Final
Water Resources Management Plan

Website version

Wessex Water

June 2014

Contents

Summary

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

This summary provides an overview of the key objectives of the plan and how we will meet them.

Wessex Water

Wessex Water is the best performing water and sewerage company. 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.

We supply more than 330 million litres of water a day to 1.3 million people in the south-west of England with high quality drinking water and do this using more than 80 sources and water treatment works and 11,500 km of water mains.

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. Water companies have a statutory duty to prepare an updated plan every five years. They 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.

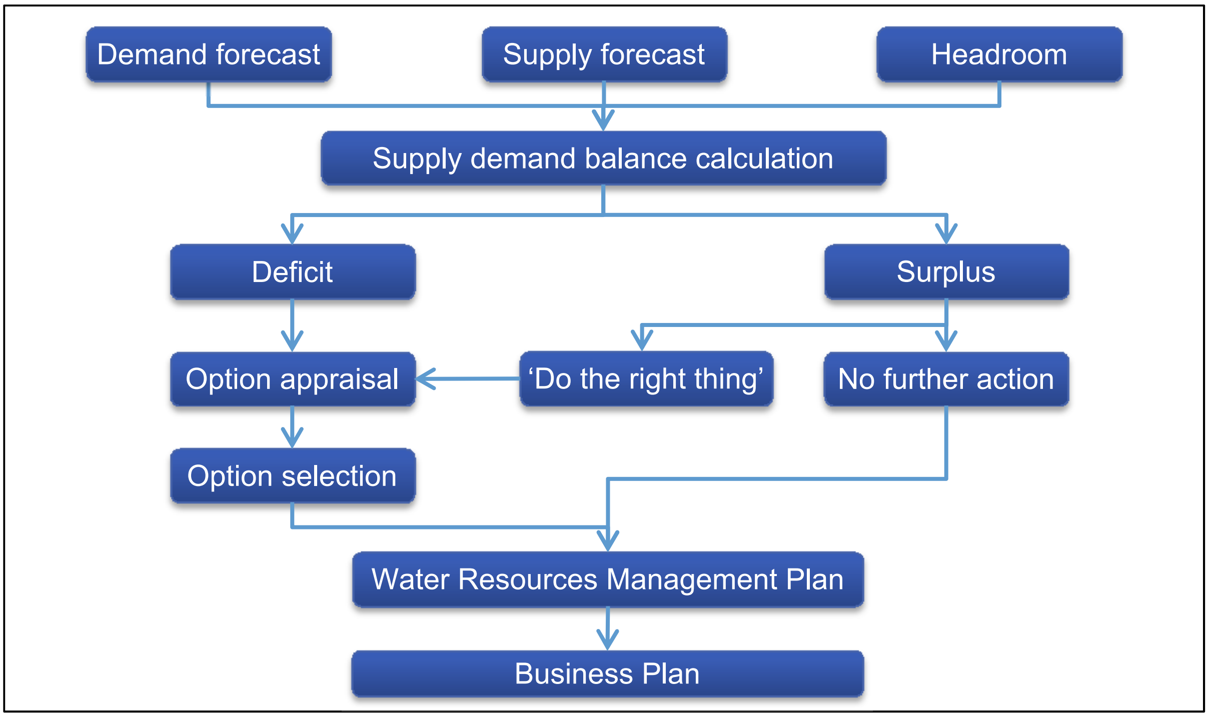
The water resources planning process is shown in simple terms in the figure below. We prepare forecasts of demand taking account of population growth, property building, customer water use behaviours, industrial needs and leakage. At the same time we develop a forecast of supplies making an assessment of the impacts of climate change, infrastructure constraints and abstraction licence changes that we need to make to protect the environment and enhance wildlife.

A headroom allowance is made for uncertainties in the forecasts and we then calculate whether there will be a balance between supply and demand over 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 ensure the balance will be restored.

If the system is forecast to be in surplus through the planning period then no further action is required. However, companies can examine options that constitute 'doing the right thing' not because the measures are required to restore a balance, but because they meet wider objectives related to government policy, customer preferences or environmental benefits.

The water resources planning process



Key objectives

In this water resources management plan there are a number of key objectives we have set out to achieve in response to what our customers have been telling us, government aspirations and environmental requirements. Objectives are also derived from our long-term strategy, Water – the way ahead 2015-2040, which we published in December 2012.

The key objectives of this plan are to:

- ensure that we can provide a reliable supply to our customers at the same time as protecting the environment
- reduce the demand for water
- reduce leakage
- reduce abstraction where it is required to improve river flows
- identify whether there is scope to transfer water to neighbouring companies.

In the sections below we describe how our plan meets these objectives.

Reducing the demand for water

Wessex Water customers currently use an average of approximately 140 litres of water every day. Many use a lot less and the average in other European countries is often lower too. We want to work with our customers to reduce average use in our area to below 125 litres per person, meaning we will abstract less and leave more water in the environment.

Our research has shown that the best way to reduce water use is for households to have a meter installed, so that they pay for the volume they use. In addition we can help customers go further by providing advice and practical assistance on wise water use, providing them with water efficient devices, and crucially being more active in helping our customers install such devices in their homes. At present customers can choose to have a meter installed for free, this is called optional metering, and each year approximately 10,000 customers make this choice. However, they do so primarily to save money rather than water. When they switch to a meter their use only drops by about 6%.

Some water companies are metering their customers compulsorily, but from talking to our customers and understanding their views we do not feel that this is the right approach for metering in our area. Additionally, as the Wessex Water area is not currently designated as being in 'serious water stress' this option is not legally open to us.

We believe that taking steps to accelerate metering is the right thing to do and so this plan proposes to install a meter when a property changes occupier. When people move house lots of things change – new routines in daily water use behaviours may be formed and people sometimes also replace or update their kitchen and bathroom with new and more efficient water using devices. Moving home is often described as a "moment of change" when we are more open to changing the way we do things, not just how we use water, but how we use energy, recycle and travel too.

Between 2008 and 2012 we undertook a major research project – our meter tariff trial – to understand just how much less water people use when they move into a house which has a metered water supply rather than an unmetered one. The answer was 15% less, i.e., their water saving was more than twice as much compared with choosing to have a meter fitted in their current house.

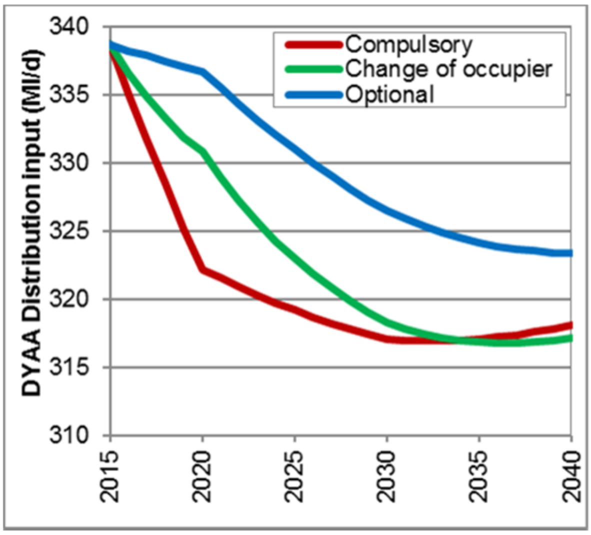
We recognise that some of our customers need help to reduce their water use. Our current water efficiency campaigns are already helping our customers save more than 500,000 litres of water each day, in particular via our free WaterSave pack of water efficient devices and through our schools education service that works with around 13,000 children each year. We are also increasingly joining up our water efficiency initiatives with our affordability work assisting lower income households and we are taking advantage of opportunities to promote energy efficiency at the same time.

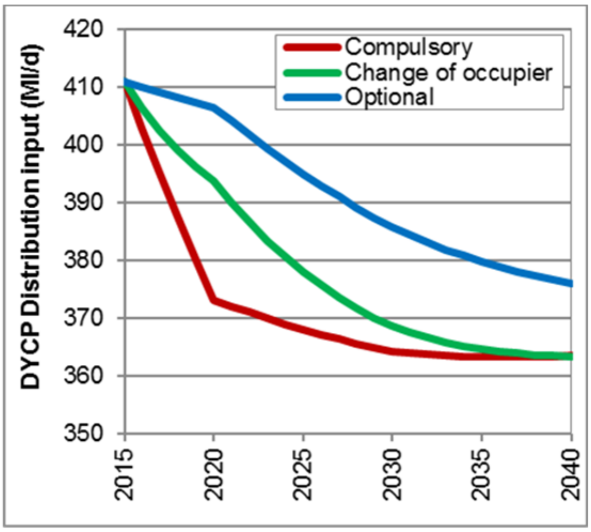
We want to go further, in particular with the following initiatives:

- large scale domestic device retrofit scheme – to offer a free audit and device fitting service; this scheme will be particularly promoted to households that are being metered on change of occupier
- social housing retrofit scheme – a partnership project to install water efficient devices in housing association properties
- water efficiency community fund – to provide devices and their installation in schools and other not-for-profit social organisations such as hospitals, councils and local services
- enhanced community engagement programme – to enhance customer awareness of the links between their water use and their environment by working with community groups and organisations such as Transition Towns.

These initiatives will help us reduce the demand for water. If we start metering properties when our customers move home from 2015, then by 2040 we will have been able to reduce demand, and therefore our abstraction from the environment, by six million litres of water a day – compared to continuing with optional metering only.

In fact, during the height of summer in a dry year (when we expect to see our peak demands) we would expect demand to be 13 million litres a day lower by taking our proposed approach. The impacts on demand of the alternative metering strategies are illustrated in the graphs below.

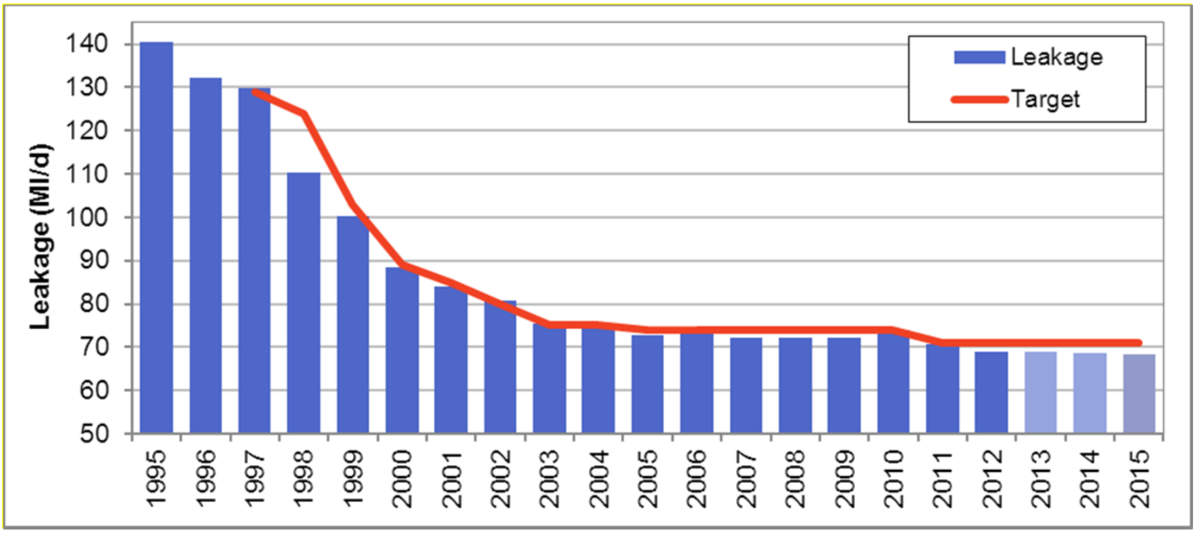




Reducing leakage

Our customers tell us that leakage is an important issue for them. They want us to reduce leakage and we agree.

In 1995 leakage was a big problem – each day 140 million litres of water was leaking from our network. We have now reduced leakage by more than 50%, while on average other water companies in the UK have only reduced leakage by 35%. We have always met the target set by our regulator as shown in the graph below.



Inevitably, with 11,500km of water mains leaks will occur, but what our customers expect is that when they do occur we fix them – quickly. That is why we now aim to mend leaks reported to us by our customers the same or the next day – and on 95% of occasions we hit this target.

We want to go further with leakage and we think the best way to achieve this is by metering customers when they move home, as described above. More than a quarter of leakage occurs from pipes between the road and a customer's property. If we install a meter in the pavement then we can detect this leakage and stop it – having more meters will help us stop more leaks. We estimate that metering customers when they move home will help us reduce leakage by 5% by 2020.

In the longer term we would like to go even further and reduce leakage by 25% if we can. However, the graph above shows that each year reductions in leakage are becoming more and more difficult, despite us spending more on finding and fixing leaks. Leakage reduction brought about by metering on change of occupier will ensure we reach the first 5% reduction towards our aspiration – but achieving our goal of a 25% reduction using existing technology would cost nearly £500 million pounds. This is unaffordable when we are trying to maintain stable customer bills. So we are proposing to invest more in research and development and to better understand the approaches taken in countries where leakage is a lot lower, in order to develop and test a strategy that will achieve our goal of a 25% reduction in leakage in a way that is affordable.

Reducing abstraction to improve river flows

All the water we abstract comes from the environment. Approximately 75% is from boreholes and wells which tap into the chalk and limestone aquifers of Wiltshire and Dorset, and 25% from reservoirs in Somerset.

Wessex Water has more than 80 sources of water and the amount we can take from each source is limited by conditions in our abstraction licences issued by the Environment Agency. To protect the environment we are not allowed to take more water than is specified in each licence. However, some of these licences were granted a long time ago and do not necessarily provide the protection that the environment needs. Therefore we have been working with the Environment Agency, Natural England and local environmental and fishing groups for many years to understand where changes in abstraction licence conditions are required to better protect the environment. As a result the changes outlined in the table below have been made since 1995.

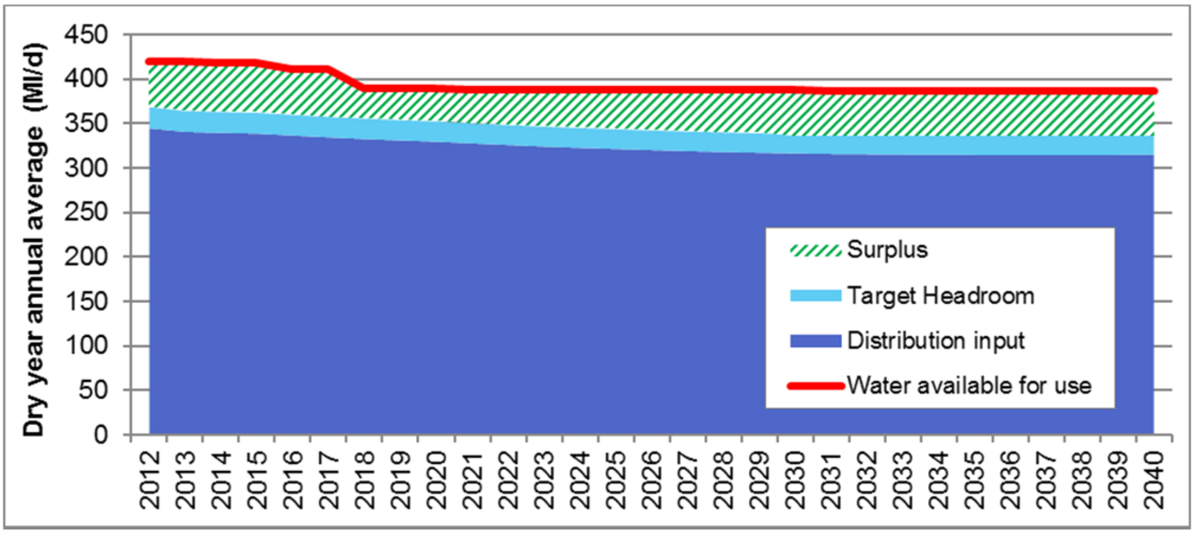
Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
AMP2 (1995-2000)	River Piddle	Briantspuddle	When river flows are low abstraction now reduced by up to 9 Ml/d and this water is used for stream support instead
AMP3 (2000-2005)	Chalfield Brook	Holt	Stream support trigger raised to a higher flow threshold to increase mitigation
	Currypool Stream	Ashford	Increased compensation flow at Currypool
	Semington Brook	Luccombe	Source abandoned and licence revoked
AMP3 & AMP4 (2000-2010)	Tributaries of the Upper Bristol Avon	Malmesbury sources	Licence to be reduced by 4 Ml/d and up to 22.5 Ml/d of additional stream support provided.
	Codford Brook	Chitterne	Licence reduced by 14 Ml/d and up to 5 Ml/d stream support provided
	River Piddle	Alton Pancras	Licence reduced by 1.3 Ml/d for public water supply and up to 2.5 Ml/d stream support provided
AMP4 (2005-2010)	River Bourne	Clarendon	Licence to be reduced by 11 Ml/d in 2018
		Newton Toney	Licence for public water supply to be reduced by 1.5 Ml/d when river flows are low and instead provided as stream support in 2018
	River Wylye	Brixton Deverill	Licence to be reduced by 5 Ml/d in 2018
		Codford	Licence to be reduced by 6 Ml/d in 2018

Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
AMP5 (2010-2015)	River Nadder	Fonthill Bishop	Licence to be reduced by 1.5 Ml/d in 2018

This plan will ensure that the changes listed above for Clarendon, Newton Toney, Brixton Deverill, Codford and Fonthill Bishop are achieved by 2018. During the AMP6 period (2015-2020) we will be investigating the impact of other sources on the environment, in particular whether the licences are consistent with the Water Framework Directive. If further changes are required they will be built into future updates of the plan.

Ensuring we provide a reliable supply to our customers

When we combine the information from our detailed analyses about available resources and predicted demands it indicates that we will have a significant surplus of resources over demands, as illustrated by the graph below. We have built into our forecasts projected rates of house building in line with local authority forecasts (approximately 4,700 houses per year), a population growth rate of 0.65% per annum and the impact of climate change on supplies based on the most recent climate modelling by the Met Office.



This graph shows demand (distribution input) falling over the period of the plan and the impact on available supplies of the licence changes to improve river flows in 2017-18.

Having identified a surplus of resources over demands we need to consider how best to use them. They could give us the opportunity to reduce abstraction from sources where there are environmental concerns. In particular, for appropriate sources, we are keen to adopt the abstraction incentive mechanism proposed by Ofwat. The mechanism provides water companies with a small financial incentive to reduce their use of sources where customers are concerned about the environmental impacts of abstraction but where investigations have shown the impacts are small or inconclusive. Furthermore, the environmental investigations we will be doing over the next five years may show that other abstraction licence changes are required and the surplus would help us accommodate them without needing to develop alternative sources elsewhere. The surplus could additionally enable us to operate cost effectively, reducing our use of our more expensive sources outside periods of high demand.

Potential new transfers to neighbouring companies

The surplus also gives us the opportunity to trade water with neighbouring water companies who may have a deficit. The government, Ofwat and the Environment Agency are keen to see an increase in trading so that resources are better used across the country. We have discussed changes to water transfer arrangements with all our neighbouring companies. Potential options with Bristol Water, Cholderton Water and Thames Water have been identified. In the case of Bristol Water we have given them an indicative offer based on changes to an existing bulk supply arrangement combined with a new transfer from the Bridgwater area equivalent to a new resource to them of up to 17.2 Ml/d.

Conclusion

This plan meets the objectives set, ensuring a robust balance between supply and demand, and including significant environmental improvements as a result of reductions in abstraction licences and the potential to make use of the abstraction incentive mechanism to bring about greater benefits. Metering properties when people move home and an enhanced water efficiency programme will drive leakage and demand down, such that average daily water use will be less than 125 litres per person by 2040.

Commercial confidentiality

Please note that no information has been excluded from this plan on the grounds that it is commercially confidential under section 37B (10) of the Water Industry Act 1991.

1. Introduction

1.1 What is a Water Resources Management Plan?

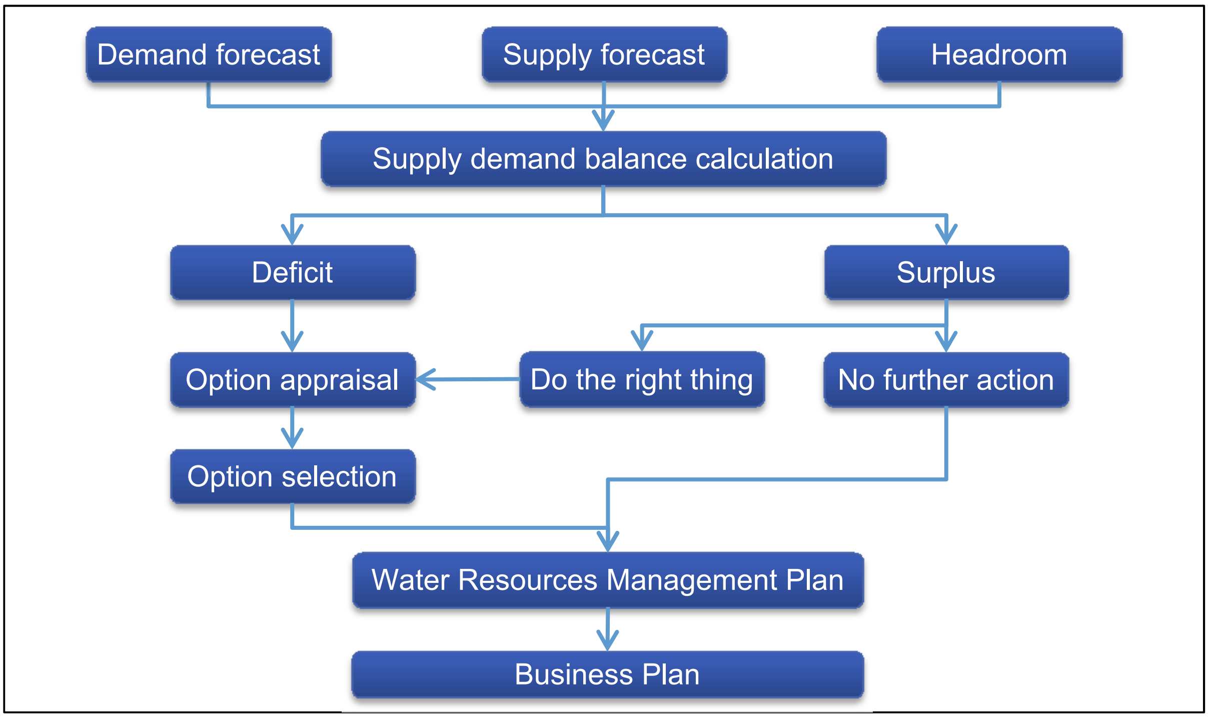
The aim of a Water Resources Management Plan is to set out how we as a water company will maintain a balance between the demand for water and the supply of water whilst protecting the environment for the next 25 years.

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 shown in simple terms in Figure 1-1. 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. A headroom allowance is made for uncertainties in the forecasts and we then calculate whether there will be a balance between supply and demand throughout the whole 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 ensure that the balance will be restored. If the system is forecast to be in surplus through the planning period then no further action is required however companies can examine options that constitute 'doing the right thing' not because the measures are required to restore a balance but because they meet wider objectives related to Government policy, customer preferences or environmental benefits.

Figure 1-1: Water resources planning process



A Water Resources Management Plan is complemented by a company's Drought Plan. A Water Resources Management Plan considers a long-term timeframe whereas a Drought Plan is a 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.

1.2 Links with company strategy and our Business Plan

Our last Water Resources Management Plan was published in June 2010. It covered the 25-year planning period from 2010 to 2035 and incorporated the planned investments resulting from our final Business Plan and the 2009 price review. This Plan covers the period from 2015 to 2040.

