with the severe and extreme drought events (note also the PET was adjusted in generation). Figure 2 to Figure 4 shows the plots of aridity index versus probability of exceedance for the three different duration events.

Table 21-1: Summary of Aridity Indices for Severe and Extreme plausible drought events, and rainfall multipliers used to perturb the rainfall sequence for each design drought event.

Drought	Design event		Worst Historic event		Severe event (1/200)				Extreme event (1/500)			
Duration			(for duration)		Aridity Index			% rainfall	Aridity Index			% rainfall
(Months)	Start Year	AI	Start Year	AI	5.0%	10.0%	7.5%	(7.5%)	10.0%	15.0%	12.5%	(12.5%)
9	1921	-2.39	1921	-2.39	-2.51	-2.63	-2.57	0.92	-2.63	-2.75	-2.69	0.87
17	1975	-3.14	1975	-3.14	-3.30	-3.45	-3.38	0.92	-3.45	-3.61	-3.53	0.87
24	1933	-2.18	2010	-2.38	-2.49	-2.61	-2.55	0.94	-2.61	-2.73	-2.67	0.92

Figure 21-1: Drought probability plotted against aridity index for 9-month period starting in April from the historic record (black points). The plausible, worse than historic generated droughts are shown for the 1 in 200 severe drought (orange point) and 1 in 500 (green point). Also shown are 5 different distributions fitted to the empirical data.

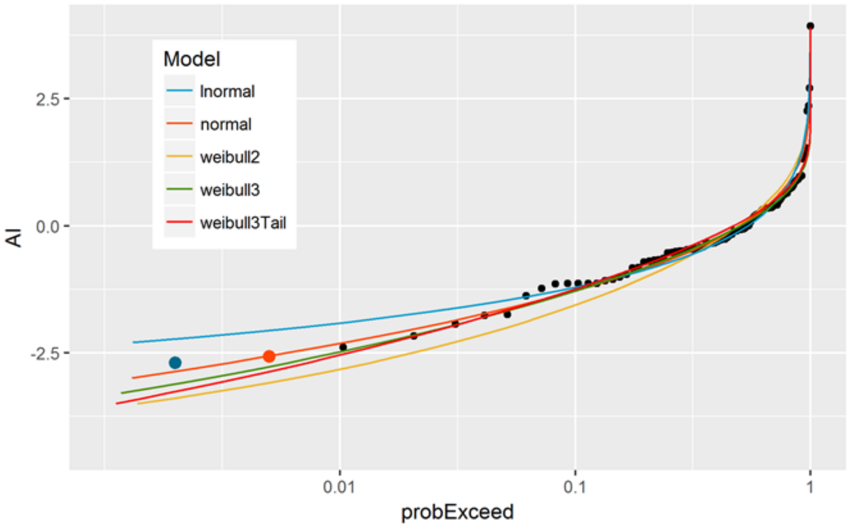


Figure 21-2: Drought probability plotted against aridity index for 17-month period starting in April from the historic record (black points). The plausible, worse than historic generated droughts are shown for the 1 in 200 severe drought (orange point) and 1 in 500 extreme drought (green point). Also shown are 5 different distributions fitted to the empirical data.