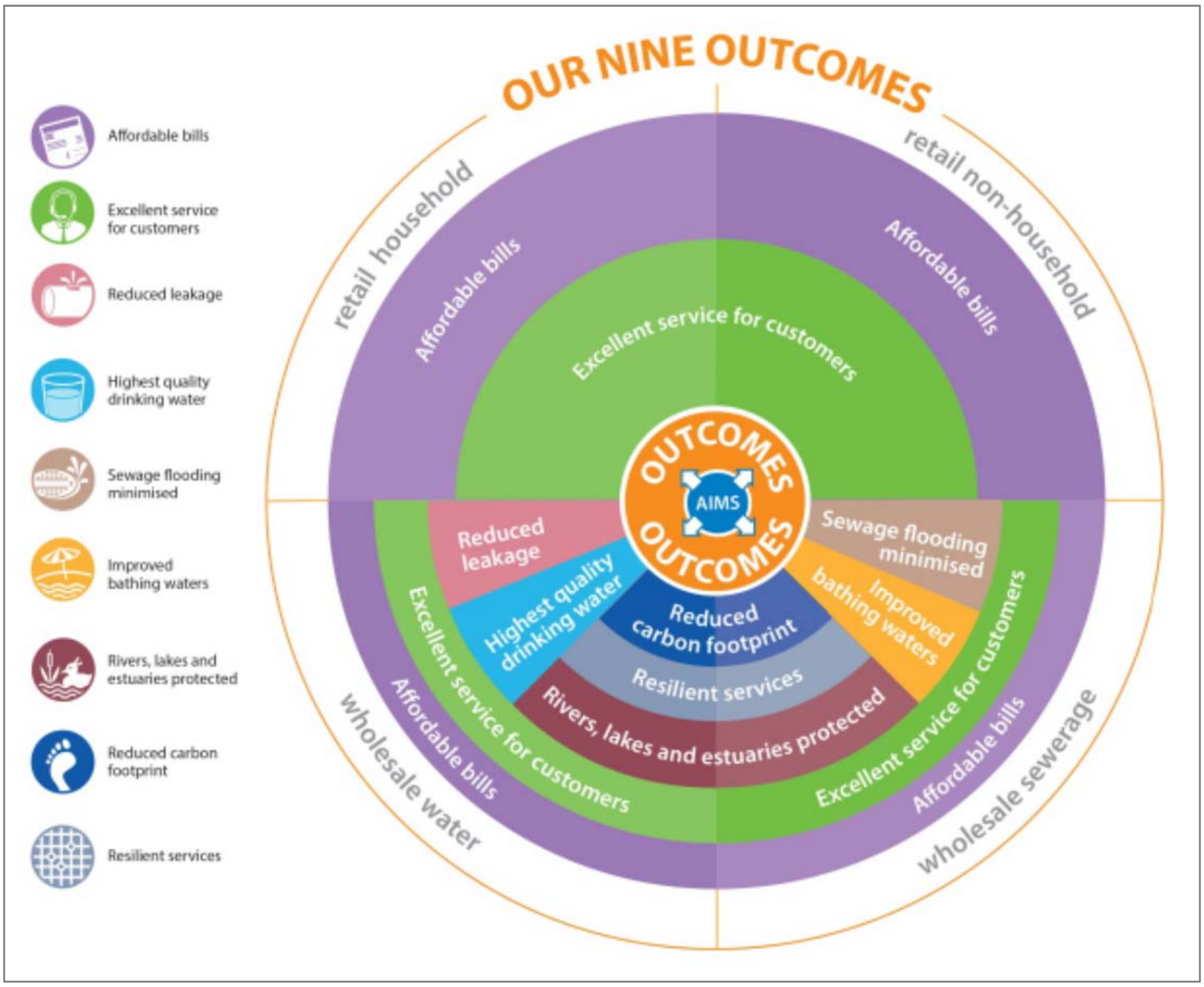
In December 2012 we published our Strategic Direction Statement entitled *Water – the way ahead 2015-2040*[1]. It sets out our long term vision for all our business activities and was developed in consultation with our Customer Scrutiny Group (CSG), our Customer Liaison Panels, Regulators and other stakeholders. The vision, which has been incorporated into our Business Plan, is structured around nine major outcomes that we intend to address – these are shown in Figure 1-2. In each case we have already made progress towards achieving the outcome but the views of customers, regulators and others show there is more for us to do.

This Water Resources Management Plan is guided by our desire to achieve these outcomes. In particular this is reflected in our proposals to reduce leakage and demand by introducing a change of occupier metering policy coupled with an enhanced water efficiency programme. Furthermore, our plans seek to maintain the availability of sources of water by catchment management rather than end-of-pipe treatment solutions.

The measures set out in this final Water Resources Management Plan are consistent with the investments and proposals specified in our Business Plan which will be approved by our financial regulator, Ofwat, by December 2014.

[1] Wessex Water (December 2012). Water – the way ahead 2015-2040.

Figure 1-2: Company outcomes



1.3 Regulatory requirements and guidelines

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 Water Resources Planning Guidelines published by the Environment Agency, Defra and Ofwat in 2012 comprising:

- The guiding principles for developing a water resources management plan (June 2012)
- The technical methods and instructions (October 2012)
- Technical instructions for the water resources planning guideline supply-demand tables (December 2012).

The development of this Plan has also been undertaken with reference to the Water Resources Management Plan Regulations 2007 and the Water Resources Management Plan Direction 2012.

Our compliance with each requirement of the Water Resources Management Plan Direction 2012 is provided in Appendix 11.8.

To support the Water Resource Planning Guidelines the Environment Agency collated the requirements of the Guidelines into a single 'checklist' of 242 items. Completion of this checklist was voluntary; we have included the list in Appendix 11.9 with a reference against each item to where in this document the required work can be found.

Key dates in the water resources planning process are given in Table 1-1. Further details of the consultation process are given in Section 2.

Table 1-1: Water Resources Management Plan process requirements

Dates	Requirement
July 2012 – February 2013	Pre-consultation phase – liaison particularly with the Environment Agency to discuss approaches to meeting the requirements of the Guidelines and give the Regulators an early sight of work undertaken and proposals.
31 March 2013	Submit draft Water Resources Management Plan to Secretary of State (Defra)
April 2013	Defra perform security checks and give permission to publish draft Plan
1 May – 31 July 2013	Public consultation of draft Plan; minimum of 12 weeks required. Consultees send comments to Defra.
August – November 2013	Water companies review comments and prepare a Statement of Response (SOR) report and a revised draft Plan.
November 2013 – January 2014	The Environment Agency review our SOR and revised draft Plan and make a recommendation to Defra as to whether: • Our plan can be published • Further information is required • An inquiry should be held.
December 2013	Submit Business Plan incorporating Water Resources Management Plan (N.B. we had not received a direction from Defra on our revised draft Plan at this time).
May 2014	Defra notify Wessex Water that they have permission to publish the Plan as a Final version without the need for further information or an enquiry.

1.4 Internal review and audit

In the development of this Plan we subjected each of the key components to internal challenge processes at technical review meetings with key staff in the business and through the preparation of working papers for our PR14 management team, Directors Meetings and Board Meetings. We also commissioned consultants Tynemarch to audit the final demand forecasting model for technical accuracy and Halcrow to undertake a strategic level review of the full Plan. The audit reports[2],[3] are available as technical appendices to this Plan.

[2] Halcrow (March 2013). Strategic technical review of draft Water Resources Management Plan, Wessex Water Services.

[3] Tynemarch (Feb 2013). Review of demand spreadsheet for draft Water Resources Management Plan.

1.5 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 consultation of the plan.
- Section 3 describes the Wessex Water supply area with specific reference to the development of our grid project and the integration of our system into a single resource zone.
- 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 examines options and proposed investments in light of the baseline supply demand balance and in particular reviews metering, water efficiency and leakage options.
- Section 9 presents the final planning supply demand balance including the selected options and reviews the need for a Strategic Environmental Assessment.
- Section 10 concludes the Plan.
- Section 11 contains appendices and references to other documents supporting this Plan.

2. Consultation on this Plan

Engagement with our customers and other stakeholders to consult with and discuss our activities is a business as usual commitment for Wessex Water.

We have regular contact with the Environment Agency at a national and regional level on a variety of water resources issues. Details of our pre-consultation liaison with the Environment Agency in relation to the development of this Plan are outlined in Section 2.1

In 2012 we established a Customer Scrutiny Group (CSG) to involve customers in the development of our Business Plan in accordance with Ofwat's customer engagement policy statement (2011)[4]. Working with the CSG enabled us to test the aspirations described in our Strategic Direction Statement and refine them as appropriate to ensure our vision is aligned with customer preferences. This Water Resources Management Plan has been formulated in the context of the development of our Strategic Direction Statement and our next Business Plan (due to be approved by Ofwat in December 2014). Details of pre-consultation liaison with our CSG on this Plan are given in Section 2.1.

We also host five regular liaison panels with stakeholders that have a special interest in particular areas, these are:

- Environment
- Customers and communities
- Services and planning
- Business customers
- Sustainability

These groups meet at least biannually to discuss pertinent issues and help us shape our business strategies. Liaison with these groups during pre-consultation and public consultation is described in Sections 2.1 and 2.2.

We also participate widely with stakeholder engagement groups hosted by other organisations in our community including local wildlife trusts and angling associations.

2.1 Pre-consultation

Pre-consultation of this Plan was undertaken between July 2012 and March 2013. 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.

[4] Ofwat (August 2011). Involving customers in price setting – Ofwat's customer engagement policy statement.

2.1.1. Statutory pre-consultation

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 regional Environment Agency staff during the pre-consultation period involving meetings on 17 July, 30 August, 11 October, 8 November 2012, 16 January, 6 February and 7 March 2013. Particular issues discussed during pre-consultation included resource zone integrity, climate change, deployable output, levels of service, demand forecasting, metering and leakage. Details of the discussions are included in Appendix 11.2.

Ofwat

We met with Ofwat in January 2013 to present our work analysing the impact of climate change on supply, our approach to the development of the (weighted) average demand forecast and our proposal to introduce a change of occupier metering policy. Details of the topics discussed are included in Appendix 11.2.

Secretary of State (Defra)

In November 2012 we wrote to Defra by email to let them know that we were undertaking pre-consultation on our draft Water Resources Management Plan.

Licenced / appointed water suppliers

In November 2012 we wrote to Scottish and Southern Electric who operate an inset appointment in our area by email to let them know that we were undertaking pre-consultation on our draft Water Resources Management Plan.

Customer Scrutiny Group and other customers

Our CSG includes representatives from the Environment Agency, the Drinking Water Inspectorate, Natural England, Consumer Council for Water, Money Advice Trust (representing the Customers and Communities Panel), Apetito Limited (representing Business Customers), the National Farmers Union (representing the Environment Panel) and West Dorset District Council (representing the Services and Planning Panel).

The Water Resources Management Plan was a particular agenda item for the CSG meeting held on 10 January 2013 and a follow up meeting was subsequently held on 25 February 2013 to discuss our proposal to introduce metering on change of occupier in more detail.

We also presented information on the development of and the emerging proposals related to this Plan to our customer liaison panels in October 2012 (Environment, Business Customers and Services and Planning) and in February 2013 (Environment and Services and Planning).

In additional to qualitatively testing the development of this Plan with our CSG and other liaison panels we also contracted Ipsos-Mori to work with us to undertake detailed customer research involving willingness to pay surveys to inform this Plan and our Business Plan. This work is described in more detail in Section 4.10 and Section 8.

2.1.2. Neighbouring companies contact plan

The Water Resource Planning Guidelines require companies to publish a view of 'need' and 'availability' with regard to future potential bulk supplies during the pre-consultation period. On 1 October 2012 we wrote to neighbouring companies[5] informing them that the initial view of our supply demand balance indicated the following surpluses that could be available as future bulk supply exports:

- Company single resource zone: approximately 10 Ml/d
- North Wiltshire area: approximately 5 Ml/d
- Exmoor / Taunton / Bridgwater area: approximately 10 Ml/d.

We also published this information on our website and informed the Environment Agency and Ofwat of this pre-consultation activity.

We have regular contact with neighbouring companies on an on-going basis, and in addition, as part of our contact plan we invited them to contact us if they wished to discuss bulk supply options based on the indicative information we provided. Discussions regarding potential future bulk supply options were held during the pre-consultation period with South West Water, Bristol Water, Sembcorp Bournemouth Water, Thames Water, Affinity Water, Welsh Water and Cholderton Water. For further details see Sections 4.7 and 9.3.

2.1.3. Wider stakeholder groups with an interest in water resources planning

In November 2012 we wrote to a wide range of stakeholder groups that are known to us to have an interest in water resources planning owing to our previous liaison with them. The consultees we contacted included:

- Natural England
- Local Wildlife Trusts
- Internal Drainage Boards
- WWF
- RSPB
- Campaign to Protect Rural England
- Waterwise
- Local MPs
- Association of Local Councils
- NFU
- Countryside Landowners and Business Association
- Westcountry Rivers Trust
- Wessex Chalk Stream and Rivers Trust
- Wiltshire Fishery Association
- The Angling Trust
- Horticultural Trade Association

The Environment Agency, Natural England and English Heritage were also consulted on our Strategic Environmental Screening Statement in February 2013 – see Section 9.

[5] Bristol Water, South West Water, Sembcorp Bournemouth Water, Cholderton Water, Thames Water, Southern Water, Welsh Water and Affinity Water

2.2 Public consultation of the draft Plan

The draft Water Resources Management Plan (WRMP) was submitted to Defra in March 2013 and we were given permission to publish the draft Plan for public consultation at the end of April.

The Plan consisted of:

- a technical report that explained in some detail all the work undertaken and methodologies followed to prepare the Plan
- a set of standard data tables
- a short non-technical summary report designed specifically to engage with a wide range of stakeholders and interested parties.

Our draft WRMP was published for public consultation on 6 May 2013. The consultation period extended for 12 weeks until 31 July 2013. The full draft Plan including all the technical appendices was made available to statutory consultees (Defra, Environment Agency and Ofwat). The Plan was also made available on our website: www.wessexwater.co.uk/waterplan and a wide range of consultees were notified of its publication by email, letter and via our customer liaison panels. In the same manner as we approached the consultation of our recent Drought Plan (January 2013), we published a 'public version' of the technical report with specific sections redacted upon the advice of our Security Manager. Paper copies of all documents were available on request.

During the consultation period we hosted two stakeholder meetings. At which Wessex Water staff presented a summary of the Plan which covered the key building blocks relating to the forecasts of demand and supply and future proposals. Issues relating to abstraction licencing, bulk supplies, climate change, population and property growth, metering, water efficiency and leakage reduction were therefore described and discussed.

The process required that consultation responses were sent to Defra who then forwarded them to us for consideration. Following the consultation we prepared a Statement of Response Report in order to respond to the comments made by stakeholders. We also prepared a revised draft Plan to incorporate any changes that we made as a result of the consultation.

Our Statement of Response and revised draft Plan were then reviewed by the Environment Agency who prepared an Advice Report for the Secretary of State to help them decide whether to direct us to publish the Plan as a final version, whether further information is required or if an inquiry should be held.

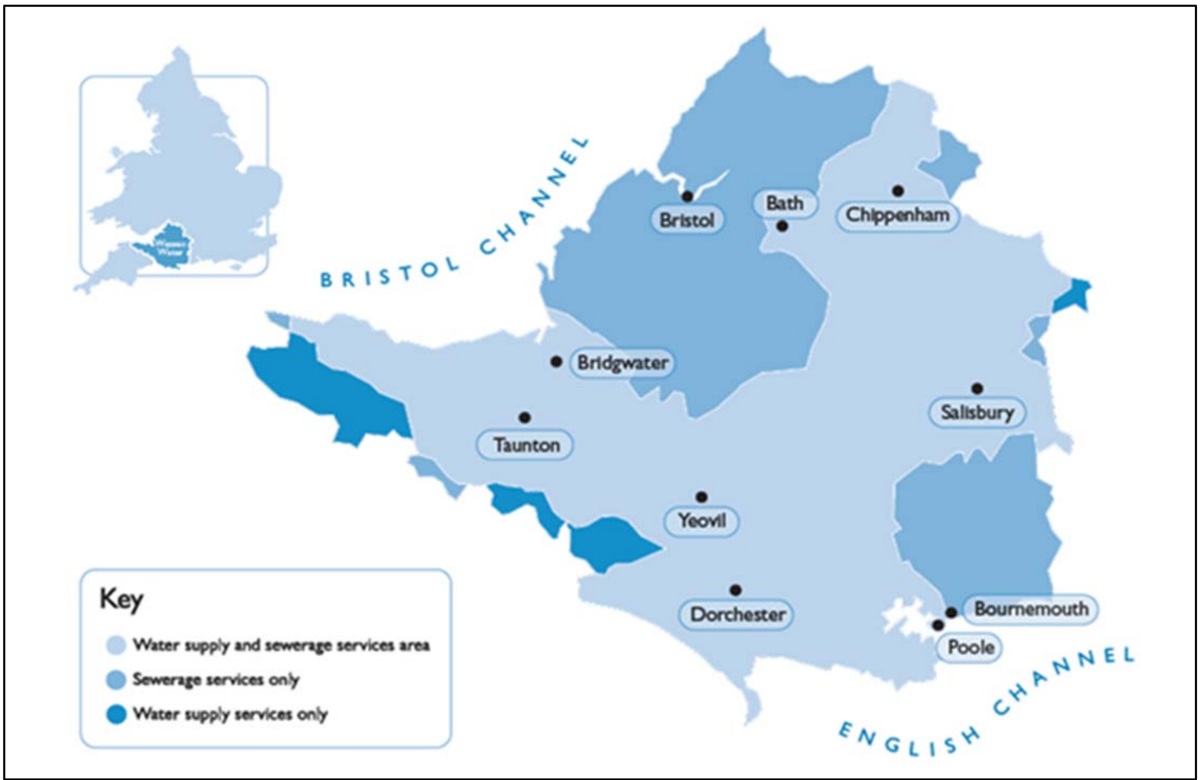
Unfortunately we did not receive direction from Defra / Secretary of State before we submitted our Business Plan to Ofwat in December 2013.

In May 2014 we were notified by Defra that we could publish this Plan as a final version without the need for further amendments, further information or an enquiry.

3. Water supply area

Wessex Water supplies 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 85 sources and over 11,500 km of water mains to treat and distribute approximately 340 million litres of water each day (Ml/d). Our sources range in size from less than 0.2 Ml/d to 45 Ml/d although there we have a prevalence of small sources – nearly 70% have an average output of less than 5 Ml/d.

The main river catchments in the Wessex 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 4.3.

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 350 Ml/d today. For more information on recent and forecast demand patterns see Section 5.

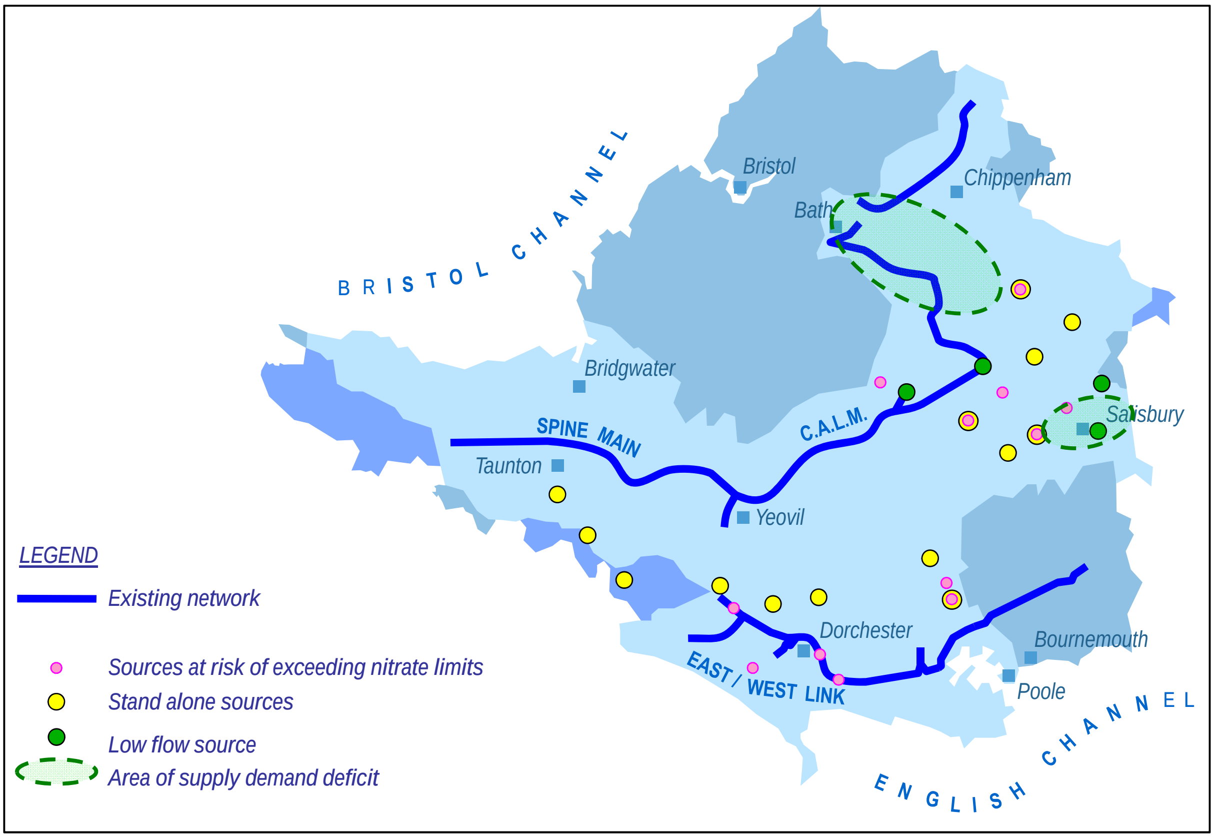
3.1 Development of the integrated grid

Currently our supply system includes transmission systems between the major surface water reservoir sources in Somerset to the demand areas in the centre and north of our region. In Dorset we have the ability to transfer water from east to west. The Salisbury area is not connected to the wider supply system.

Key issues that will put the balance between supply and demand at risk in the future that were identified in our last Water Resources Management Plan and Business Plan are illustrated in Figure 3-2. In particular:

- 'Low flow sources' where licence reductions are required to help improve river flows and lessen the impact of our activities on the environment but will result in areas of demand deficit
- Sources at risk of exceeding the maximum limit for nitrate in drinking water
- 'Stand-alone sources' meaning that the customers they supply cannot be supplied from an alternative source should an unforeseen outage occur.

Figure 3-2: Wessex Water supply area and issues identified in the previous water resources management plan



The options studies undertaken in 2008 identified that providing improved inter connectivity between our sources and the areas of demand would enable us to deal with the key issues identified. The concept of the regional grid is that infrastructure links are constructed so that surplus water can be utilised to cover for outages and low flows reductions, without the need to develop any new water resources. Eliminating the stand-alone sources by connecting them to the wider network will improve network flexibility and the current sub-divisions within the east resource zone will be removed. Furthermore the grid will allow the delivery of low nitrate water to the areas that exceed the limit for nitrates in drinking water.

The options assessment showed that the benefits of an integrated approach were significantly greater than the costs. Furthermore the environmental and social impacts of the integrated approach were less than the alternatives. Therefore, as the integrated grid satisfied all the water resource management and business planning requirements and had fewer environmental and social impacts, it was taken forward by Wessex Water to meet the key objectives within the last Water Resources Management Plan and Business Plan.

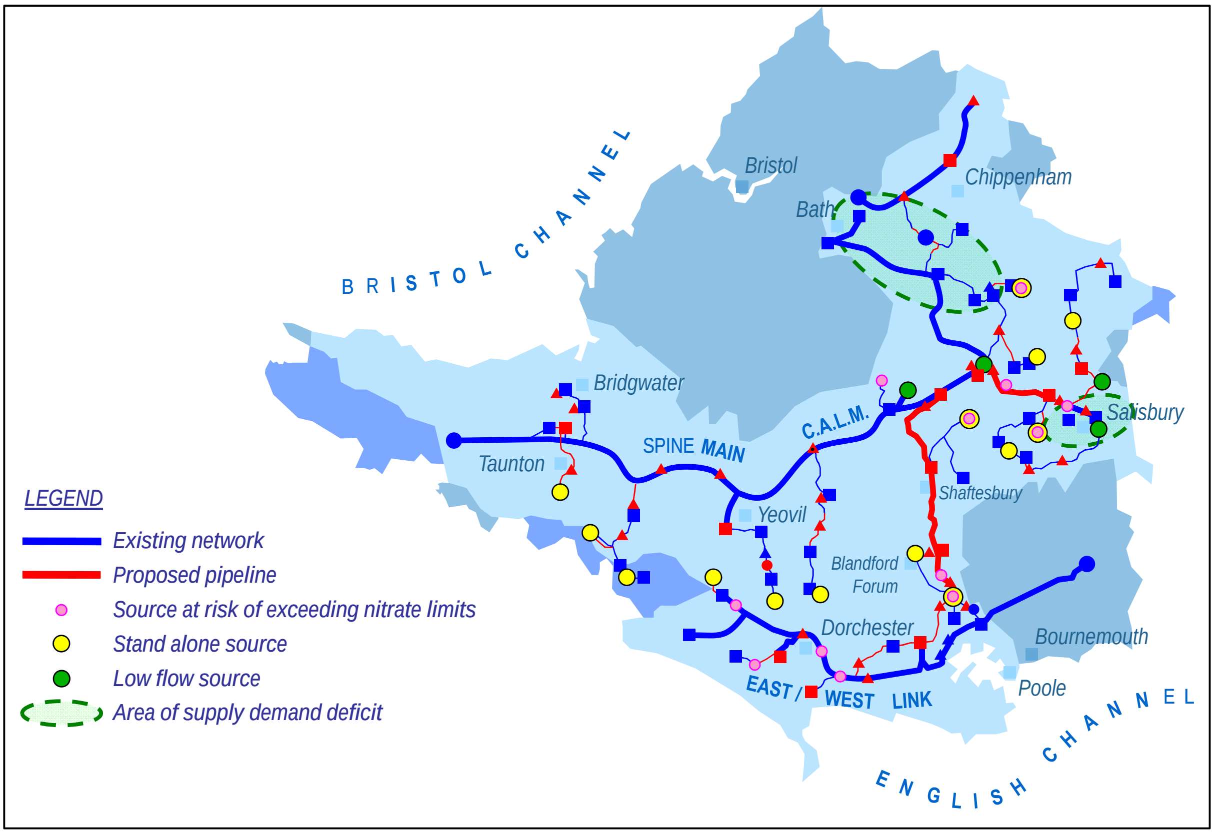
The grid proposal was approved by Ofwat in 2009 and work started at the beginning of the current AMP period in 2010. Progress to date for the largest part of the project, the major transfer scheme from Corfe Mullen to Salisbury, is summarised below:

- Concept design completed in 2010/11
- Outline design and route selection including land referencing, environmental surveys etc. completed in 2011/12
- The planning application, including Environmental Impact Assessment, was submitted in November 2012 and is due to be determined in April 2013
- Construction will commence in autumn 2013 and continue for four years
- Commissioning is scheduled for 2017 and the grid will be fully complete by March 2018.