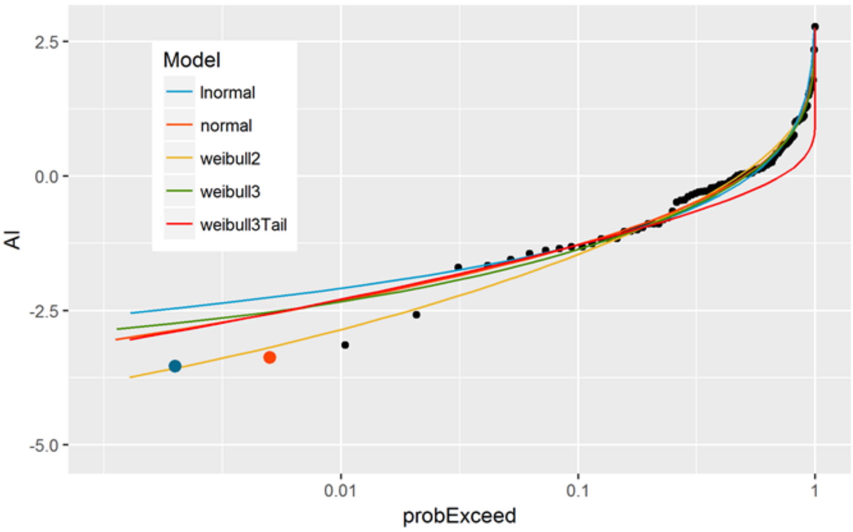
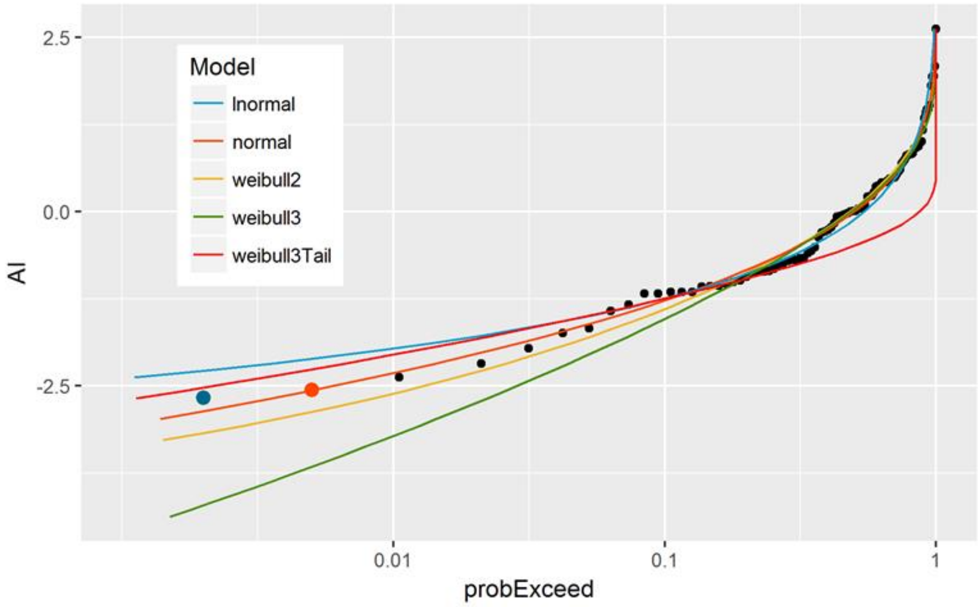


Figure 21-3: Drought probability plotted against aridity index for 24-month period starting in April from the historic record (black points). The plausible, worse than historic generated droughts are shown for the 1 in 200 severe drought (orange point) and 1 in 500 extreme drought (green point). Also shown are 5 different distributions fitted to the empirical data.



22 Annex J: Pre-consultation

22.1 Pre-consultation contacts and comments received

The following groups and organisations were notified during pre-consultation of the development of this plan, and invited to comment.

- Environment Agency
- Ofwat
- Defra
- Consumer Council for Water
- Natural England
- Canals and River Trust (formerly British Waterways)
- Drinking Water Inspectorate (internal meeting)
- South West Water (now including Sembcorp Bournemouth Water)
- Bristol Water
- Thames Water
- Veolia Water
- Southern Water
- Cholderton Water
- WWF
- Energy Saving Trust
- Scottish and Southern Electric
- Wessex Water: Futures Panel
- Wessex Water: Catchment Panel
- Wessex Water: Wessex Water Partnership
- RSPB
- Citizens Advice Wiltshire
- Money Advice Trust
- Age UK
- Advice UK
- Bristol Avon Catchment Partnership
- Dorset Catchment Partnership
- Hampshire Avon Catchment Partnership
- Somerset Catchment Partnership

Table 22-1 summarises the comments received during pre-consultation and where we have addressed these in our Plan.

Table 22-1: Pre-consultation comments received

Organisation	Comment	Where addressed
Thames Water	We note the identification of potential surplus in your supply area that could provide an opportunity for new bulk supply transfers and the intention to fully assess the resilience of any potential transfers. We have discussed the potential for Wessex Water to provide a bulk supply to Thames Water and we would like to continue to explore this potential option in the development of our WRMP19.	Section 2.1.2; Section 10.2.4
Cholderton Water	No comments raised	-
Natural England	No comments raised	-
WWF	Responsive demand management - Outline of smarter demand management options to periods of low rainfall	Section 0
	Explicit section on responsive demand management and communications, reflecting Waterwise drought report recommendations.	Section 5.2.3
	I welcome the inclusion of an assessment of the resilience of drought and any potential transfer	Section 10
Southern Water	Establish best estimates of source outputs under the relevant range and severity of drought events	Section 2.1.2; Section 10.2.4

22.2 Pre-consultation with the Environment Agency

Table 22-1 summarises the methods discussions we had with the Environment Agency during pre-consultation meetings and in follow up email correspondence, and Table 22-2 summarises the topics raised in the pre-consultation letter they sent us dated 25th October 2017

Table 22-2: Summary of methods discussions with Environment Agency

Methods discussion topic	Date of engagement	Issues presented/comments received
Problem characterisation and risk composition	18/10/2016	**WW Oct-2016** - Conducted problem characterisation following UKWIR decision making and risk based planning guidelines. Problem characterisation identified a low level of vulnerability, which justified adopting risk composition 1. We have adopted risk composition 2 to align with drought plan requirements and consider plausible events beyond the historic record. **EA Response Dec-2016** - The EA consider this to be a useful assessment as part of developing WRMP19; it is hard for us to criticise this extra work.

Methods discussion topic	Date of engagement	Issues presented/comments received
Water resource zone integrity and risk assessment	13/06/2017	**WW June 2017** – presented assessment, and concluded that supply area is a single resource zone. EA - Noted that Maundown (Exmoor), with population of approx..100,000 & 42,000 properties, is a standalone area, which may be at risk - WW stated resilience schemes being developed. Pipework between Bournemouth (both ways) for resilience. EA - also noted more resilience is required in the north drought management zone, as this dictates LoS . Improving resilience of the north zone through better links and removing constraints, may be a cheaper/easier way of moving to 1 in 200 LoS.
Drought scenarios and risk assessment	15/07/2016; 18/10/2016; 20/01/2017;	WW - Potential drought scenario analysis circulated to EA for comment 15/11/2016. Comments received back from EA on 19/12/2016. Revised approach for generating plausible droughts based on approach applied in Water UK Long-term planning framework project presented and discussed on 20/01/2017.
Supply forecast: hydrological modelling	15/07/2016	WW – Method for development of hydrological modelling as input to Miser model presented and discussed.
Supply forecast: DO calculation	13/06/2017	WW – Method for deployable output calculation presented.
Supply forecast: climate change	24/08/2017	EA - WW using 11 scenarios, following same approach as WRMP14. Scenarios show changes will be between -3.5 Ml/d to +0.5 Ml/d, depending on scenario. WW likely to use median scenario but should explain choice.
Supply forecast: outage	24/08/2017	EA - WW confident in outage record, likely to be 24 Ml/d for DYAA (increase of 2 Ml.d from WRMP14), no figure yet for DYCP. More events but fewer sources due to sustainable reductions. EA advised scenario testing an outage at Maundown WTW due to isolation of works. WW – outage allowances modified, following further work.
Demand forecast: population and properties	15/07/2016	WW – methodology to develop forecasts presented. Query raised regarding issue of constraining local council growth. EA - WW using local plan based forecast with trend based plans beyond LA plans scope. LA's to review during the consultation period. Suggestion that population living in void properties goes into unmeasured nHH population as this isn't used to calculate pcc. WW to raise this query through the demand network to get a consensus across the industry. Pragmatic approach to developing most likely growth scenario is sensible.
Demand forecast: micro-components	19/10/2017	EA - WW have segmented by measured and unmeasured, and are using survey based data which is appropriate.

Methods discussion topic	Date of engagement	Issues presented/comments received
Demand forecast: non-household demand	13/06/2017	EA - WW stated Servelec have carried out the nHH demand forecast. Has shown a decline in consumption for nHH (15 Ml/d over 25 yrs) due to reassignment for retail separation. This decline in consumption should see a rise in surplus. WW queried how to ensure they receive info from retailers. EA advised that retailers have an obligation to provide the information.
Demand forecast: leakage and leakage consistency changes for WRMP19	29/09/2017	EA - Scenarios for leakage for 15 % of DI, and 15 % reduction over next 5 years based on current leakage. But customers not WTP for further reductions, but are happy to keep leakage reduction static. WW advised that pcc has been revised due to the reassessment of leakage.
Inclusion of sustainability reductions	13/06/2017	WW – confirmed sustainability changes included in baseline. Liased with Christopher Greenwell (EA), Environment Planning Specialist, to determine scenarios for potential future reductions. EA - WW to run scenarios for the investigations; happy with assumptions made at this stage. At present the volume of one SR in the baseline [stubhampton] has not been confirmed.
Headroom and uncertainty	19/10/2017	EA - queried absence of TLL (S3) from headroom calculations. EA: WW to clarify the headroom glidepath and data in the headroom uncertainty calculations. WW – modified assessment to include TLL (S3) issues.
Options appraisal, final planning scenario	29/09/2017	EA - WW Queried the removal of the change of occupier metering from the baseline. EA response - This needs to be included in the baseline, but can be removed from the final plan as an option. Also justification required on why the company are not opting to install smart metering as an option. WW – change of occupier included in the baseline.
Scenario testing	19/10/2017	WW – scenarios to be tested in plan presented.
SEA/HRA	24/08/2017	EA - SEA/HRA screening statement being done by Ricardo. Scoping report not required as no options.