The other parts of the project are progressing in parallel with the work on the major south to north transfer and in some cases have already been completed.

Figure 3-3 shows the layout of the grid and how it provides interconnectivity between sources and areas of deficit and provides resilience for stand-alone sources and sites at risk of high nitrates.

Figure 3-3: Integrated grid connections to address the water supply issues we are facing



3.2 Water resource zone integrity

The geographical unit for water resources planning is the water resource zone. The water resource planning guidelines 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.

In accordance with the guidelines we undertook a water resource zone integrity assessment following the methodology set out by the Environment Agency in May 2011[6]. We began discussing resource zone integrity issues with the Environment Agency in November 2011; we completed a draft stage 1 assessment pro-forma and comments from the Environment Agency allowed it to be refined with further information added for enhanced clarification. Our final assessment is included in Appendix 11.3.

Our assessment led us to propose developing the draft Water Resources Management Plan on the basis of a single water resource zone. Previous Plans were developed on the basis of four zones (north, south, east and west) however, the development of our more integrated grid by 2017/18 will more fully connect our system so that stand-alone areas in the east are

[6] Environment Agency (May 2011). A proposed approach to ensuring water company water resource zones are integrated.

connected to the wider network and the south zone will become connected to the north zone. We proposed to take a pragmatic approach and undertake the assessment of resource zone integrity for the post-2017/18 situation rather than the pre-grid situation which would only exist for the first 3 years of a 25 year Plan.

Following their review of our assessment, in July 2012 we received a letter from the Environment Agency that agreed in principle to the development of the draft Plan on the basis of a single resource zone.

3.3 Catchment approach

Whilst water resource zones are the key geographical area over which a water company should ensure that a balance between supply and demand exists, catchments are the key assessment area for assessing our impacts on the water environment. Therefore in this Plan, as well as undertaking an analysis at water resource zone level, we have presented the results at catchment level.

We now take this catchment based approach across our business, including in our Business Plan.

In this Plan we assess our impacts at a catchment level, and, from working with the Environment Agency and Natural England, we propose appropriate investigations and investments to understand and improve the environment. This work will also help ensure compliance with the Water Framework Directive (WFD), the Habitats Directive and drinking water standards amongst others.

We have defined the catchments based on the major river basins of the Wessex Water area as shown on the map below (Figure 3-4).

Figure 3-4: Catchment map for the Wessex Water region

Since November 2011 Wessex Water has been leading the Frome and Piddle Catchment Initiative. This is one of the 25 Catchment Initiatives launched by Defra in March 2011. We have found that working at this local catchment scale is ideal for understanding the issues that affect the water environment and which are of concern to the local communities. At this scale it was possible to develop a genuinely local partnership to prepare the catchment plan and to develop effective solutions that are in tune with local aspirations and, vitally, are practical and realistic. The resulting plan can be found at http://www.fromeandpiddle.co.uk/

In October 2013 we were asked by Defra to co-host a similar initiative for the River Stour and we are working alongside a further two initiatives which have been recently established on the Bristol Avon and Hampshire Avon. We are keen to work with other partnerships as they form, particularly in Somerset. These partnerships are integral to the local delivery of WFD actions to achieve good status, and we are keen to work together with them to seek the most effective solutions. We are also working closely with the four Local Nature Partnerships within our operational area, as again, these cross-sectorial groups provide a good mechanism to identify issues, share knowledge and undertake wider delivery actions on the ground to achieve our common goals.

Working collaboratively at this scale provides us with the opportunity to share our plans more widely, receive comments and recommendations on how we can deliver greater environmental gains and provides the opportunities to explore more innovative solutions. Working more closely with stakeholders is a key aspect of our business plan and an area which is likely to expand in future AMPs to deliver the WFD.

3.4 Levels of service

'Levels of service' are a contract between a water company and its customers setting out the standard of service that customers can expect to receive from a water company. In the specific context of a Water Resources Management Plan, levels of service relate to the average frequency that a company will apply restrictions on customer water use. The frequency of restrictions varies with type i.e. a temporary use ban would be expected to occur more frequently than a non-essential use ban imposed through a Drought Order.

Wessex Water has not imposed restrictions on customer water use such as a hosepipe ban (Temporary Use Ban) since 1976. Our supply system is designed to ensure that we can meet unrestricted demands in the event of a repeat of the conditions experienced during the drought of 1975/76. We equate this to a frequency of customer restrictions (Temporary Use Bans and Drought Orders) of 1 in 30 years. Based on a review of the hydrological record over the last 100 years we would not expect to ever need an Emergency Drought Order (standpipes / rota cuts).

We investigated customer opinions and preferences in relation to levels of service and this work is explained in Section 4.10.

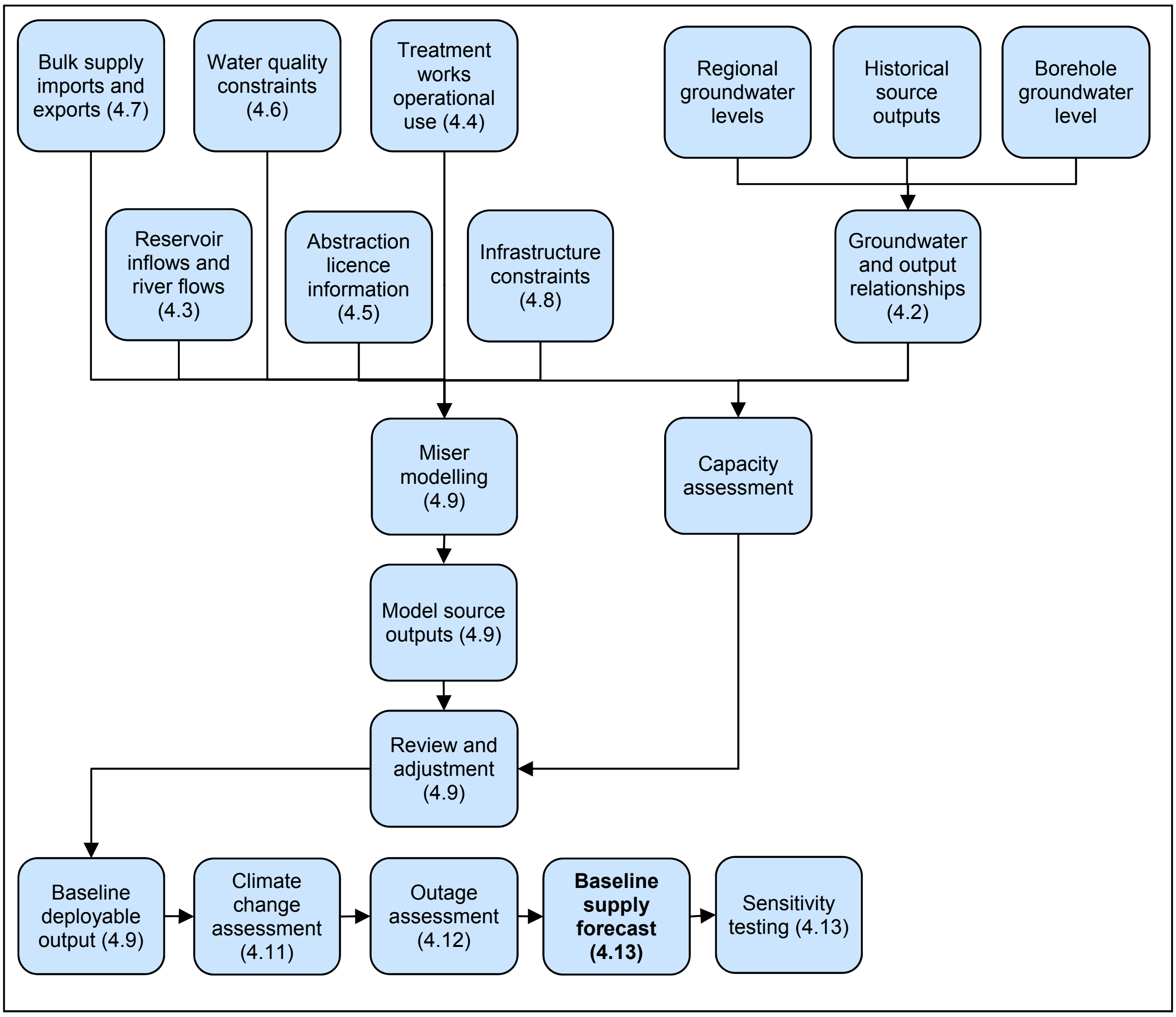
The planned level of service assumed in this Water Resources Management Plan is consistent with our Drought Plan. Our Drought Plan[7] sets out our strategic and operational responses to extended periods of dry weather.

[7] Wessex Water (January 2013). Final Drought Plan.

4. Supply forecast

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*[8]. 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 section of this chapter where each element of the assessment is explained.

Figure 4-1: Supply forecast development process



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. As shown in Figure 4.1 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.

[8] 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.

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

The robustness of the deployable output assessment depends upon the application of robust inputs (i.e. the assessment data set) to the Miser model and in the development of this Plan we have reviewed and updated where necessary all the information specified in Figure 4-1. In particular we have developed a *Handbook of Source Yield Information*[9] that presents the work done to re-examine the groundwater and output relationships that are a key input to the Miser model. This piece of work represents an improved approach to our supply forecasting since the last WRMP and further details are given in Section 4.2

We confirmed our intention to review our deployable output assessment for the development of the draft Water Resources Management Plan with the Environment Agency during a pre-consultation meeting in July 2012 and again in November 2012 at which time we shared some initial draft documentation on the work to review groundwater and output relationships.

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 4.8 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 4.9 explains the Miser modelling process and the derivation of baseline deployable output
- Section 4.10 examines deployable output and levels of service
- Section 4.11 outlines the assessment of the impact of climate change
- Section 4.12 outlines the outage assessment
- Section 4.13 then describes the overall baseline supply forecast and discusses some key sensitivities.

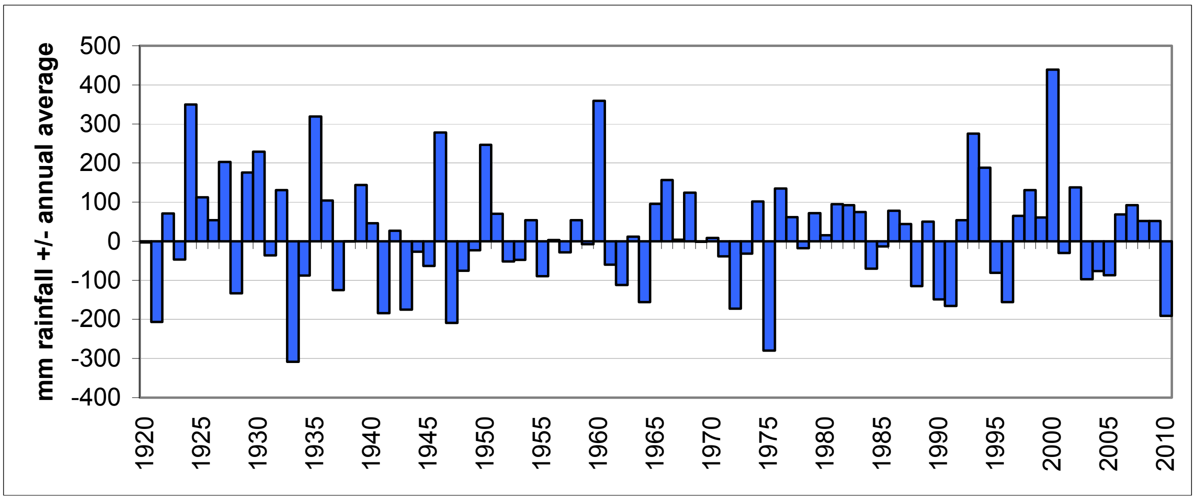
[9] Wessex Water (November 2012). Handbook of source yield information.

4.1 Supply forecast context – level of service, rainfall patterns and data records

Wessex Water's planned level of service is to meet unrestricted customer demand in the repeat of the conditions experienced in the drought of 1975/76 (which is when restrictions were last imposed). We equate this level of service to a frequency of imposing restrictions such as a Temporary Use Ban (hosepipe ban) once every 30 years.

This level of service can be set in the context of the long-term rainfall record that indicates drought severity and the magnitude of return periods. Annual average rainfall in the Wessex region is 838 mm (1961-1990). Figure 4-2 shows the variability around this average over the last 90 years. During this period there have been four years which were over 200 mm (25%) drier than average (including 1975) and nine years that were over 200 mm wetter than average.

Figure 4-2: Annual average rainfall variability in the Wessex region



In 2007 we undertook an analysis of historical rainfall sequences to examine the magnitude and frequency of droughts prior to 1975 and to place the drought of 1975/76 in the context of the longer record. We identified that dry years of particular significance to this region occurred in 1887/88, 1920/21, 1933/34 and 1943/44 (Wessex Water, 2007[10]). These droughts varied in their magnitude, duration, consistency of dryness and spatial extent. The analysis suggested that the dry weather experienced in 1975/76 was significant but not exceptional in the longer term record.

We have good measured data records of groundwater levels, reservoir storage and river flows that can be used for supply forecast modelling for the period since 1975 but little or no useful measured data for the earlier period.

Rainfall runoff models were therefore developed from the historical rainfall sequences to examine the effect of historical droughts since the 1890s on inflows to reservoirs and groundwater recharge (Mott MacDonald, 2009[11]). It was shown that whilst severe, the drought in 1975/76 was not the 'worst' in the record for every reservoir and aquifer and the study concluded that the period of actual measurement of inflows and groundwater levels since 1975 was representative of the longer term variability.

[10] Wessex Water, June 2007. Analysis of pre-1975 rainfall sequences: the identification of drought occurrence and severity.
[11] Mott MacDonald, March 2009. Wessex Water water resources models data series extension.

To support work for our last Water Resources Management Plan and Drought Plan, the modelled data sequences of groundwater level and reservoir inflows were then used to undertake an analysis of the likely impact of historical droughts on source outputs (Wessex Water, 2009[12]). The modelled sequences were input to the mathematical relationships (developed as part of our last Water Resources Management Plan) between regional groundwater levels and borehole source outputs and to our surface water reservoir models. Likely source outputs in droughts that occurred before 1975 were then calculated. Although the analysis was conducted offline from our Miser modelling software (and so does not account for conjunctive use in determining source outputs) it served as a useful sensitivity test to compare resource availability in various drought periods and suggested again that the 1975/76 drought was not significantly more severe than other droughts in the record. Indeed, the study suggested that overall resource availability in 1898, 1921, 1944 and particularly in 1934 was lower than in 1976.

This analysis has been updated for the development of this Plan and is explained in Section 4.10 which examines the relationship between deployable output and levels of service.

[12] Wessex Water (August 2009). Impact of historic droughts on water resource availability.

4.2 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 their output is limited only by infrastructural constraints such as treatment plant capacity or a licence limiter. 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 that these hydrological constraints have 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.

To improve on the approach we took for our last Water Resources Management Plan we contracted consultants Hyder to support us in analysing the hydrological constraints of our sources and to develop a 'handbook of source yield information'[13] to support this Plan.

An analysis method was developed that is consistent with the approach outlined by the UKWIR 2000[14] report and recommended by the Water Resource Planning Guidelines and the 2012 UKWIR project WR27[15] . 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.

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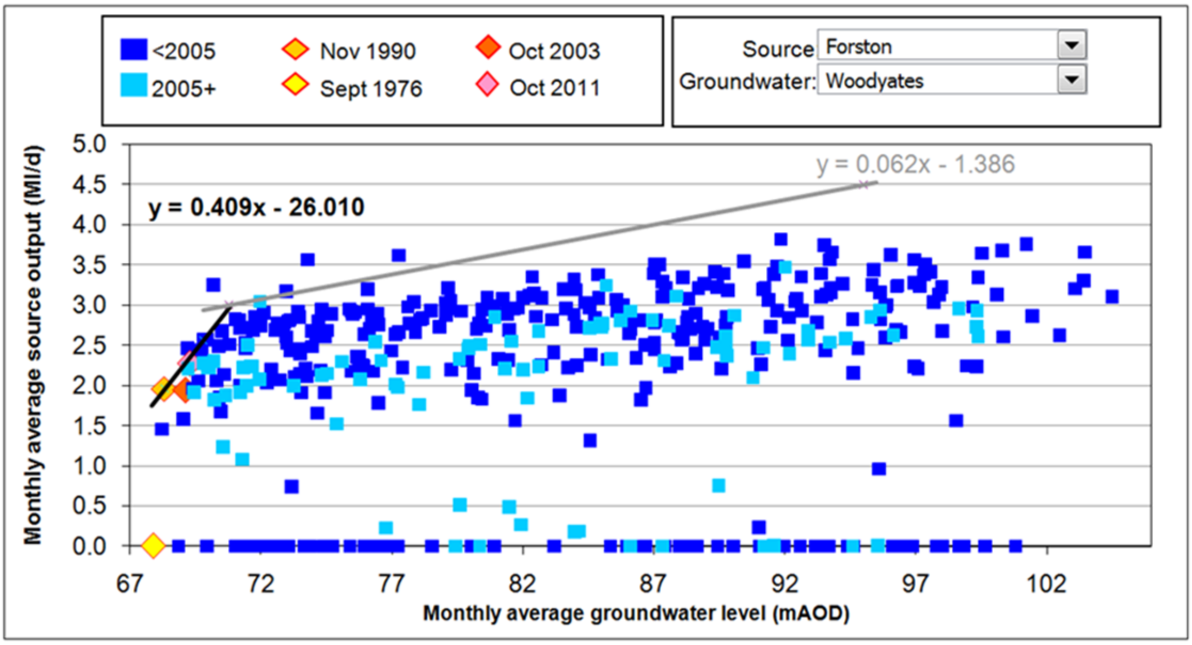
[13] Wessex Water (March 2013). Handbook of source yield information.
[14] UKWIR/EA (2000) A Unified Methodology for the Determination of Deployable Output from Water Sources
[15] UKWIR (2012), Water Resources Planning Tools 2012 (WR27), Deployable Output Report. Halcrow Group Ltd, ICS Consulting, Imperial College and University of Exeter Centre for Water Systems.

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 4-3 below. 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.

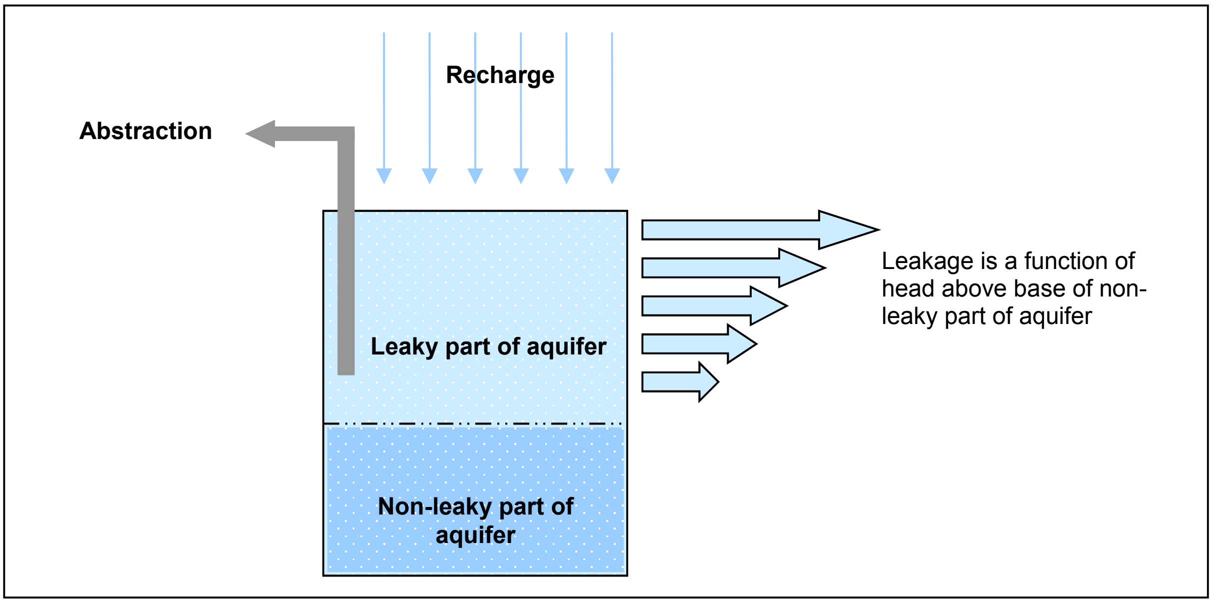
Figure 4-3: Example correlation between monthly source output and Woodyates groundwater level for Forston



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 good calibration of historic water levels has been obtained using this approach. The conceptual basis of the single point models is illustrated in Figure 4-4. The models were developed in Excel first, including calibration of historical groundwater levels against model levels and then applied to Miser.

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



4.3 Reservoir inflows and river flows

Surface water sources are represented in detail on the Miser model. Reservoir storage, compensation flow and the use of pumped storage are all simulated. The key data input is historic reservoir inflow and river flow sequences (to determine pumped storage). Appendix 11.6 contains an extract from our Miser model representing Durleigh and Ashford reservoirs.

Inflows to reservoirs are not recorded at any of our sites but they can be derived using variety of standard techniques including rainfall-runoff modelling, mass balance calculations, regression analysis and sampling of historical flow observations. We have developed stand-alone Excel based models for each reservoir 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.

Section 4.1 described the work we have undertaken to extend reservoir flow sequences back to the 1980s[16],[17].

[16] Mott MacDonald (March 2009). Wessex Water water resources models data series extension.
[17] Wessex Water (August 2009). Impact of historic droughts on water resource availability.

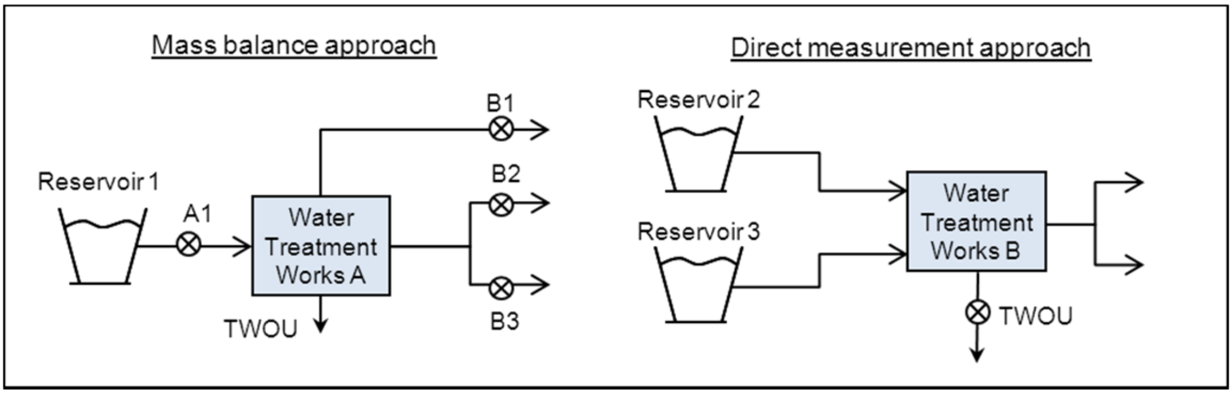
4.4 Treatment works operational use

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 and larger TWOU volumes are associated with surface water treatment plants (2 - 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 of deployable output. 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 4-1 (at the beginning of Section 4).

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. For this works water that has been operationally used is measured as it is discharged to a local watercourse. Figure 4-5 illustrates the mass balance approach for an example water treatment works. TWOU is equal to A1 – (B1 + B2 + B3).

Figure 4-5: Schematic illustrating how treatment works operational use is calculated



A schematic for each our surface water treatment works is provided in Appendix 11.5.

By 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. To avoid double counting, the value we have entered for TWOU in Table 'WRP1 Baseline Supply' for this Plan does not include volumes used operationally at our surface water treatment works. Table 4-1 provides the implied 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	8.0	0.52
Durleigh	Durleigh Reservoir	12.0	2.09
Fulwood	Leigh and Luxhay Reservoirs	9.0	0.32
Maundown	Wimbleball and Clatworthy Reservoirs	2.3	1.43
Sutton Bingham	Sutton Bingham Reservoir	6.0	0.35
Total	-	-	4.71

^ 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 0.04 Ml/d in 2011/12.
- **Iron treatment works**: associated with filter backwashing; accounted for 1.5% of works output, 0.14 Ml/d in 2011/12.
- **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 0.7 Ml/d in 2011/12 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 0.88 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 and as such is reported in Table 'WRP1.Baseline Supply'.

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 operation uses would not be significantly impacted.

4.5 Abstraction licences and sustainability reductions

The main way of ensuring our water supply activities do not have an unacceptable 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.

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 recent investigations and outcomes. 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

Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
	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**
	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.

Investigation period	River / environmental feature	Source	Outcome and mitigation if appropriate
	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**
	Durleigh Brook	Durleigh	**Investigation showed the need for trials in AMP6 involving variations in compensation flows, introduction of spate flows and river restoration measures.**

In 2011 we also made changes to reduce the annual licenced volumes of a group of sources that we do not utilise as fully as the licence would have allowed (i.e. owing to infrastructure constraints) and we also revoked some licences altogether for sources that had previously been previously decommissioned but where the licenced had been retained. These changes amounted to a reduction in our total licenced volume of 50 Ml/d (over 18,000 Ml/a).

4.5.1. ‘Low flows’ licence changes resulting from AMP4 and AMP5 studies

Between 2005 and 2010 (AMP4) we investigated the impact of all of our abstractions in the Hampshire Avon catchment on the flows in the Hampshire Avon and its tributaries to understand whether or not they were impacting unacceptably on this Special Area of Conservation (SAC). These investigations were driven by the Environment Agency’s Restoring Sustainable Abstraction programme and their conclusion was that to ensure the protection of the SAC it was necessary to reduce abstraction at Brixton Deverill, Clarendon, Codford and Newton Toney (Table 4-2).

During AMP5 we investigated a further suite of sources and from these studies is was concluded that licence reductions would be required at Bourton, Bishops Cannings, Fonthill Bishop, Upton Scudamore boreholes and Upton Scudamore Springs to ensure sustainable abstraction in the future.

Table 4-3 specifies the licence reductions necessary as a result of the AMP4 and AMP5 studies and details the impact these licence changes have on the deployable output of each source. All of these changes are included in the Environment Agency’s National Environment Programme (NEP).

These licence changes have been incorporated into our Miser model so that they are built in to our assessment of available supplies for the development of this Plan. The impact on deployable output resulting from the licence changes specified in the Table are consistent with our reporting in Table WRP1a BL Licences.

Table 4-3: Licence and deployable output changes resulting from AMP4 and AMP5 investigations

Source	Reduction in daily abstraction licence limit (Ml/d)	Reduction in annual average deployable output (Ml/d)	Reduction in peak deployable output (Ml/d)
Brixton Deverill	5.00	5.00	5.00
Clarendon	10.96	10.96	12.00
Codford	6.00	4.00	6.00
Newton Toney	1.50	1.50	1.50
Bourton	2.00	0.00	0.00
Bishops Cannings	1.15	0.00	0.00
Fonthill Bishop	1.50	0.75	1.50
Upton Scudamore boreholes	5.40	0.00	0.00
Upton Scudamore springs	0.00*	0.00	0.00
Total	**33.51**	**22.21**	**26.00**

* No change to Upton Scudamore springs daily licence, source available for less of the year though as hands-off flow trigger raised – see Table 4-2.

We have not been advised by the Environment Agency of any other abstraction licence reductions that we should assume in developing this plan, including to ensure "no-deterioration" under the Water Framework Directive.

Most of these licence changes will come into force in April 2018 on completion of our integrated grid project (Section 3.1). The change at Newton Toney is expected to come into force in April 2015 in conjunction with using the 1.5 Ml/d of reduced licence to provide stream support to the River Bourne when flows are low.

Two of the four sources will effectively be switched off as a result of the changes in Table 4-3: Clarendon, all the time and Codford for 5 (summer) months of the year on average. These existing assets, however, could be used as a contingency resilience measure. Discussions have been occurring with the Environment Agency about permitting the short term use of these sources. Any use of these sources to provide resilience must be low enough so as not to adversely impact the River Avon SAC. To provide a contingency resilience measure, the need to use these sources cannot be planned, therefore, the sources will need to be kept operationally available – often termed 'sweet'. To achieve this each source will need be used on a weekly basis, for a few hours, to maintain the assets in a state of readiness to ensure the water is ready for supply and is wholesome. Again any use of these sources must not adversely impact the River Avon SAC. We are currently finalising our proposals for the resilience and sweetening use. These proposals will be presented to the Environment Agency in the autumn of 2013 as part of a draft licence application to implement the 23.5 Ml/d reduction, detailed in Table 4-3. The use of the sources for these purposes does not form part of the Company's Drought Plan, and does not provide a deployable output under the Water Resources Management Plan process.

These licence reductions were in addition to the changes in abstraction from our Chitterne source which had been investigated in the period 2005 to 2010. As a consequence of this investigation the abstraction licence of the Chitterne source has been reduced by 14 Ml/d on average and 7 Ml/d for peak (licence changed in 2011).

In accordance with the Water Resources Planning Guidelines no allowance for sustainability reductions has been included in the headroom assessment.

4.5.2. Malmesbury public water supply and stream support changes

Background

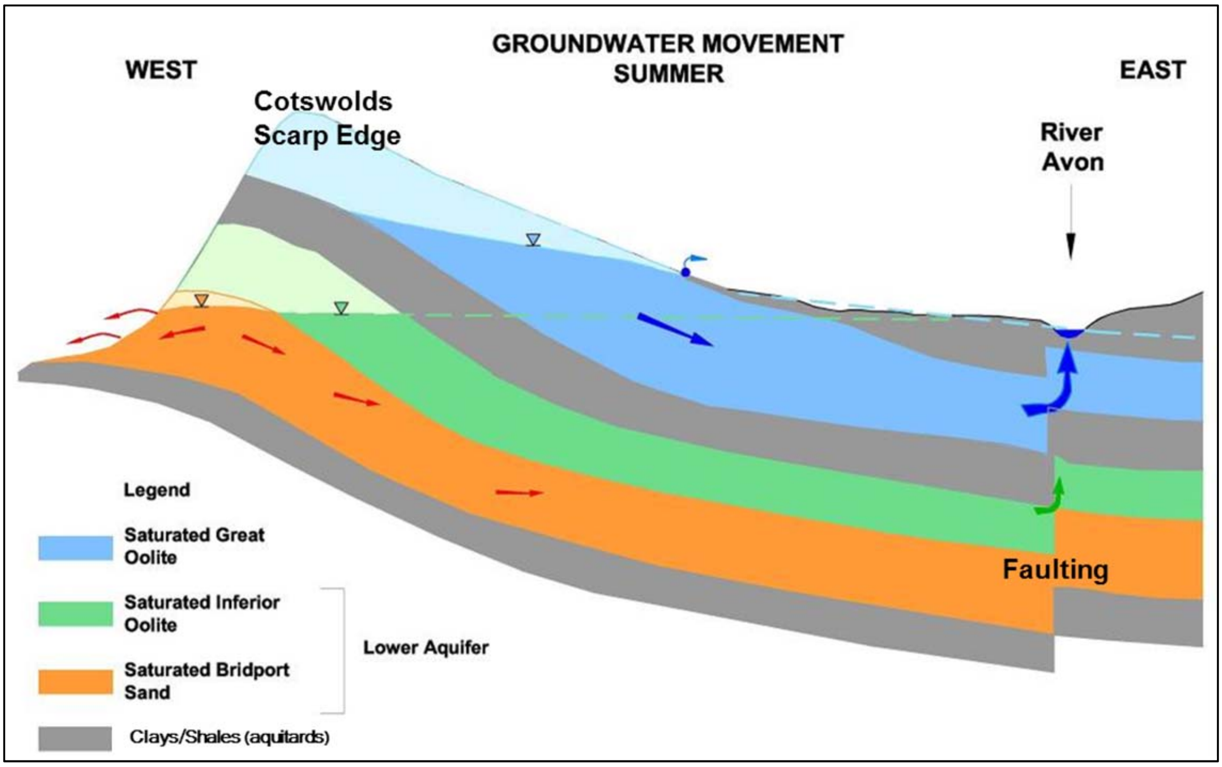
Since the early 1990s Wessex Water and Bristol Water have been working with the Environment Agency to improve river flows in the Malmesbury Avon. During dry summers (such as 1990 and 1995) the river through Malmesbury would go dry (Figure 4-6). The parties formulated an agreed solution in the mid 1990's. This solution has proved successful in maintaining acceptable river flows since July 1995; however, analysis to support a licence application to formalise this solution has identified two sustainability issues related to the Inferior Oolite aquifer. These two residual issues are detailed in this Section plus the measures the two companies are planning to take to ensure the restoration of sustainable abstraction and acceptable river flow in the Malmesbury Avon catchment.

Figure 4-6: Sherston Avon at St John's Bridge June 1995

The Inferior Oolite and Great Oolite aquifers

Wessex Water and Bristol Water abstract from the aquifers that provide baseflow to the River Avon: the Inferior Oolite (and Bridport Sand) and the Great Oolite. A schematic east-west section through the catchment showing the aquifer geometry is shown in Figure 4-7. The much greater outcrop area and its geometry means that the Great Oolite aquifer provides the vast majority of the baseflow to the River Avon. The aquifers are sandwiched between clay/shale that effectively hydraulically separates the aquifers, and the eastward dip of the rocks means the aquifers become confined. However, an eastwards flow of water occurs because geological faulting provides connection between the aquifers and this allows aquifer outflow into the River Avon.

Figure 4-7: West-east schematic section through the aquifers beneath the Malmesbury Avon catchment



<u>Resource development</u>

Both aquifers have a long history of being used for public water supply by both Bristol Water and Wessex Water.

Bristol Water

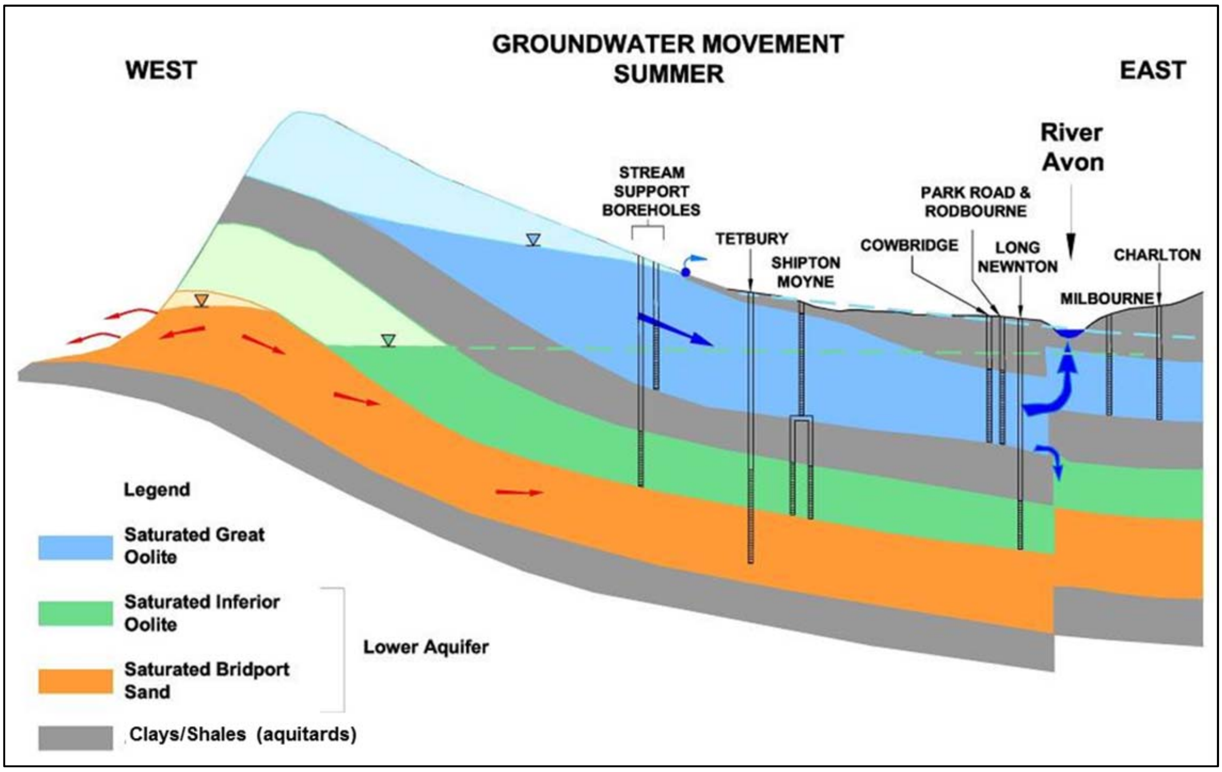
The town of Tetbury is supplied with water from the Inferior Oolite by Bristol Water; the source in Tetbury was drilled in 1927. Bristol Water also operates sources at Long Newnton and Shipton Moyne, the location of all three sources is shown on the schematic section in Figure 4-8. The Shipton Moyne source, which was completed in 1933, allows water to be abstracted from both aquifers, but is primarily viewed as an Inferior Oolite source. The Long Newnton source also draws from the Inferior Oolite; it was developed in 1961 to meet growing demand, supplementing the existing source at Shipton Moyne.

Wessex Water

The sources at Charlton and Rodbourne have been in operation since the 1960's drawing water from the Great Oolite. Park Road (not used since 1987) was also operational in the 1960's. The source at Milbourne became active in 1976.

In the 1970's Wessex Water Authority undertook a major water resource study of the Malmesbury Avon catchment seeking to develop new sources to meet growing demand. The outcome of this work was the Malmesbury Groundwater Scheme, which saw a new source at Cowbridge, and increased abstraction at Rodbourne. The study identified that the abstraction from these sources would adversely impact flows in the River Avon and some tributaries. To mitigate this impact stream support sources were developed. Water is abstracted from the Great Oolite (2 sources) and Inferior Oolite (4 sources) as required, up to a licensed limit, and added to the river to support prescribed flow conditions set a gauging stations along the Avon river network. The new source and increased public water supply usage, plus the stream support mitigation sources were licensed in 1981; with a subsequent increase in public water supply usage observed through the 1980's which has remained 'stable' since then.

Figure 4-8: Geological schematic section showing public water supply and stream support locations



<u>The problem, the solution and testing</u>

During the 'dry' summer of 1990 the Sherston Arm of the Avon in Malmesbury dried and flows in the Tetbury Arm become very low. This triggered a series of studies, with a major piece of work undertaken by the National River Authority. This concluded that the public water supply abstractions exacerbated a natural low flow situation, resulting in environmentally unacceptable flows. The Authority and water companies subsequently formulated a solution to restore new target river flows, documented in a Memorandum of Understanding (MoU) in 1996. These target flows were set based on river diary studies undertaken by local residents during the 1990s. The solution involved reduction in abstraction for public water supply and an increase in stream support rates.

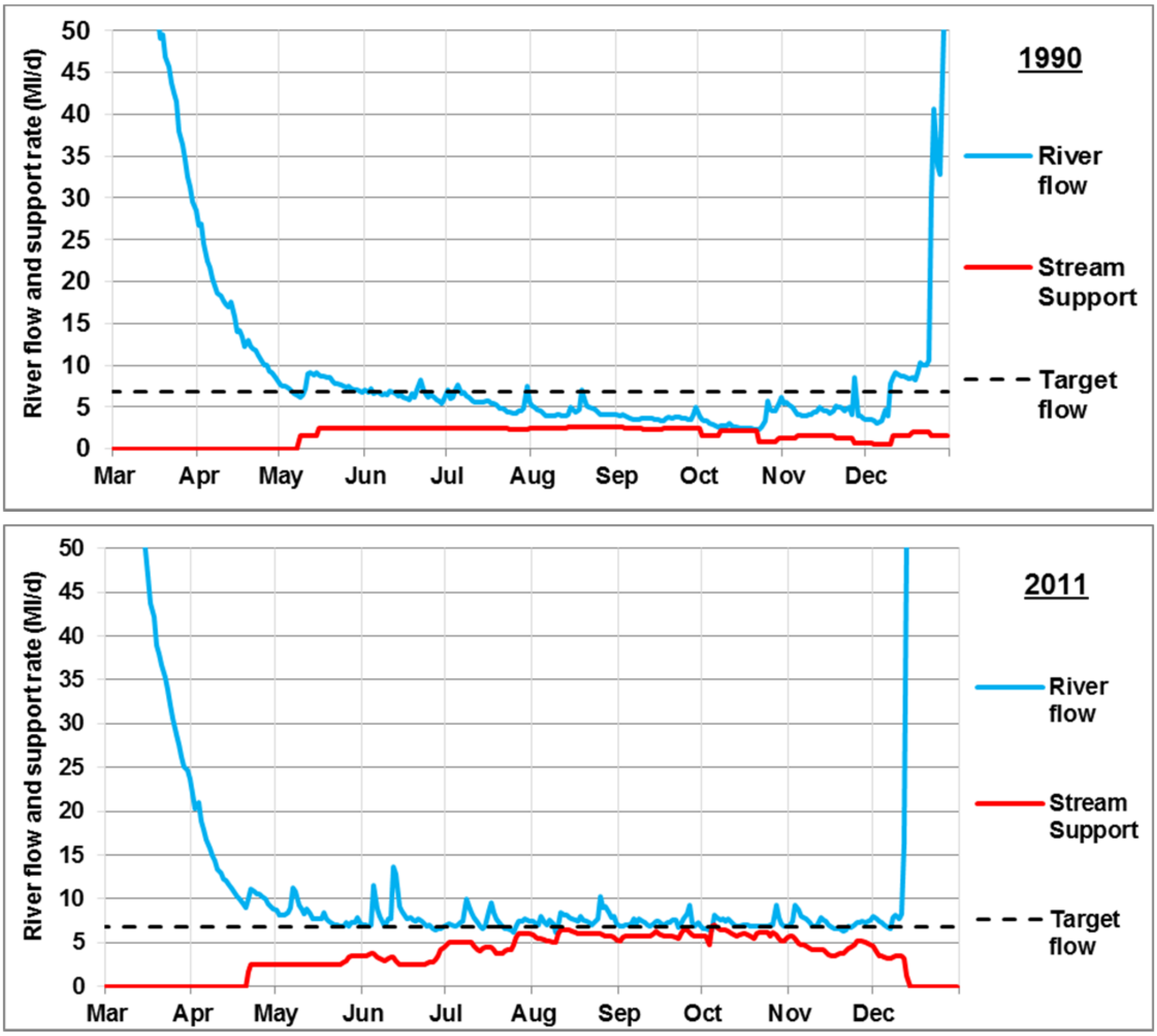
Bristol Water undertook to reduce the Shipton Moyne/Long Newnton licensed volume from 18 to 8 Ml/d. The reduction in abstraction commenced in 1995 and has been at or below 8 Ml/d since 1998. The shortfall in supply was made good by a funded scheme to increase abstraction/treatment capacity at their Purton source in the River Severn catchment.

The measures to improve river flow undertaken by Wessex Water were specified in the MoU and subsequently in a Statement of Intent (2002), signed by WW, EA, and Ofwat. The solution involved seeking to minimise public water supply abstraction at Cowbridge and to use the Inferior Oolite resource released by Bristol Water for increased stream support at Luckington and Stanbridge (Sherston Arm) and Tetbury (Tetbury Arm).

This revised abstraction regime has been tested under Section 32 consents since July 1995 and has demonstrated that the target river flows can be maintained under a range of weather conditions. This included a “signal” test during the dry summer of 2003 to test the available resources and recharge potential of the Inferior Oolite aquifer.

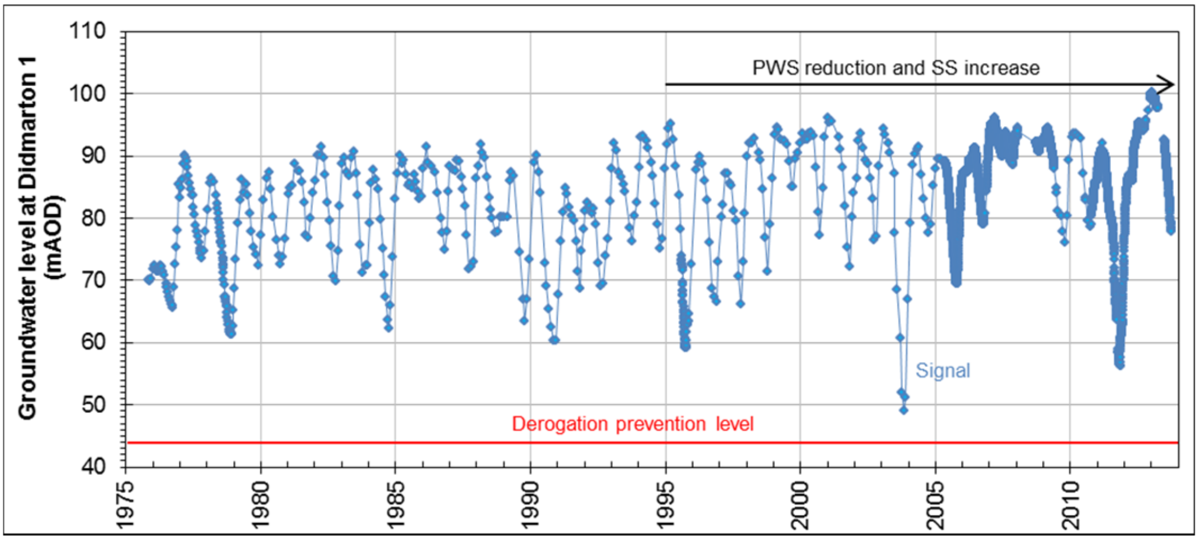
The graphs in Figure 4-9 show the benefit of increased stream support. The figure shows the observed flow in the Tetbury Avon at Brokenborough, upstream of Malmesbury, which occurred in 1990 and 2011, two ‘dry’ summers. The 1990 flow, under the current licence conditions, shows very low flow, whereas in 2011 with enhanced stream support the target flow is maintained. Similar significant improvements are seen in flows in the Sherston Avon.

Figure 4-9: Mean daily flow in the Tetbury Avon recorded at Brokenborough in 1990 and 2011



On average (1978 to 2011) 2.9 Ml/d of stream support is needed from the Inferior Oolite aquifer to maintain the target river flows. This is less than the Bristol Water reduction, consequently there has been a net reduction in abstraction from the Inferior Oolite and hence a rise in the Inferior Oolite groundwater level has occurred, as seen in the longer term record from Didmarton No1 (Figure 4-10).

Figure 4-10: Inferior Oolite water level at Didmarton No.1

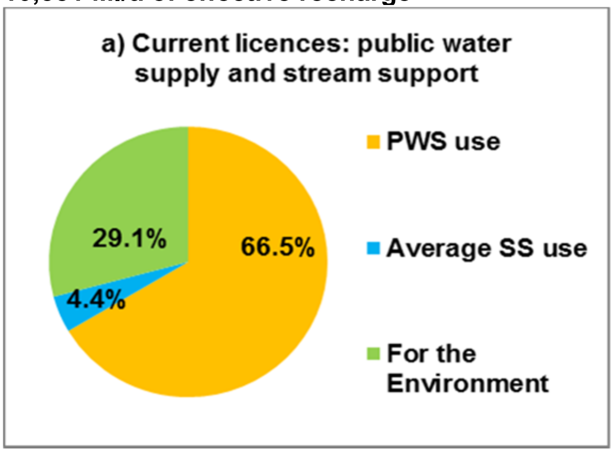


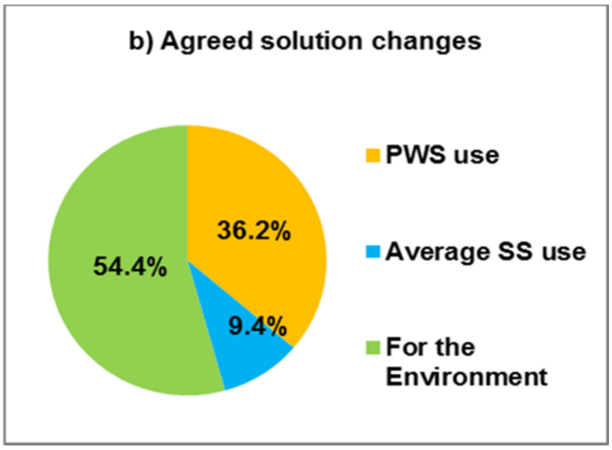
To test our conceptual understanding about how the aquifer behaves (i.e. how water gets into, flows through and leaves the aquifer) a computer based numerical transient groundwater flow model of the Inferior Oolite (and Bridport Sand) has been constructed and successfully calibrated. This model has allowed the sustainability of the proposed solution to be evaluated. Short time frame modelling (10 years) showed that based on contemporary public water supply abstraction rates the trialled solution was sustainable.