Table 22-3: Summary of topics raised in pre-consultation letter from Environment Agency dated 25th October 2017

Summary of comments	Addressed in:
Drought scenarios – your WRMP should investigate resilience to a range of plausible droughts.	Section 10.1
We expect you to choose demand-side options as part of your preferred programme	Section 9
You should use the updated method for calculating leakage described in Consistency of Reporting Performance Measures (UKWIR, 2017) to determine the leakage options for your WRMP.	Annex A; Section 9.6.

Summary of comments	Addressed in:
It is important that the potential impacts of changes to reported leakage are accounted for in your draft WRMP to avoid the risk of material change to plans in future. The expectation is that you will show how you have used the method and if necessary, use scenarios to assess the impacts on the water balance and the options in your plan.	Annex A; Section 5.7
We also expect you to show how you will meet the requirements in the Defra Guiding Principles that the downward trend for leakage should continue and that total leakage does not rise at any point in the planning period.	Section 5.7.3
We expect you to fully explore resource sharing during WRMP19 and beyond, and we recognise you are a partner on WRSW/West Country WR Group.	Section 2.1.2
Any options to export water to another company must be done in a way that does not pose unacceptable risks to water supply.	Section 10.2.4;
[options to export water] must also be done in a way that ensures compliance with Water Framework Directive (WFD) objectives.	NA
Any raw water transfers should be assessed for their potential to spread Invasive Non-Native Species (INNS). Any identified risks and mitigation measures must be discussed with the Environment Agency and Natural England for both new and existing transfers.	Section 4.4.6
Aside from any government direction, we expect your plan to clearly demonstrate how you have considered and tested what the right level of service is for your customers and on what basis this decision is made, bearing in mind the long term needs of customers. The impact of restrictions on businesses and households when deciding on a planned level of service needs to be taken into account.	Section 11; Section 2.2
We expect to see meaningful engagement with customers using descriptions and indicators that will help them understand the risks and reasons for the measures proposed	Section 2.2 and Section 99
Informed by this [customer] engagement you should clearly set out in your plan how solutions are resilient for your customers over the long term.	Section 9.2
You should include any risks to delivery of the solutions, flexibility within them and evidence that you have considered the full range of options for managing the risks.	Section 99.2
Your plan should set out a reference level of service that would mean resilience to a drought with at least an approximate 0.5% chance of annual occurrence (i.e. approximately a 1 in 200 year drought event).	Section 3.3.19.2
You should explain how you have selected and modelled this drought event.	Section 10.1 9.2
You should include any risks to delivery of the solutions, flexibility within them and evidence that you have considered the full range of options for managing the risks.	Section 99.2
This scenario should quantify any additional deployable output required, any preferred options and the expected incremental costs of this scenario. You should set out how you have calculated this, the evidence you have used and the assumptions you have made. You should explain at what point in the planning period the reference level of service could be achieved, and if your solution leads to any changes in the level of service for temporary use bans and non-essential use bans.	Section 3.3.29.2

Summary of comments	Addressed in:
Government expects water companies to follow the water company water resources planning guideline when preparing their draft WRMP. It provides guidance and details on the technical methods of the water resources planning process. This revised guideline was released in April 2017 and has been jointly produced by the Environment Agency, Natural Resources Wales, the Welsh Government, Defra and Ofwat. To support our guideline, we have also produced a set of supplementary documents and templates that provide further information on specific topics. These include the supply-demand and water company level tables to be used for capturing and presenting water resources planning data at a resource zone level to support your WRMP. These are all available from Huddle or upon request from the Environment Agency.	Annex H; Section 3.2 9.2
In May 2016, Defra released 'the guiding principles' which sets out advice for water companies in England. Government expects you to take account of the advice set out in this document when developing your WRMP.	9.2
Your WRMP should clearly demonstrate your commitment to protect and improve the environment, and we expect you to consider the Water Industry National Environment Programme (WINEP) for PR19 for your company.	Section 4; 9.2
We expect you to review the outputs of the Water UK project 'Water Resources Long Term Planning Framework' and consider what it means for your company and the range of resilience solutions you have considered.	Section 3.2.39.2
We welcome your proposals outlined in your pre-consultation letter to consult with a range of statutory and non-statutory stakeholders, including your customers and neighbouring water companies.	Section 2.1 9.2

23 Annex K: Supplementary resilience information

For security reasons this appendix is not available in the version of this Plan published on our website.

24 Annex L: Reference list of supporting documents

Documents highlighted in bold are available as appendices to this plan.

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