Consequently, following testing the agreed solution to the low river flows was for Wessex Water to formally reduce their abstraction licences for public water supply from 39.8 Ml/d to 35 Ml/d and for Bristol Water to formally reduce their abstraction licences for Long Newton / Shipton Moyne from 18 Ml/d to 8 Ml/d. In addition Wessex Water would increase the licenced volume for stream support from the Inferior Oolite at three sites from a combined maximum of 7.5 Ml/d to 25 Ml/d.

To calculate the changes in aquifer resource allocation from the current licence conditions to the agreed solution an overall water balance of the two scenarios was examined. During the period 1978 to 2010 the average annual recharge to the Inferior Oolite (and Bridport Sand) aquifer was 10,551 Ml/d. The stream support need and full licenced public water supply abstractions are expressed as a percentage of the annual average recharge in Figure 4-11. It can be seen that the agreed solution will result in a marked increase in the allocation of resources to the environment – from only 29% to 54%.

Figure 4-11: Inferior Oolite aquifer resource allocation based on 1978 to 2010 and assuming 10,551 Ml/a of effective recharge





Licensing

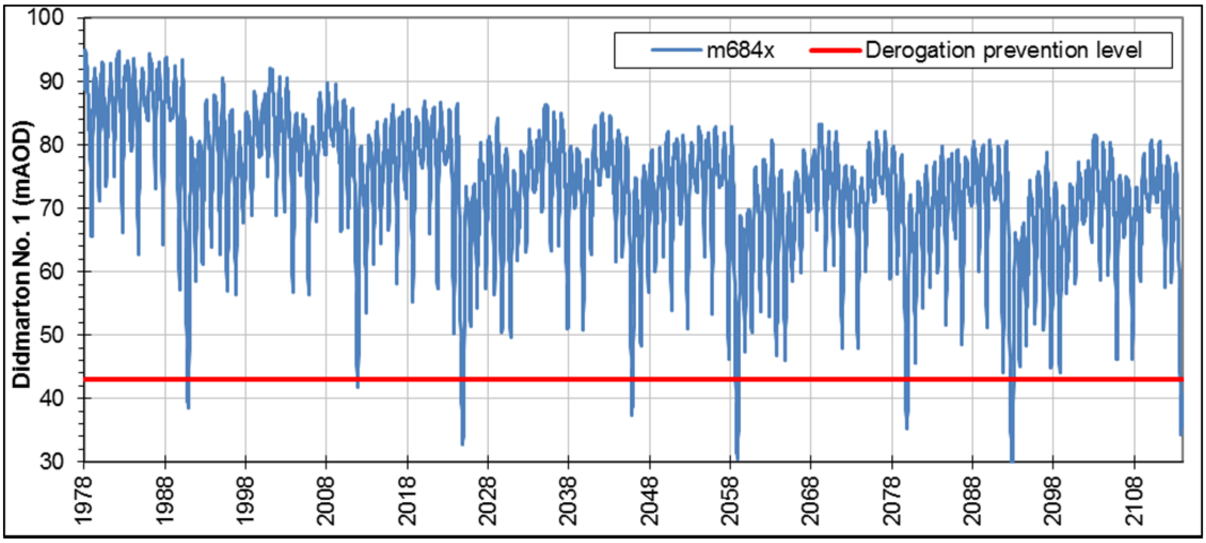
Documents to support the licence changes to implement this solution were subsequently prepared, and draft versions submitted to the Environment Agency for pre-application comment.

The Environment Agency expressed concern that if the Bristol Water public water supply sources were used at full licence, whilst stream support maintains the new target river flows, then the water level in the Inferior Oolite aquifer in a repeat of 1990 conditions may drop below the derogation prevention level (43 mAOD) (Figure 4-12). This level is set to ensure continuity of supply to two large private sources that abstract from the Inferior Oolite.

During this process Bristol Water enquired as to whether they could abstraction more than 8 Ml/d from Shipton Moyne / Long Newnton, as the average stream support need (2.9 Ml/d) was less than the quantity being given up. Consequently to address both points the time frame of the model was extended. The modelling period now covers 136 years. Such a long period of time was required as the storage changes in the Bridport Sand take several decades to equilibrate. Climate input data for the model is not available for such a long time frame, so a repeating climate sequence of 1978 to 2011 was used to generate a 136 year sequence. Therefore in the modelling period the extreme event of 1990 occurs 4 times: in 1990, 2024, 2058 and 2092.

The result of this modelling is shown in Figure 4-13. The modelling indicates that target river flows and acceptable groundwater levels can be maintained under almost all circumstances; however there is a possibility of a long term decline in the water levels in the Inferior Oolite aquifer, reaching a dynamic equilibrium after ~80 years. This will only occur if all the revised public water supply licences which abstract water from the Inferior Oolite are maximised (11.28 Ml/d) all the time.

Figure 4-12: Modelled Inferior Oolite groundwater level assuming revised maximum use of public water supply sources and maintenance of new stream flow targets



A review of the modelling outputs identifies sustainability issues for both the short and long-term:

- **Long term**: the modelling period starts with the aquifer 'full' (i.e. above 90 mAOD) based on recent use. The combination of full licence public water supply and stream support abstraction produces a long term adjustment, with winter maxima declining by ~15m, such that in a repeat of dry summers like 1990 and 2011 the derogation of protected rights is predicted.

- **Short term**: The need to maintain river flows in notable ‘dry’ years causes a marked decline in aquifer water level in that year, increasing the risk of derogation of private supplies.

On-going Inferior Oolite water level monitoring would highlight the risk of derogation in any given year as a dry summer continued. The private supplies are of a size that tankering water to them, if derogation occurred, is not considered to be viable or a satisfactory mitigation measure. The only measure that can be implemented quickly to reduce the risk is to reduce further abstraction from the Inferior Oolite aquifer. Consequently, to ensure the private supplies are not derogated, either less water for public supply has to be abstracted or the stream support rate reduced or a combination of both. At such a time Bristol Water’s prevailing demand situation may mean that little or no public water supply reduction could be made. Altering the stream support rate would be contentious at a time when the aquatic environment needs it most. Therefore, an adequate reduction in abstraction may not be achievable to prevent derogation. Consequently a robust mitigation measure needs to be in place well ahead of when it is needed.

Following receipt of these findings the two water companies, in consultation with the EA, have been evaluating options to overcome these short and long term sustainability issues.

Further modelling work has shown that to arrest the long term water level decline the average take from the Inferior Oolite aquifer needs to be reduced by a further 1.5 Ml/d. A reduction in stream support take is not considered viable as this would see river flows declining below the target levels. Therefore options to reduce public water supply take, and to find replacement water, or to help refill the aquifer have been considered.

To address the short term issue, again a further reduction in Inferior Oolite take or aquifer refill is needed, but only for a limited period of time to either help ‘fill up’ the aquifer to ensure summer water levels remain above the derogation prevention level.

<u>Options to further improve Inferior Oolite water levels</u>

Ten alternative options to address the long and short term sustainability issues are summarised in Table 4-4. The relative merits and high level cost estimates of each option are presented in the table.

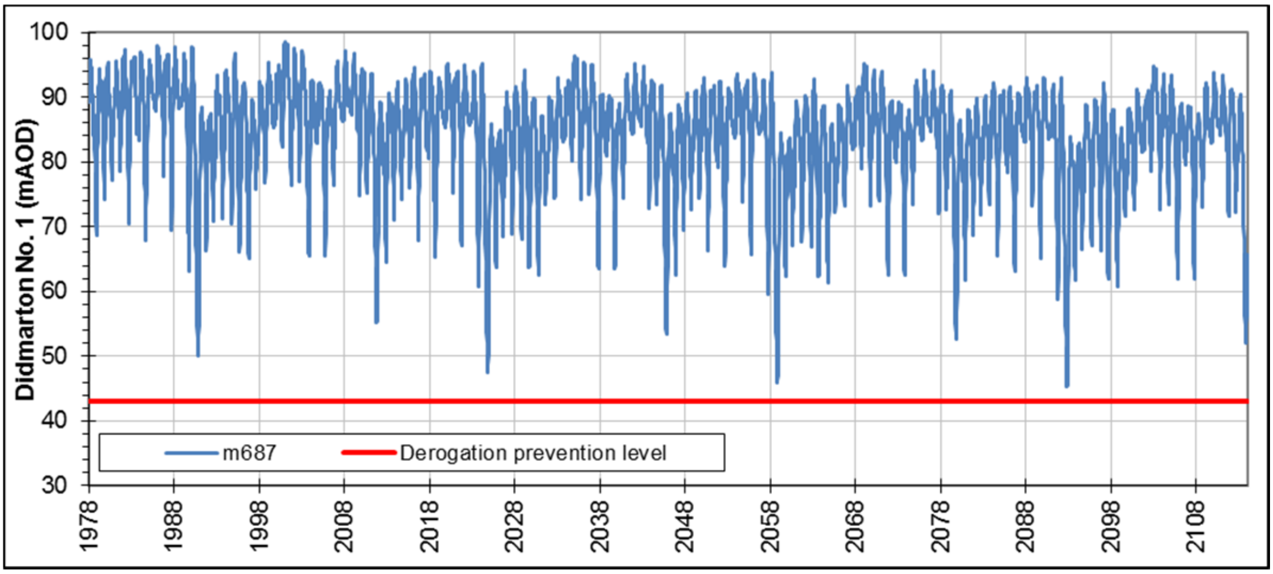
Preferred option

The following approach has been by the agreed, subject to contract, by the water companies to ensure a sustainable solution:

The preferred option is number 6. A 1.5 Ml/d reduction in Bristol Water’s licensed abstraction from the Inferior Oolite arrests the long term decline and see the aquifer water level above the derogation level in all but three years. This reduction would be matched by an equivalent reduction in their bulk supply to Wessex Water in Bath. To solve the short term issue and to provide additional resilience a pipeline would be constructed between Wessex Water’s Cowbridge source and Bristol Water’s Shipton Moyne source.

The licence change would link the quantities in Bristol Water’s licences for Tetbury and Long Newton/Shipton Moyne and set an annual total of 3570 Ml, equivalent to a daily abstraction rate of 9.78 Ml (a 1.5 Ml/d reduction). This change has been modelled and the impact upon the Inferior Oolite water level is shown in Figure 4-13, which shows the water level remains above the protection level in all summers.

Figure 4-13: Modelled Didmarton groundwater level (m687) with Bristol Water public water supply set at 9.78 Ml/d all the time and with stream support rate set to maintain new target river flows plus pipeline transfer operated in accordance with draft control rules



A daily peak abstraction limit of 12.28 Ml/d would be maintained, but with a monthly average limit equivalent to 9.78 Ml/d. This change further reduces the allocated of the annual Inferior Oolite recharge to public water supply such that the percentage allocated to the environment on average will be 61% (Figure 4-14).

Figure 4-14: Inferior Oolite aquifer resource allocation based on 1978 to 2010 and assuming 10,551 Ml/a of effective recharge

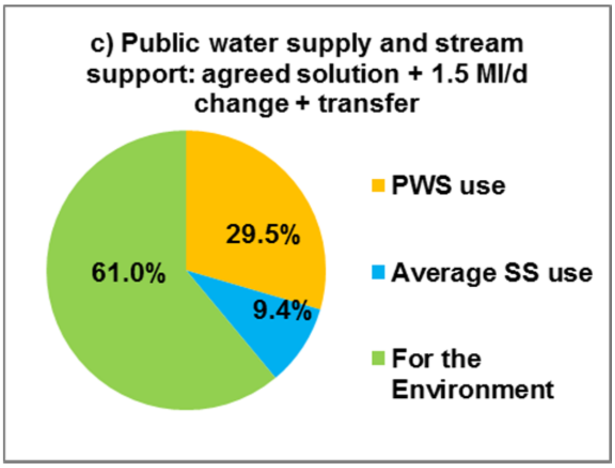


Table 4-4: Summary of options to improve Inferior Oolite aquifer water level

Option		Capital cost	Opex	Addresses Long term issue?	Addresses Short term issue?	Potential value of lost resource	Comments
1	Aquifer storage recharge – Luckington / Stanbridge – winter refilling	£1.5m	£50k	✓	×	£0m	No additional resilience Treatment may be required
2	Aquifer storage recharge – Foxley Winter refilling	£3.7m	£35k	✓	✓	£0m	Dry weather / drought resilience Has some hydrogeological uncertainty Treatment may be required
3	1.5 Ml/d Bristol Water reduction - Refurbish abandon sources to balance reduction	£8.3m	£300k	✓	×	£7.5m	No additional resilience
4	1.5 Ml/d Bristol Water reduction, Wessex Water pipeline transfer to Bristol Water.	£3.5m	£22k	✓	×	£7.5m	Limited additional resilience
5	1.5 Ml/d Bristol Water reduction, Wessex Water reduce import to Bath by 1.5 Ml/d	£0m	-	✓	×	-	Dry weather / drought resilience for Inferior Oolite water levels and increased resilience Bristol Water's public water supplies
6	1.5 Ml/d Bristol Water reduction – Wessex Water reduce Bristol Water import by 1.5 Ml/d into Bath, plus Wessex Water pipeline transfer to Bristol Water.	£3.5m	£22k	✓	✓	£7.5m	Meets objectives
7	7. 5 Ml/d Bristol Water winter reduction with Wessex Water pipeline transfer to Bristol Water – winter transfer	£ 3.7m	£26k	✓	✓	£0m	Dry weather / drought resilience for Inferior Oolite water levels and increased resilience Bristol Water's public water supplies
8	New Great Oolite public water supply borehole for winter use only	£1.3m	£50k	✓	×	-	No additional resilience Winter use potentially restricted in dry winter
9	Great Oolite used for stream support with pipeline from Rodbourne to Luckington	£6.0m	£40k	×	×	£25m	Dry weather / drought resilience for Inferior Oolite water levels. Only achieves a 0.94 Ml/d reduction in Inferior Oolite abstraction.
10	18 Ml/d Great Oolite public water supply reduction seeking to reduce stream support need by 1.5 Ml/d	£20.5m	£255k	×	×	£90m	No additional resilience. Considerable technical uncertainty, current best estimate indicates that it only achieves a 1 Ml/d reduction in Inferior Oolite abstraction.

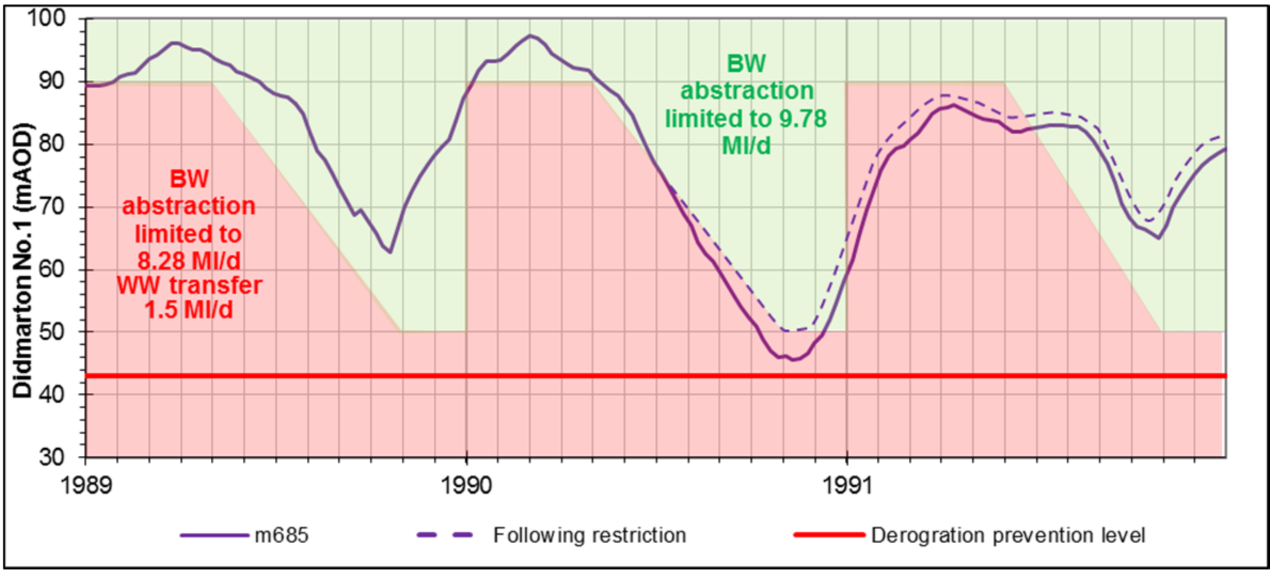
In addition, a pipeline connection between the companies would be made in the Malmesbury area to provide additional resilience (1.5 – 3.0 Ml/d transfer) to both companies' abstractions and the provision of stream support. The operation of this supply will be defined by a control curve, which will be set to maintain the Inferior Oolite water level above the derogation prevention level (i.e. address the residual long term decline)

The need for an additional element of resilience, to be provided by the pipeline, is required because of potentially differing climate regimes to those modelled, in particular if:

- The aquifer does not start full, i.e. a 1990 (Feb-Dec) type low recharge pattern does not start after a wet winter such as 1989/90.
- The climate conditions are harsher than 1990, i.e. the period of little or no recharge that is longer than occurred in 1990, possibly due to climate change.
- Modelling predictions prove to be unreliable. The model is 'good' for its type and the model has been passed as 'fit for purpose' by an independent reviewer. The model is calibrated to observed data. To date the minimum water level recorded in the Inferior Oolite aquifer at Didmarton is 49 mAOD (Figure 4-10), however, the model predicts levels declining to ~30 mAOD. Therefore some of the model's predictions are outside the calibration window. A marked deviation from the model's predictions is not expected, should the aquifer water level actually decline below 49 mAOD, but the model's predictions cannot be guaranteed.

A control curve has yet to be agreed by all parties, but a working draft is shown in 4-15 to illustrate how it is likely to operate. The curve has been set to enhance winter refilling and to ideally maintain the water level in the 'green' zone through the summer/autumn. The groundwater level (purple solid line) shown on Figure 4-15 is taken from a model run that did not account for a control curve pipeline transfer from Wessex Water to Bristol Water for the period 1989-1991,showing the predicted water level based on Bristol Water's 1.5 Ml/d reduction (licence change). The chart indicates no abstraction restriction in 1989, but during July 1990, the water level enters the red zone and Bristol Water would need to reduce abstraction, with a commensurate transfer via the pipeline. The potential benefit of this reduction is shown as a dashed line (this has not been modelled). A further reduction in Bristol Water abstraction and a pipeline transfer would be required between January and March 1990 to help refill the aquifer. The use of this pipeline therefore could occur in the winter as well as the summer. Based on the modelled water levels shown in Figure 4-13 it is likely that the pipeline will be used once in every 5 years (on average) to maintain the Inferior Oolite water level.

Figure 4-15: Inferior Oolite (Didmarton No1) control curve (draft) for Bristol Water public water supply abstraction and Wessex Water transfer



This is the lowest cost option that solves both the long term and short term issues. It does involve the loss of resource by Wessex Water both in the reduced import from into Bath and from the transfer in the Malmesbury area. However given Wessex Water's supply demand surplus and the improved reliability it provides to its resources in the Malmesbury area this is a good use of some of the surplus.

<u>Summary</u>

The application of Option 6 will ensure the use of the Inferior Oolite aquifer for public water supply and stream support is sustainable in the long term and provides resilience against climate conditions more severe than 1990 and 1975/76. It also affords resilience in the event of a supply emergency. These measures plus the other proposed licence changes i.e. for public water supply reductions and increased stream support rates, will ensure the maintenance of target river flow along the Malmesbury Avon, which supports a healthy river ecology.

4.5.3. Proposed water resource investigations for AMP6

Table 4-5 specifies the water resource investigations that the Environment Agency included in the update of the National Environment Programme (NEP) in August 2013. Following this guidance we have included these investigations in our AMP6 investment programme as part of our Business Plan for 2015-2020.

Table 4-5: Proposed AMP6 water resource investigations

River / water feature	Source(s)	Investigation driver
Mitigation option appraisals		
Sutton Bingham Stream	Sutton Bingham Reservoir	Compensation flow adjustments to trial and monitor spate flows and river restoration
Durleigh Brook	Durleigh Reservoir	
New investigations		
Ashford Reservoir, Hawkridge Reservoir and Cannington Brook	Ashford and Hawkridge Reservoirs	Water Framework Directive and Heavily Modified Water Bodies
River Piddle	Briantspuddle	Water Framework Directive – concern over the effect of abstraction – i.e. reduction in flow and impact on stream ecology
Devils Brook	Dewlish	
Lambrook	Compton Durville	
Horner Water	Nutscale	'No deterioration' and Water Framework Directive
Middle Stour	Black Lane	'No deterioration'
	Shapwick	
	Stubhampton	
Maiden Bradley Brook	Dunkerton	

We are also proposing a further investigation to undertake baseline environmental monitoring for the Drought Plan as the Environment Agency have requested this to resolve current uncertainties in the effects of the drought measures we have proposed.

We are including these investigations in our Business Plan proposal to Ofwat and, depending on the outcome of the investigation will make appropriate changes to our licences and consequently how we operate.

4.5.4. Abstraction incentive mechanism (AIM) and a proposal for Mere

Wessex Water generally has some flexibility in how it chooses to operate its sources to meet demands across its supply area. Our integrated grid project, as well as improving resilience, will increase this flexibility. A surplus of resources over demands (see Section 7) means that the scope for flexibility could extend into dry periods and not just be available under wetter conditions when resources are naturally more plentiful.

As described in earlier in this Section we have investigated the environmental impact of many of our abstractions and where it has been shown that changes are required changes have been made. However sometimes the results of the investigations are inconclusive or the impact is assessed to be small, or, despite the lack of impact as assessed on a scientific basis, there remains significant local concern about the impact of abstraction.

In these cases we believe that Ofwat's proposed Abstraction Incentive Mechanism (AIM) would have a very useful role to play[18].

Following the Itchen Initiative (2011) report by WWF the concept of an Abstraction Incentive Mechanism (AIM) has been developed. The concept is to try and gain environmental benefits from reducing abstraction without changing abstraction licences. Changing abstraction licences may result in the requirement for significant resource or infrastructure investment to maintain a balance between demand and supply either across a water resources zone or more locally around the affected sources. The costs involved in changing abstraction licences could have a significant impact on bills, and may be disproportionate compared to the environmental benefits – which in many cases are difficult to define.

Rather than formally changing licences an AIM provides an incentive for a water company to reduce its abstraction from a particular source when abstraction is most likely to have an environmental impact, but does allow a company to continue the abstraction should that be necessary due to a lack of water availability at other sources due to dry weather or outages. Although this may involve some abstraction at times when river flows are low ecological systems are usually robust enough to mitigate the impact of such temporary impacts. There are exceptions however, for instance, if the impact of abstraction were to fundamentally change the characteristics of a river from being perennial to a winterbourne. In these cases AIM is not the right solution and licence changes should be implemented as soon as practical.

The AIM principle was proposed by Ofwat in January 2013 and in their methodology two approaches were outlined based on (1) reputation incentives and (2) financial incentives. For AMP6 (2015-2020) the main approach was based on a reputational incentive. However they also requested that companies propose sites where financial incentives may be appropriate in their Business Plan submissions in December 2013. Such proposals were expected to be well designed, evidenced and stretching. We designed a proposal for the Mere source against these criteria.

Reputational AIM

The Ofwat methodology for assessing the suitability of sources for AIM links to whether the source abstracts from or affects water bodies classified as Band 1, 2 or 3 by the Water Framework Directive (WFD).

Ofwat gathered information from us on historical abstraction volumes at a number of sources to use in their assessment of the suitability of the sources to the application of a reputational (or financial) AIM. At the time of preparing our revised draft Plan their assessment was on-going and so to provide information for this WRMP we reviewed which sources it may be appropriate for a reputational AIM to be applied ourselves.

Appendix 11.7 contains a Table and Figure that summarises our assessment of the environmental status of each source – with a red, amber, green classification. There are considerable inconsistencies between the WFD bandings and our assessment of the environmental impacts. This is because the bandings are a high level risk assessment and do not take into account local knowledge, nor do they reflect the more detailed studies undertaken by the Environment Agency and Wessex Water over the last 20 years which we have incorporated into our assessment.

[18] Ofwat (January 2013). Setting price controls for 2015-20 – framework and approach. A consultation.

In identifying suitable sites for a reputational AIM we took account of four factors:

- Would there be any environmental or customer benefit in applying the AIM to a particular source?
- Is there sufficient network flexibility to allow an alternative source to be used in preference to the source to which the reputational AIM is applied?
- Does a reputational AIM conflict with any other proposed work at the source during AMP6, for instance a low flow investigation?
- Would following an AIM put at risk any statutory requirements such as abstraction licence compliance?

We considered the appropriateness of including the green, amber and red sources for a reputational AIM, as outlined below.

It is not appropriate to apply a reputational AIM to the green sources as there is not believed to be any significant environmental impact from the abstraction. There is no problem for AIM to solve.

On the face of it the amber sources might appear to be the most suitable for a reputational AIM. These are sites where there may be an environmental impact from abstraction but no other solution is in place yet. However for all of these sources a detailed investigation is proposed for AMP6 and a reputational AIM incentive would run contrary to the implementation of these investigations. This is because a key part of the investigation is to maximise, at least for a period, the output of the source to get reliable information on the impact of the abstraction on groundwater levels, river flows and the ecology. The investigation may also involve a period of minimising abstraction (to obtain contrasting information) but as this is required as part of the investigation it does not require AIM to provide an incentive to do it.

Without prejudicing these investigations AIM may be a suitable solution that is identified for some of these sites from the investigations, but for implementation late in AMP6 or in AMP7. One amber site, Mere, is identified as suitable for AIM. This is proposed for a financial incentive as described below but it would also be suitable for a reputational AIM which could run concurrently.

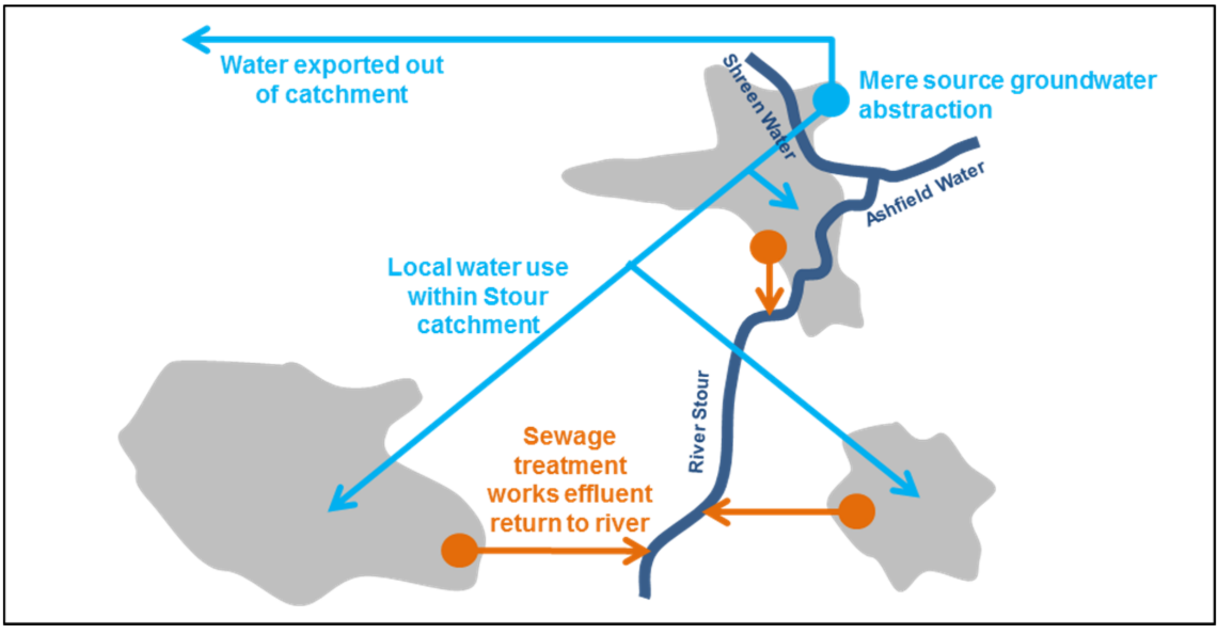
The red sites are those where abstraction licence reductions have been shown to be necessary. In all cases these changes will be implemented in 2018 following the completion of the Grid project. They are therefore not suitable for AIM in the long term because at that point the (reduced) licences will become acceptable.

<u>A trial application of AIM – Mere source</u>

The Mere source in the Stour catchment has been identified both of being at risk of causing deterioration in WFD status and being of concern to local residents. Given the circumstances outlined below it is an ideal site for a trial of the AIM approach to abstraction management.

The original settlement at Mere was located on the spring lines and water has been abstracted for a variety of uses ever since; previously for watercress farms and plant nurseries and currently for a fish farm which uses, and returns, water to the Ashfield Water. Water is also abstracted, under licence, by Wessex Water to meet demand for drinking water. The abstraction licence has been set at Mere at 9 Ml/d since 1979. This water is used to supply local homes in Mere, Gillingham and the surrounding villages and about half the water abstracted is pumped to Whitesheet service reservoir and from there it supplies communities in Yeovil. The Figure below illustrates the Mere source abstraction schematically in relation to the local watercourses.

Figure 4-16: Schematic of Mere source distribution



The effect of abstraction at our source in Mere on the Shreen and Ashfield Water was investigated as part of the Environment Agency's Restoring Sustainable Abstraction programme in 2005-08. That study concluded the effects were minor in terms of the extent of drying and on the flow in the headwater streams and, as abstraction at Mere has not changed significantly in recent years, the changes in flow of the headwater streams are due to climatic variation (rainfall). As a result of this investigation the Environment Agency concluded that no change in the abstraction licence was required. By contrast reductions were required at other sources, and in particular those in the Wylye and Bourne catchments described above.

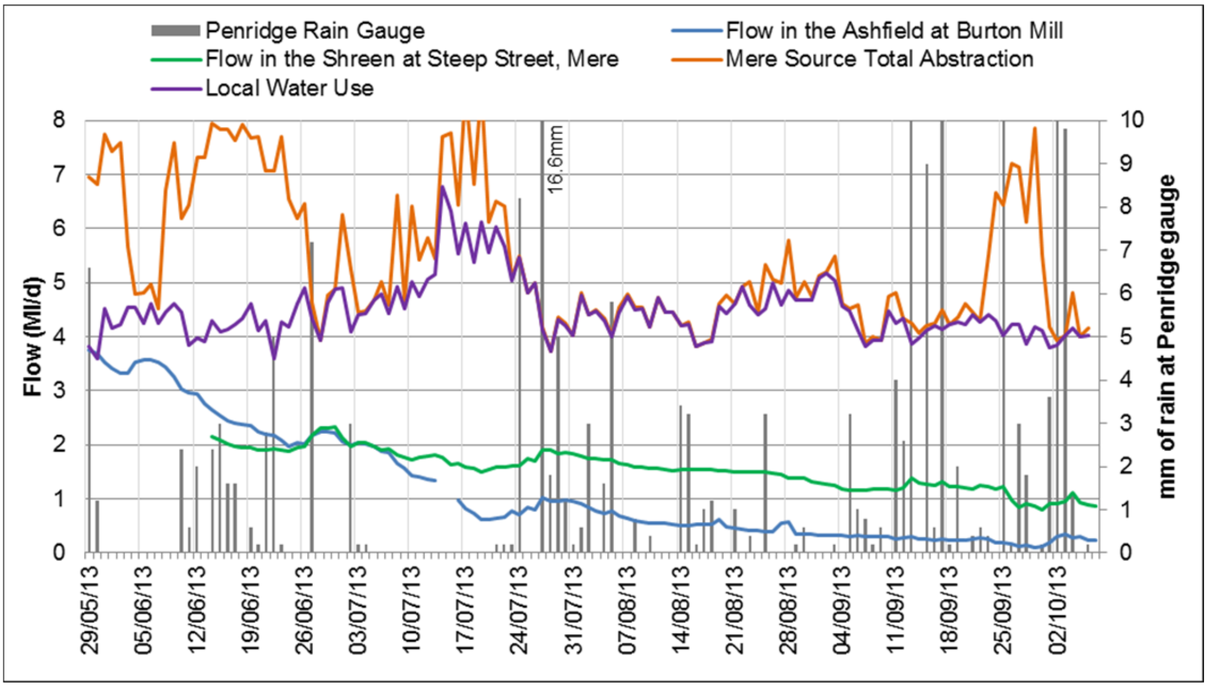
However, in the dry summer of 2011 the Shreen in the centre of Mere dried up and at a public meeting on 2 December 2011 attended by more than 120 people, Andrew Murrison MP expressed his constituents' concern over the extent of stream drying primarily in the Shreen below Steep Street, and asked what could be done to improve the flows. The Mere Rivers Group was formed and they have worked with Wessex Water to find new ways of investigating the problems in Mere to balance the need for a public water supply with maintaining good and healthy flow through the village.

The Mere Rivers Group includes representatives from Wessex Water, the local community, local councils, the Environment Agency and Wiltshire Wildlife Trust. It aims to co-ordinate measures to restore acceptable flows in each water course and communicate with the local residents. As well as working with Wessex Water it seeks to bring together riparian owners in the town to come up with a unified River Management Plan which will help improve water quality and wildlife in the Shreen and Ashfield Water.

During the summer of 2013 there was a joint trial between Wessex Water and the residents of Mere to monitor flows in the rivers in Mere. Despite the dry weather Wessex Water tried to minimise the transfer of water out of the catchment and the Mere Rivers Group members encouraged residents to help by reducing their water use. Gauges were installed on the Shreen and the Ashfield Water following consultation with local residents and other organisations.

The results of the trial so far are shown in Figure 4-17. They are consistent with the AMP4 investigations.

Figure 4-17: Results of the Mere trial 2013



In taking this issue forward there are three basic options.

- Given the results of the AMP4 studies Wessex Water could continue to abstract water at up to its licenced rate in all years. However this approach is not supported by customers in the area, and fails to recognise that there is some impact on the flow in the river, even if the impact has not been shown to be damaging.
- Reduce the licence quantity of the source. This would significantly affect Wessex Water's supply demand balance. Any licence reduction would translate directly through to a reduction in deployable output. Reducing the Mere source licence would increase abstraction during droughts and dry periods from other sources in the area that are of equal or greater environmental concern. In addition the Mere source is strategically well placed to cover short outages at a many other sources in the area. Availability of the source for periods at its full output therefore improves the resilience of supplies in this area.
- An AIM approach where the licence is retained but a financial incentive / penalty is imposed on the company if the source is used for exporting water to Yeovil at times when the impact on river flows is likely to be greatest. This approach will not affect the sources deployable output or ability to be used to cover outages but it will encourage a significant reduction in the average use of the source, for a modest increase in operational costs.

The AIM approach appears ideal for this source because:

- It recognises the locals concerns over the impact of abstraction
- The abstraction from the Mere source 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.

- The incentive will encourage Wessex Water to use other sources where the environmental impact is definitely less, for example Sutton Bingham reservoir to the south of Yeovil.
- There is no impact on the source's deployable output or contribution to resilience in the event of source outages. Thus AIM does not cause or bring forward any source, or infrastructure costs.
- It works very well with demand management and community engagement – "you do your bit, we'll do ours".
- The difference in the short run marginal costs of the sources involved is modest, about £64/Ml.

We believe this financial application of AIM meets the criteria set down by Ofwat in their methodology. These criteria were that any proposal should be – well-designed, evidenced and stretching.

The Mere proposal is well designed as it builds on the AMP4 low flow investigation allowing the incentive to be targeted when it will make the most environmental difference and when abstraction is of most concern to customers. It is an ideal site for the application of AIM as there is strong customer support for a reduction in abstraction at this location but not the evidence that a total cessation of abstraction is merited by the environmental impact. It is also applied to a part of the system where there are choices that can be made in terms of which sources, or the balance of sources, that are used to meet demand.

The proposal is well evidenced. The AMP4 study and the current trial during 2013 have given a robust understanding of the hydrology and hydrogeology and the benefits that will be gained from the application of AIM.

The proposal is stretching in that it involves reducing the export of water from the Mere source to a maximum of 100 Ml/a (when groundwater levels are low) from a previous average of 447 Ml/a.

In April 2014 Ofwat advised that during AMP6 they will not be pursuing the reputational AIM concept. However, we remain committed to the application of AIM at Mere and have included it in our Business Plan as a performance commitment.

4.5.5. Abstraction reform

Wessex Water is following the abstraction reform process closely. We have been participating in the consultation that Defra has been running in 2013 and 2014 on a number of different options as to how abstraction licences may be reformed. Defra has been very clear, and Wessex Water thinks that this is very important, that the purpose of abstraction reform is not to change (or reform) current licences where these are believed to be unacceptably impacting on abstraction. Defra's expectation is that that these will all have been dealt with by the time any new abstraction licence regime comes into place – possibly in the mid-2020s.

In its input to the abstraction reform process to date Wessex Water has made it very clear that whilst it is easy to conceptualise a more dynamic arrangement of licensing and abstraction the water company infrastructure involved in abstraction, treatment and distribution of the water is site specific, immobile and generally very inflexible. A move to a more dynamic system of licensing and abstraction is likely therefore to lead to stranded assets and the requirement for new assets – at least an equivalent rate of abstraction.

4.5.6. Water stress

The Environment Agency defines 'water stress' as the recurrent imbalance that arises from an overuse of water resources caused by consumption being significantly higher than water availability and that it is a chronic problem, different to drought which is temporary and caused by a short-term rainfall deficit. At Defra's request in 2007 the Environment Agency produced a three-tier classification of water stress in England (low, moderate and high) calculated on the basis of population density and demand on available water resources. Using this methodology the Wessex Water region was classed as in 'low water stress'. The classification was used to determine which companies were expected under the Water Industry (Prescribed Condition) Regulations 1999 (as amended) to fully evaluate compulsory metering in their options analysis for the last round of Water Resources Management Plans and Ofwat's 2009 Price Review.

In 2012 the Environment Agency reviewed their methodology for determining water stress and they published a consultation[19] on a new approach in October 2012. The proposed new approach moved the Wessex Water area into 'serious water stress' status. As a result of the consultation however the approach was amended again and the final classification[20] published in July 2013 indicated Wessex Water's level of water stress as 'not serious'.

At the time of preparing the draft Water Resources Management Plan the 2012 water stress classification (which defined the Wessex Water area as in serious stress) was technically still under consultation and so the 2007 classification of low water stress was incumbent. However, regardless of either water stress classification we appraised a compulsory metering programme (as well as appraising a change of occupier metering programme) in the development of this Water Resources Management Plan and so we are compliant with the Water Industry (Prescribed Condition) Regulations 1999 (as amended). Please see Section 8 for the metering options analysis.

[19] Environment Agency (October 2012). Improving the classification of water stressed areas, consultation document.
[20] Environment Agency (July 2013). Water stressed areas – final classification.

4.6 Water quality and catchment management

Seventy-five per cent of the water we abstract comes from groundwater sources and the majority of this is of very good quality requiring little treatment other than chlorination before being suitable for supply to customers. In recent years we have noticed deterioration in the quality of water at some sources particularly in relation to nitrate and pesticide concentrations at some sources. The Water Supply (Water Quality) Regulations 2000 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 and in 2012 we carried out over 200,000 tests on water samples to monitor the quality of water we supply to customers; our mean zonal compliance with the drinking water standards was 99.98%.

In many ways issues around raw water quality currently represent a larger challenge to Wessex Water than water resources issues.

This Plan demonstrates that we have a robust water resources position with a supply demand balance surplus throughout the planning period (Section 7). This surplus has been achieved not by developing new resources but by reducing demand – since the mid-1990s we have halved leakage, increased metering (to over 50% and therefore above the national average), and promoted water efficiency to our customers – both domestic and commercial (Section 5). As well as creating a surplus of resources we have been able to significantly reduce abstractions from water sources where there were concerns over their impact on river flows and river ecology (Section 4.5)

Our robust water resource position was demonstrated in the dry weather of 2011 and early 2012. Before the drought broke in early April our reservoirs were still 84% full. However they would have been 94% full if it were not for a water quality problem. In late January 2012 we detected high levels of the pesticide metaldehyde in one of our reservoirs – such that it could not be used for public water supply. Working with the Environment Agency we traced the pollution upstream and identified the source of the contaminant. The farmer concerned was warned by the Environment Agency about his use of metaldehyde in the future. However this still left us with a reservoir full of non-compliant water. Therefore, despite the prevailing drought conditions, it was necessary to almost empty the reservoir and let it refill with cleaner water that was now coming in from the catchment – refill occurred just before the end of the dry weather at the beginning of April.

This is one example of many sites where we are dealing with water quality issues. We have approximately 20 different sources of water at risk from high concentrations of nitrate, and about 15 sites at risk of high concentrations of pesticide. This represents a major challenge to us to ensure that we can maintain sufficient compliant water into supply.

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 seven 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 on farm information on nitrate and pesticide concentrations and providing this to farmers to help them optimise their applications. This work is showing some benefit for nitrates, but has resulted in significantly reduced pesticide levels – including metaldehyde – even despite the wet weather in 2012 when we might have expected more metaldehyde to be applied because slugs can be more of a pest in damp conditions.

Whilst this is clearly the right approach in most circumstances – and it has been strongly supported by the Government in the Water White Paper – 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.

Our 2011 report *Managing Water – Managing Land*[21] gives further details of our catchment approach. 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 2015 will be included in our next Business Plan for review with Ofwat and the Drinking Water Inspectorate.

Table 4-6: 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>6.21</td><td>12.00</td><td rowspan="4">Nitrate</td><td rowspan="8">2005</td></tr>
<tr><td>Eagle Lodge</td><td>6.99</td><td>8.20</td></tr>
<tr><td>Empool</td><td>12.47</td><td>19.10</td></tr>
<tr><td>Winterbourne Abbas</td><td>1.47</td><td>2.77</td></tr>
<tr><td>Friar Waddon</td><td>7.45</td><td>7.83</td><td rowspan="4">Pesticides</td></tr>
<tr><td>Ulwell</td><td>0.72</td><td>0.47</td></tr>
<tr><td>Sutton Bingham</td><td>5.77</td><td>18.00</td></tr>
<tr><td>Durleigh</td><td>17.38</td><td>27.00</td></tr>
<tr><td>Bulbridge</td><td>0.69</td><td>0.76</td><td rowspan="5">Nitrate</td><td rowspan="5">2010</td></tr>
<tr><td>Fonthill Bishop*</td><td>4.33</td><td>5.50</td></tr>
<tr><td>Hooke</td><td>2.48</td><td>1.61</td></tr>
<tr><td>Shapwick</td><td>3.91</td><td>5.88</td></tr>
<tr><td>Sturminster Marshall</td><td>15.91</td><td>20.00</td></tr>
<tr><td>Alton Pancras</td><td>2.44</td><td>3.42</td><td rowspan="6">Nitrate</td><td rowspan="7">2015</td></tr>
<tr><td>Belhuish</td><td>4.32</td><td>7.15</td></tr>
<tr><td>Friar Waddon</td><td>7.45</td><td>7.83</td></tr>
<tr><td>Milborne St Andrew</td><td>4.42</td><td>6.74</td></tr>
<tr><td>Sutton Poyntz</td><td>8.60</td><td>5.79</td></tr>
<tr><td>Forston</td><td>2.99</td><td>2.01</td></tr>
<tr><td>Ashford</td><td>6.53</td><td>14.00</td><td>Pesticides</td></tr>
</table>

*Deployable outputs for Fonthill Bishop presented in this table are net of the 1.5 Ml/d 'likely' sustainability reduction; current licence is 7.0 Ml/d.

[21] Wessex Water (April 2011). *Catchment management, managing water – managing land.*

The description above of our catchment management approach indicates that our supply forecast needs to take into account of 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 levels of nitrate and so this constraint was built in to the Miser model deployable output run – this can be seen in the graphs presented in Appendix 11.4.
- Outage allowance – historical data on water quality related outages are used to derive an appropriate allowance for future outages – see Section 4.12 for details.
- 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.

4.7 Bulk supply imports and exports

Our water supply system is not entirely isolated from the supply networks owned and 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.

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.

Table 4-7: 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
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
Sembcorp Bournemouth Water	Stubhampton	1.27	1.27
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 in 2015/16.

Table 4-8: 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. 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.

With the exception of the expected change to the Bristol Water to Bath transfer, the values reported in Tables 4-7 and 4-8 are the same as we reported in our last Water Resources Management Plan. It is assumed that these will be available at current agreed average and peak rates throughout the planning period. 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 (2013).

The volumes stated are within the existing physical and operational transfer capacities.

We have recently negotiated a bi-directional 'resilience transfer' with Sembcorp 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. It does not therefore appear in the tables above.

In accordance with the Water Resources Planning Guidelines we published an indicative supply demand balance position in October 2012 – this made neighbouring companies aware of our forecast surplus (Section 7) and therefore the potential for us to provide new bulk supply exports to companies in supply demand deficit or for resilience (see Section 2.1.2). Particular discussions regarding new transfers have taken place with Bristol Water, Thames Water and Cholderton Water.

At the time of publishing this final Water Resources Management Plan no new or varied bulk supply agreements have been confirmed with other companies although some discussions remain underway and we are expecting that discussions with Bristol Water confirming the expected reduction in the Bath import will be concluded soon. The sensitivity of our supply demand balance to possible new bulk supply exports to Bristol Water and Thames Water are examined in Section 9.

4.8 Source infrastructure constraints and decommissioning

4.8.1. 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, relift pumps, transmission mains and treatment works are specified to ensure that these constraints are accounted for in all model runs.

4.8.2. Source mothballing and decommissioning

We currently operate and maintain over 100 sources and in the development of this Plan have identified the opportunity to rationalise some of these assets to improve efficiency. We propose to decommission or mothball the sources listed in the table below.

Table 4-9: Sources to be mothballed or decommissioned

Source	Average DO† (Ml/d)	Peak DO† (Ml/d)	Design capacity (Ml/d)	Assumption and comment*
Nutscale	3.33	3.50	3.50	Mothball – keep licence; 6 properties to continue to be fed off the raw water main with point of use treatment.
Blashford	12.3	22.5	22.5	Mothball – retain assets and keep licence but keep out of service. Not used into supply since 2008 due to lack of demand and difficulty treating algal by-products.
Bossington	0.20	0.80	0.80	Decommission – permanent cessation of use and revoke licence. Not used into supply since 2003 due to lack of demand and not compliant with disinfection policy.
Langdon	0.15	0.60	1.27	Decommission – permanent cessation of use and revoke licence. Not used into supply since 2004 due to cryptosporidium risk, high levels of nitrate and low summer yield.
Moorbrake	0.14	0.09	0.60	Decommission – permanent cessation of use and revoke licence. Not used into supply since 2003 due to very low output and non-compliance with disinfection policy.
Widdenham	0.42	0.44	2.00	Decommission – permanent cessation of use and revoke licence. Not used into supply since 2006 due to cryptosporidium risk and low summer yield.
Woolcombe	0.45	0.85	2.00	Decommission – permanent cessation of use and revoke licence. Not used into supply since 2000 due to cryptosporidium risk and low summer yield.
Total	**16.99**	**28.78**	**32.67**	**-**

† 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

Of the sources listed in the table above, mothballing Blashford will result in the biggest change to our overall deployable output documented in our last Water Resources Management Plan. In place of this resource we are developing a bi-directional potable water resilience supply with Sembcorp Bournemouth Water. Whilst this will not have a reliable drought yield (and so it is not listed as an import or export in Table WRP1) it will provide a contingency supply for both companies.

4.9 *Miser modelling to derive deployable outputs*

4.9.1. Background to Miser

Wessex Water has 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. Appendix 11.6 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:

- demand is distributed at District Metered Area (DMA) level. We have 658 DMAs and the average demand in each DMA is just over 0.5 Ml/d. In effect the Miser model gives a supply demand balance calculation at DMA level
- infrastructure limitations
- 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.

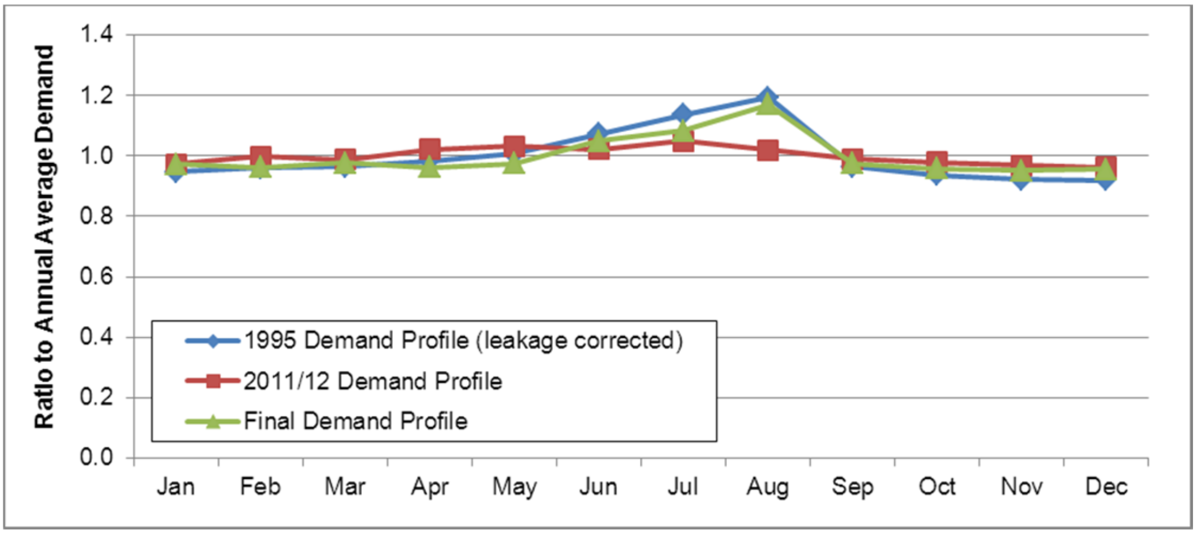
4.9.2. Application of demand forecasts to Miser model

The demand forecasts outlined in Section 5 are applied to the Miser model for the purposes of deployable output modelling. To allocate the regional (single resource zone level) demand forecast appropriately to the 658 demand nodes (DMAs) in the model an Excel based allocation model was developed to apportion the resource zone annual average demand to each node and to profile the demand through the year to account for higher demands in the summer relative to the winter. The model is used in the following way:

1. Dry year annual average and dry year critical period (peak week) forecast demand at a regional (single resource zone) level (see Section 5) is input to the model.
2. Each of the demand nodes in the model is ‘tagged’ to its Water into Supply (WIS) zones which will be used to define the profile of its demand through the year.
3. A monthly demand profile is calculated for each of the 33 WIS zones. The WIS zone demand profiles are based on the actual 2011/12 (base year) WIS zone profiles and the

regional 1995 demand profile (corrected for the change in leakage since 1995), derived according to Equation 1. The final profile is presented in Figure 4-18:

Figure 4-18: Base year, 1995 and forecasted demand profiles



Equation 1: Monthly Demand Profile Derivation

$$D[x, y_n] = D_{2012}[x, y_n] \cdot \frac{f_{1995}[Az, y_n]}{f_{2012}[Az, y_n]}$$

Where:

$D_{2012}[x, y_n]$ = Actual demand in WIS zone x in month y_n

$f_{1995}[Az, y_n]$ = Normalised demand profile for 1995 across all WIS Zones (A_z) in month y_n

$f_{2012}[Az, y_n]$ = Normalised demand profile for 2012 across all WIS Zones (A_z) in month y_n

$D[x, y_n]$ = Profiled demand in WIS zone x in month y_n

4. The forecast annual average and peak week demands (set in step 1) are then applied according to Equations 2 to 4. Note that forecasted demands for June and July (Equation 3) are reduced downwards by 0.33 and 0.66 respectively to compensate for the increase in August which is applied to simulate the peak week condition.

Equation 2: Predicted monthly WIS demand factored according to the regional annual average forecast (applied to all months except June – August)

$$Dp[x, y_n] = D[x, y_n] \cdot AAF$$

Equation 3: Predicted monthly WIS demand for June and July factored against to the regional annual average forecast and adjusted to compensate for the peak demands in August.

$$Dp[x, y_6] = D[x, y_6] \cdot AAF \cdot 0.33(D[x, y_8] \cdot CPF)$$

or

$$Dp[x, y_7] = D[x, y_7] \cdot AAF \cdot 0.66(D[x, y_8] \cdot CPF)$$

Equation 4*: Predicted monthly WIS demand for August factored against to the regional peak month forecast*

$$Dp[x, y_7] = D[x, y_8] \cdot CPF$$

Where
AAF = Forecasted annual average demand correction factor
CPF = Forecasted peak week demand correction factor

5. The predicted WIS zone demand is then apportioned to each DMA according to the observed proportioning of demands at WIS and DMA level from 2011/12.

This process is consistent with recommendations in UKWIR 2012 (WR27)[22].

4.9.3. Deployable output modelling assumptions, review and adjustments

Average and peak deployable outputs for each source were 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)
- Demand scenario as per the dry year annual average and critical period demand forecasts plus 10% global demand uplift factor – as described in Section 4.7.2.

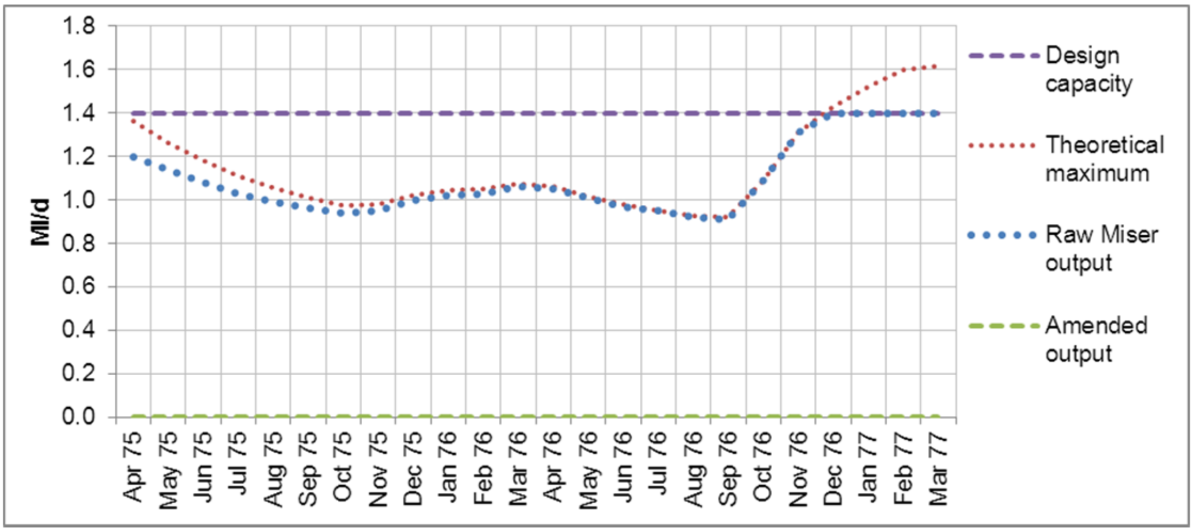
Peak deployable output for each source is defined by the output in August 1976. Average deployable output for each source is defined by the average output over the full 24-month optimisation period.

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 Cherhill 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; 46 of our sources (53%) are of this nature.

[22] UKWIR (2012). Water Resources Planning Tools 2012 – deployable output report.

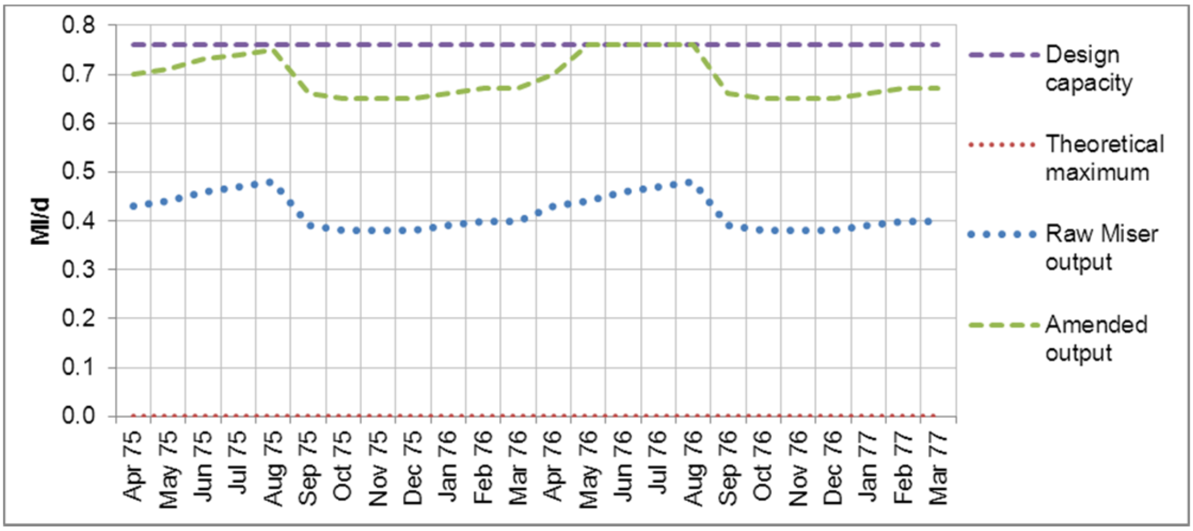
Figure 4-19: Cherhill source outputs from the deployable output Miser run



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 that has been 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.

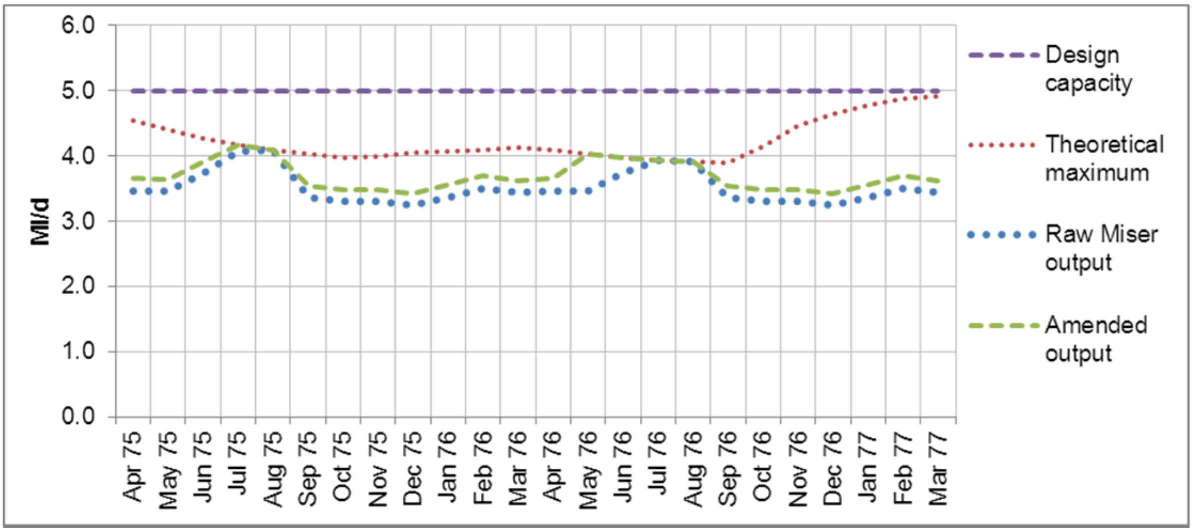
Figure 4-20 illustrates the monthly raw Miser outputs for Bulbridge source which is constrained by its licence and infrastructure design capacity and not hydrology. It shows that the source is not 'maximised' by the model run and so an amendment is made to uplift the outputs during the critical period (May-August 1976) to reflect design capacity. It is important that the average deployable output calculated for the source takes into account the annual demand profile. Therefore it would not be appropriate to uplift the output of every month to the design capacity. Instead the remaining 20 months are adjusted by the average uplift during the 4-month critical period factored by the proportion of the annual demand expected to occur during those months (i.e. divided by 1.1). The resulting profile of amended source outputs used to calculate average deployable output for Bulbridge source is shown below.

Figure 4-20: Bulbridge 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 4.21 below

Figure 4-21: Dunkerton source outputs from Miser and the amended values used for defining deployable output

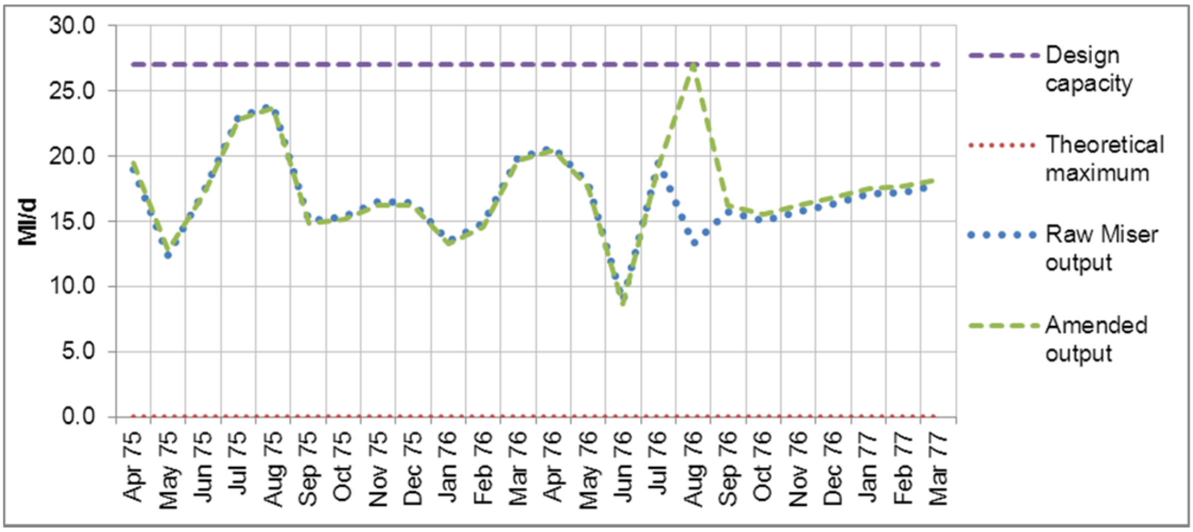


37 of our sources (43%) require post-modelling adjustments of this nature to define their deployable output values.

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) and then to make a downward adjustment 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[23]) 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 4.22 presents the adjustments of this type that have been made to Durleigh reservoir.

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

Figure 4-22: Durleigh source outputs from Miser and the amended values used for defining deployable output



Appendix 11.4 contains a graph for every source and a summary table illustrating the amendments made to the raw Miser outputs to derive deployable output.

4.9.4. Baseline deployable output

Following the review and adjustment of the Miser outputs as described above overall regional deployable output can be summarised as in Table 4-10 below.

Table 4-10: Planned level of service baseline deployable output with and without sustainability reductions

Scenario		Deployable output
Dry year annual average	Without sustainability reductions	426.48 Ml/d
	With sustainability reductions	404.27 Ml/d
Peak week critical period	Without sustainability reductions	514.34 Ml/d
	With sustainability reductions	488.34 Ml/d

NB - Sustainability reductions include AMP4 confirmed and likely AMP5 reductions

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

In accordance with the recommendations of WR27 the deployable output assessment for our sources is given a confidence rating of AA. We have good availability of consistent information relating to source constraints (therefore ‘A’ for Availability) and while our modelling examines the 1975/76 drought in the greatest detail we have set our assessment in the context of the longer time series of data extending back to at least 1900 (therefore ‘A’ for length of data).

Deployable output for our last Water Resources Management Plan was 439 and 556 Ml/d for the average and peak scenarios respectively. The reductions in deployable output are a result of the sustainability licence reductions for low flows (see 4.3.1), source decommissioning (see 4.6) and minor changes to the hydrologically constrained sources as a result of the new analysis (see 4.1).

4.10 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[24]). As stated in Section 3.4 our planned level of service is to meet unrestricted customer demands in the repeat of the conditions experienced in 1975/76 which we equate to a frequency of restrictions once every 30 years.

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.

If our level of service was changed so that customers expected to experience restrictions more or less frequently the deployable output of our supply system would be changed too.

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
- No restrictions
- Reference scenario levels of service

Table 4-11 summarises deployable output under the alternative level of service scenarios, the derivation of these values is explained below.

Table 4-11: Deployable output under different levels of service scenarios

Scenario	Dry year annual average deployable output
Planned level of service	404.27 Ml/d
No restrictions	404.07 Ml/d
Reference level of service	418.65 Ml/d

<u>Planned level of service</u>

Wessex Water's planned level of service is that we will meet unrestricted demand in a repeat of the conditions experienced during the drought of 1975/76 meaning that if conditions were more severe restrictions may be required. Analysis of historical records (see Section 4.1) suggests that a drought of this magnitude occurs approximately once every 30 years and so we equate this to a level of service of once every 30 years. This planned level of service is unchanged since our last Water Resources Management Plan (2010) and is consistent with our Drought Plan (2013).

<u>No restrictions</u>

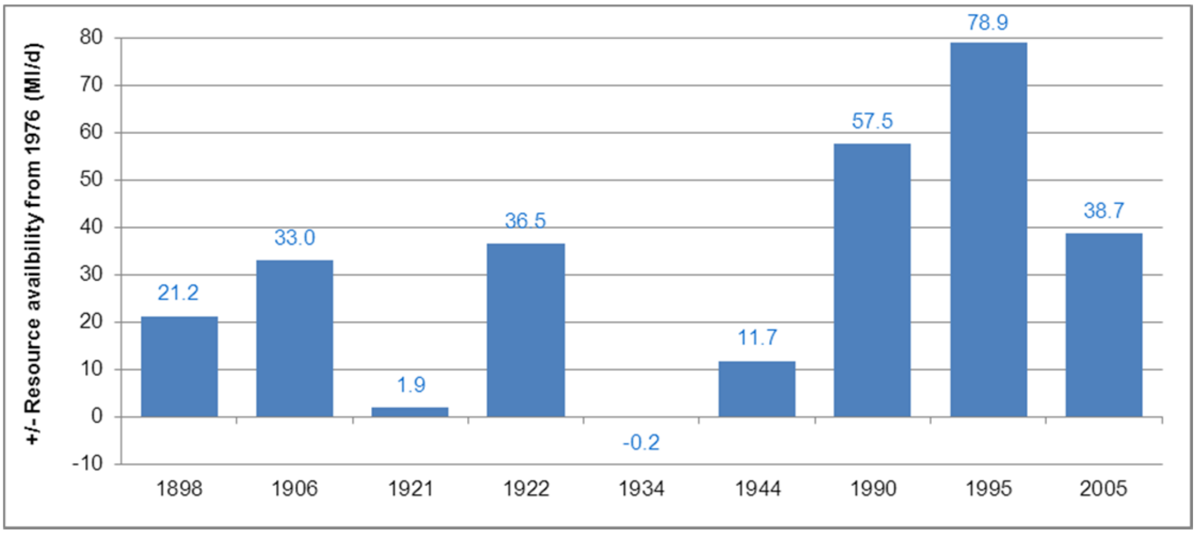
A scenario of no restrictions would mean that we could meet unrestricted demands in all historical droughts. In order to achieve this increased level of service we would need to operate our supply system differently than we do today, for example manage our reservoir levels so that they were drawn down less thus preserving more storage meaning that the

[24] UKWIR (2012). *Water Resources Planning Tools 2012 – Deployable Output Report (WR27).*

deployable output of our supply system would be reduced. This could have the effect of bringing forward investment to maintain a balance between supply and demand over the planning period.

To assess the deployable output of a no restrictions scenario we have updated the analysis of historical groundwater sequences and reservoir inflows described in Section 4.1 with the revised groundwater and source output relationships described in Section 4.2. This has enabled us to make estimates of available yields in the key droughts since the 1890s. If we were to meet unrestricted demands in all of these years, and not just for a repeat of 1975/76, then this would reduce demand by the difference between the yield in 1975/76 and the yield in the drought with the lowest resource availability calculated on a like for like basis. Figure 4-23 shows that resource availability in 1934 was 0.2 Ml/d less than in 1976, giving a deployable output for a no restrictions scenario of 404.07 Ml/d.

Figure 4-23: Resource availability in key drought years since the 1890s relative to 1976



<u>Reference level of service</u>

The reference level of service specified in the Water Resources Planning Guidelines requires an assessment of a scenario in which a Temporary Use Ban (hosepipe ban) is imposed once every 10 years and a non-essential use ban, requiring a drought order, once every 40 years.

The reference level of service would therefore result in imposing restrictions more frequently than our current planned level of service. This would mean that we could meet a higher level of demand on average, because in the drier years demand would be managed down by the impact of restrictions.

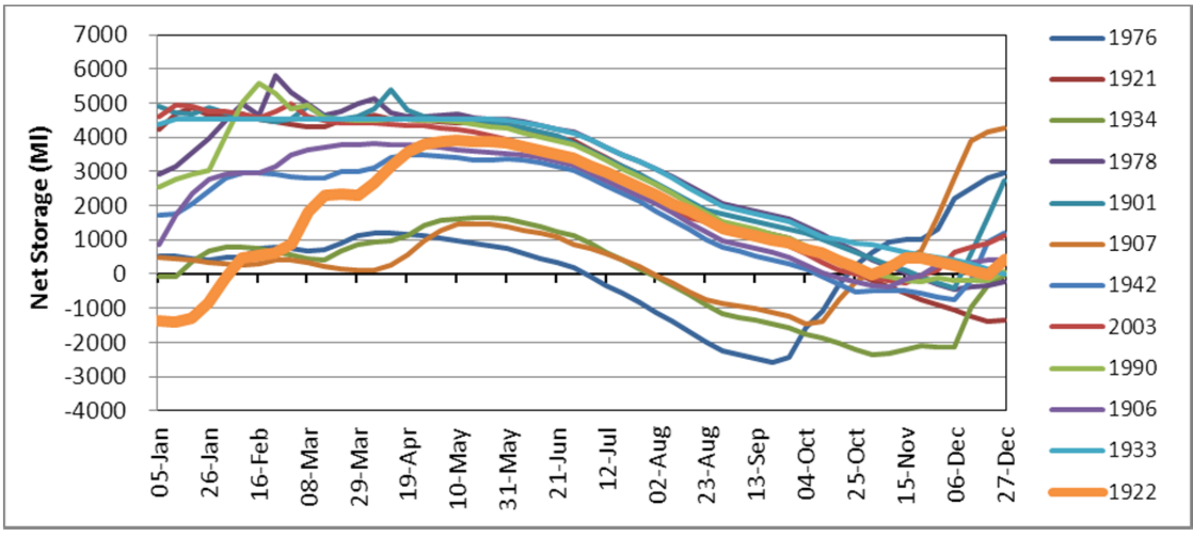
To assess the impact on deployable output of reducing our level of service to customers to the reference level we:

- Determined what would be the average output that could be supplied if restrictions were triggered with a frequency of once every 10 years.
- Reviewed the benefit of restrictions and other measures in a drought to ensure that they would be able to balance the impact of the higher source outputs in the years that are more severe than 1 in 10. This is necessary to ensure that the water supply system does not entirely run out of water in these circumstances.

To define the yield for the 1 in 10 drought we have taken the same approach as applied for the planned level of service but this time the system just meets unrestricted demand under the 1 in 10 drought conditions. Reservoirs are simulated to just reach their emergency (net) storage levels at the end of the drought period and groundwater outputs are maximised.

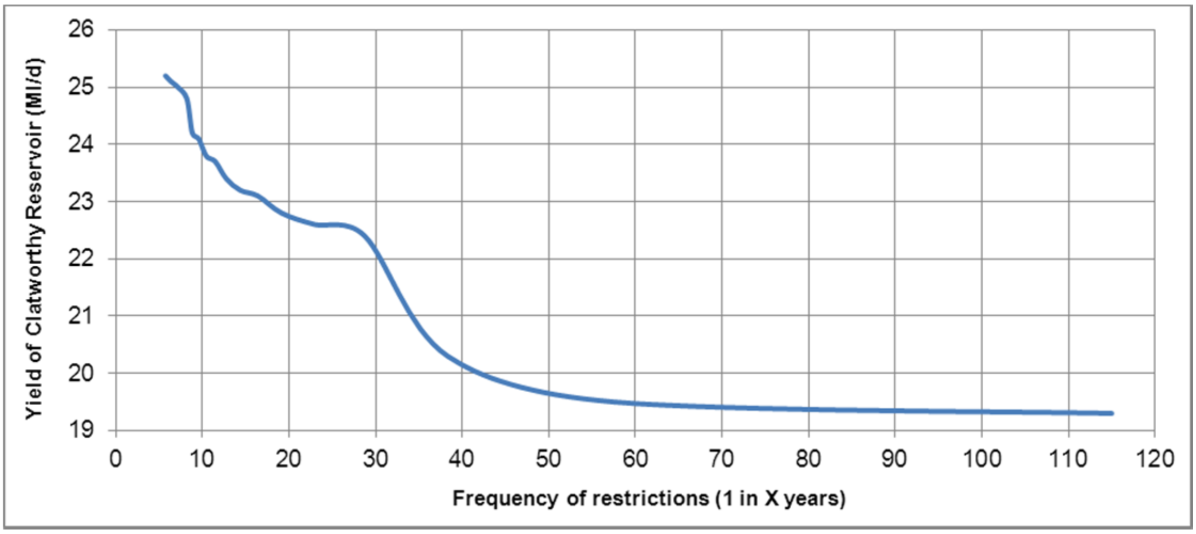
We have determined which year from the historical record best represents the 1 in 10 drought by analysing the long term simulation of the behaviour of Clatworthy Reservoir. The model steadily increases demand on the reservoir until, in 12 of the 115 years of the period of record, the reservoir level was simulated to reach or go below the emergency (net) storage level. This identified 1922 as the 1 in 10 drought as illustrated in Figure 4-24.

Figure 4-24: Net storage in Clatworthy Reservoir simulated so that demands could be just met in a 1 in 10 drought (1922)



Taking this approach it is possible to draw a graph that relates the yield of Clatworthy Reservoir to levels of service. Figure 4-25 shows how as the frequency of restrictions is increased (i.e. lower x-axis value) the yield increases.

Figure 4-25: Relationship between levels of service and the yield of Clatworthy Reservoir



The majority (75%) of our water supplies are from groundwater sources and so we have also examined modelled groundwater levels in key drought years, including 1922 (to represent the conditions with a 1 in 10 year frequency). Figures 4-26 and 4-27 show average monthly modelled levels for Woodyates and Ashton Farm that were developed as part of the extended historical sequence project in 2009[25].

Figure 4-26: Average monthly modelled groundwater levels for Woodyates in key drought years

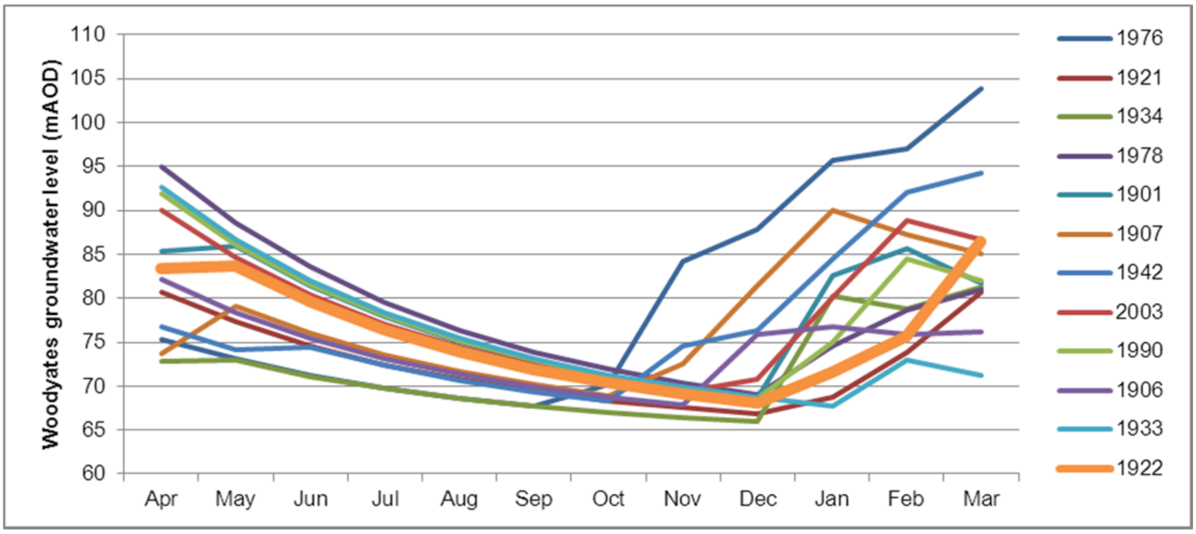
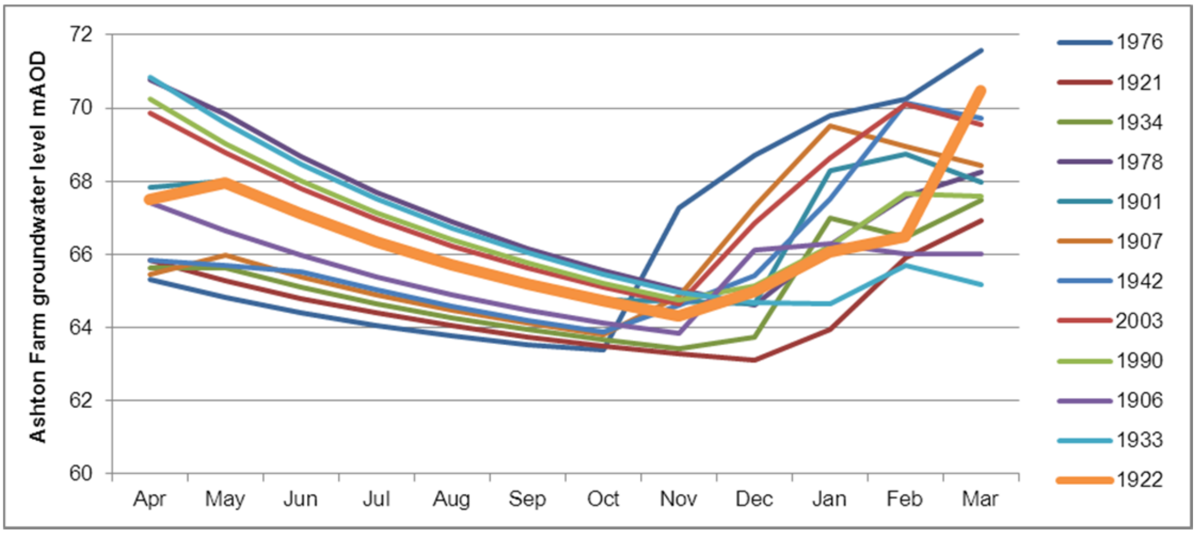


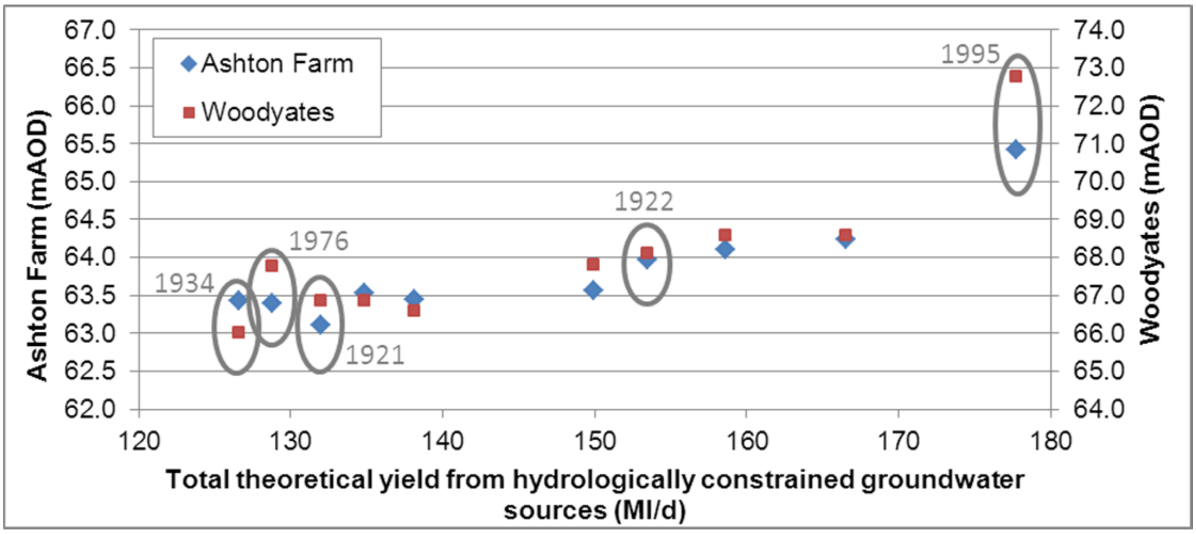
Figure 4-27: Average monthly modelled groundwater levels for Ashton Farm in key drought years



Using the mathematical relationships between groundwater levels and source outputs we described in Section 4.2 we have been able to test the sensitivity of the theoretical yields from our hydrologically constrained groundwater sources in these droughts. Figure 4-28 shows that the lowest yield from groundwater sources occurred for 1934.

[25] Mott MacDonald (March 2009). Water resources models data series extension report.

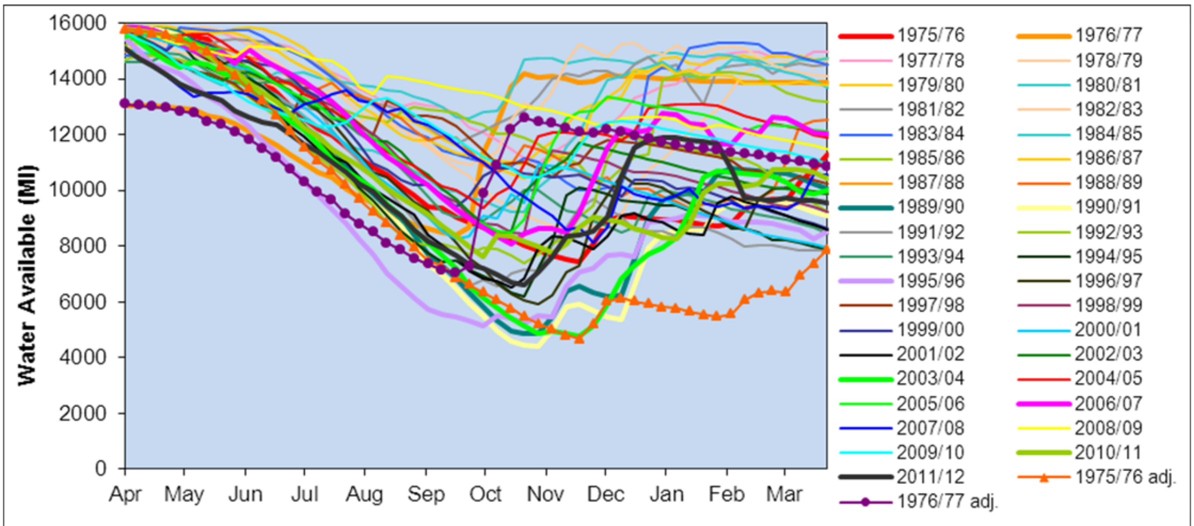
Figure 4-28: Relationship between minimum groundwater levels and total theoretical yields



It is however necessary to consider the impact of a reduced standard of service on the whole of our system and not just Clatworthy Reservoir or groundwater sources in isolation. Figure 4-23 (see also Section 4.1) indicates that that if our water resource system were just to fail in a repeat of the conditions experienced in 1922 (the 1 in 10 dry year) the available deployable output would be 36.5 Ml/d greater than in a repeat of the 1975/76 drought (also with unrestricted demands). Therefore an initial conclusion is that for the reference level of service the deployable output would be 440.77 Ml/d (baseline plus 36.5 Ml/d).

In this analysis it is important to verify that in the years that are more severe than the 1 in 10 event it would be possible to maintain robust supplies with restrictions and other drought measures in place. In our Drought Plan (2013) we estimate that the demand savings that would be obtained from implementing customer restrictions would be 8.5 Ml/d across our region. Figure 4-29 below, reproduced from our Drought Plan, shows that resource availability starts to reduce around the same time each year in the late spring. Assuming that restrictions are triggered in May and are effective through to September then they would have an annual average equivalent effect of 3.5 Ml/d.

Figure 4-29: Resource availability since 1975 (see Drought Plan for further explanation)



In our Drought Plan we did not identify any specific additional benefit from a non-essential use ban. Under the reference level of service scenario it is likely that other measures in our

Drought Plan would be triggered including drought permits affecting Clatworthy Reservoir compensation flow and pumping from the River Yeo to Sutton Bingham Reservoir. These would increase available output by up to a further 4.38 Ml/d. In addition, in these circumstances, we would be making use of our drought emergency source near Bath which has an output of up to 6.5 Ml/d. Therefore, in total, the drought measures available to mitigate the impact of increased demand under worse than 1 in 10 conditions is 14.38 Ml/d.

This is less than the difference between the source outputs available under 1922 conditions (the 1 in 10 year) and under the 1975/76 drought. Therefore to ensure that reliable supplies can be maintained under at least 1975/76 conditions it is necessary to cap the increase in deployable output for the reference level of service to the planned level of service deployable output plus the benefit achieved from imposing restrictions and the other drought measures. This results in a reference level of service deployable output of 418.65 Ml/d (baseline plus 14.38 Ml/d).

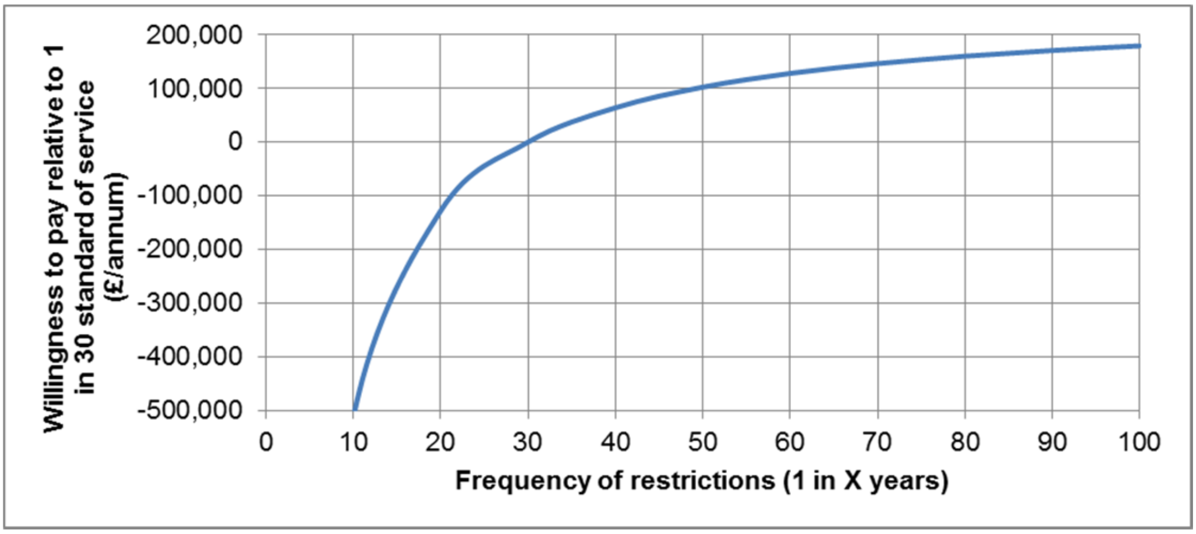
Wessex Water does not plan against the reference level of service because this involves deploying the main drought measures available in meeting demand in a dry year with a frequency of 1 in 10 years, and leaves no acceptable options in reserve should conditions be worse than 1975/76. The need for potentially unacceptable drought orders, both on supply and demand, would therefore become the first line of defence should conditions be worse than planned.

4.10.1. Customer views on level of service

Wessex Water has provided an unrestricted supply of water to our customers for over thirty-five years. We have recently undertaken research to identify customer preferences (i.e. their willingness to pay for alternative measures and standards of services) to understand, in quantifiable terms, how much this reliability of supply is valued. The research was undertaken by Ipsos-NERA and their report is available as a technical appendix[26] to this Plan. The results indicate that, compared to the reference (1 in 10) scenario, customers give a value of £0.5m per annum to the current planned level of service (1 in 30) provided by Wessex Water, but would only be prepared to pay an additional £1m per annum to reach a level of service that avoided restrictions altogether (1 in 100 for example) – this is illustrated by Figure 4-30.

[26] NERA and Ipsos Mori (March 2013). Customer preferences for services and Price for PR14 and WRMP14 – prepared for Wessex Water.

Figure 4-30: Customer preferences on levels of service shown as relationship between willingness to pay for alternative levels of service relative to current level of service



Given the surplus of resources over demands (see Section 7) changing the level of service has not been considered as a supply demand option in this Plan.

4.11 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 climate change in our long term planning. Specific risks to our business and our adaptation, mitigation and management strategies were outlined in our report to Defra under the Climate Change Adaptation Reporting Duty[27]. 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 5.6.6 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 the future climate in south-west England is likely to be characterised by wetter winters and drier summers although changes to mean annual rainfall will be less marked (see Table 4-12 below).

Table 4-12: Overview of UKCP09 projections relative to the 1961-1990 baseline period. Source: Wessex Water (January 2011)

Climate factor/indicator	2020s	2050s	2080s*
Annual mean precipitation	0 to +10%	-10 to +10%	0 to +10%
Summer (Jun-Aug) precipitation	0 to -10%	-10% to -30%	- 10% to -40%[a] - 20% to – 50%[b]
Winter (Dec-Feb) precipitation	0 to +10%	+10 to +20%	+20% to +30%[c] +10% to + 20%[d]
Spring and autumn precipitation	0ºc to +10%	0ºc to +10%	0ºc to +10%
Annual average temperature	+1ºc to +2 ºc	+2ºc to +3 ºc	+2ºc to +5ºc
Summer mean temperature	+1ºc to +2 ºc	+2ºc to +4 ºc	+3ºc to +6ºc
Summer mean maximum temperature	+2ºc to +3 ºc	+3ºc to +5ºc	+3ºc to +7ºc
Warmest day of summer	0ºc to +2 ºc	+2ºc to +4ºc	+2ºc to +6 ºc

[a] variation depends on the emissions scenario used (i.e. higher variation under high emissions scenario); [b, d] driest part of the region, range reflects different emissions scenarios; [c] wettest part of the region.

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'[28]. The approach involved a vulnerability assessment (to determine the type of analysis required in the more detailed analysis) followed by a four-stage analysis approach:

[27] Wessex Water (January 2011). *Wessex Water's report to Defra under the Climate Change Adaptation Reporting Duty.*

[28] Environment Agency (2012). *Climate change approaches in water supply planning – overview of new methods.*

- Stage 1 – assess the impact of climate change on groundwater levels and river flows (for the 2030s)
- Stage 2 – assess the impact of different groundwater levels and river flows on source deployable outputs
- Stage 3 – scale the impact determined for the 2030s through the planning period
- Stage 4 – determine the uncertainty associated with climate change and include in the headroom analysis.

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

4.11.1. Vulnerability assessment of the impacts of climate change

As stated in the Water Resources Planning Guideline 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 4-31 and this information was discussed with the Environment Agency and Ofwat during the pre-consultation period.

Table 4-13: Climate change vulnerability assessment

Assessment criteria	Comments	Information source
Critical drought years	1975/76, 1920/21, 1933/34, 1943/44 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. Analysis has shown that in the approximately 120 years of record since the 1890s there have been five drought events of similar magnitude, extent and duration to the drought of 1975/76. This suggests a 1 in 23 year return period. The level of service used in previous Water Resource Management Plans is to maintain unrestricted supplies in a repeat of the 1975/76 drought which we have tended to quote as a 1 in 30 year level of service for customer restrictions.	Same references as above plus: Final Water Resources Management Plan, Wessex Water, June 2010.

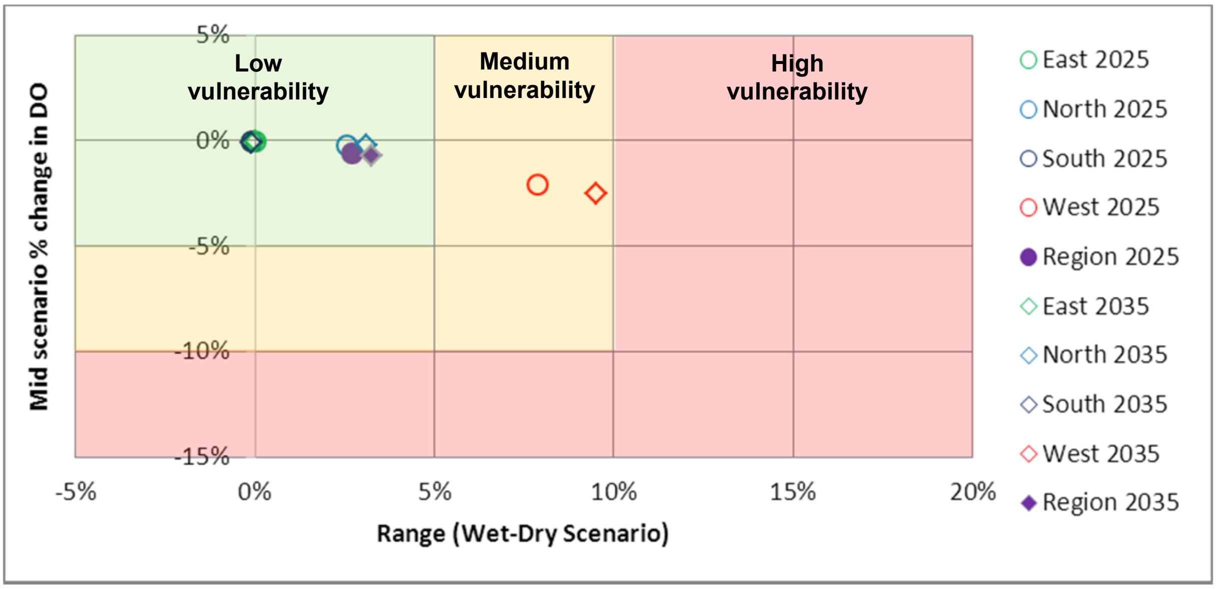
Assessment criteria	Comments	Information source
Sources	We have over 100 sources. Approximately 75% of the water we supply comes from groundwater and 25% comes from surface water reservoirs. We also have some key imports of water from neighbouring companies which account for *c*.2% of our distribution input. The development of our integrated grid during AMP5 and AMP6 will connect 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). Resource zone integrity assessment – see Chapter 3.
Supply-demand balance in the base year	The annual review of the Water Resource Management Plan for 2011/12 (the base year) indicated a satisfactory resource position throughout the year. The security of supply index (SOSI) calculation reported in table 10A of the Regulatory Report 2012 was 100%. The surpluses for the reporting year 2011/12 (the base year) were 58 Ml/d on average and 68 for the critical period.	Annual review of the Water Resource Management Plan 2012 Table 10A Regulatory Return 2012.
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. This was confirmed in October 2012 when we published our indicative supply demand balance and a view our 'need' and 'availability' for new bulk supplies with neighbouring companies.	Section 2.1.2 of this Plan
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.	Drought Plan (Final, January 2013) Wessex Water's report to Defra under the Climate Change adaptation reporting duty. January 2011.

Assessment criteria	Comments	Information source
Climate change deployable outputs (dry, mid, wet scenarios from 2009 water resources management plan's)	Our previous Water Resources Management Plan analysed groundwater level sequences using method 2B whereby factors were used to perturb rainfall and potential evaporation sequences in single point groundwater models. Reservoir inflow and other river flow sequences were analysed using method 1B whereby flow factors were used to perturb flow sequences directly (with the exception of the Currypool flow sequence which was one of the catchments that was modelled by the UKWIR project and so method 1A was used).	Water Resources Management Plan 2009, Appendix 2B, The effect of climate change on inflows and groundwater recharge.
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. At the time of our last source yield review for PR09 approximately half of our sources were judged to be hydrologically constrained making them particularly susceptible to the impacts of climate change. Appendix 7.4 of our Drought Plan (2011) 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 7.4 of Drought Plan – Drought Permit Option Screening.
Sensitivity (Low medium or high)	Sources in the south of our area (formerly our south resource zone) 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 and demonstrate greater variability in the impact on deployable output of scenarios explored for PR09.	
Vulnerability classification	The magnitude versus sensitivity plot (see Figure 4-31) suggests **our single resource zone (region) is of low vulnerability to climate change.** At PR09 we had four water resource zones and of these only the west zone (where the majority of our surface water reservoirs are located) indicates a medium risk; north, south and east all indicate low risk.	Water Resources Management Plan 2009, Appendix 2B, The effect of climate change on inflows and groundwater recharge.

Assessment criteria	Comments	Information source
Identify overall vulnerability and proposed climate change assessment approach	The decision tree in the Water Resources Planning Guidelines (p. 52) states that low and low-medium risk zones can be assessed using approaches 1.1, 1.2, 1.3 or 1.4. A review of these approaches in the context of the available models and data available to use led us to propose using: • 1.3 to perturb groundwater sequences using rainfall and potential evaporation for the 2030s from the 11 climate models. • 1.4 to perturb river flow sequences and reservoir inflows using monthly flow factors for the 2030s from the 11 climate models	N/A

Figure 4-31 below shows the magnitude-sensitivity plot of information from our previous Water Resources Management Plan – the change in deployable output for the 'mid' scenario is plotted against the uncertainty as represented by the range of change in deployable output (the difference between the 'wet' and 'dry' scenarios). At the time of our last Water Resources Management Plan we undertook the analysis for four resource zones and so each of these are shown although it should be noted that for this Plan we are undertaking all of our assessments at a single (regional) resource zone level (see Section 3.2). The figure shows that the impact of the 'mid' climate change scenario on deployable output was low (<3% by 2025 and 2035) in all resource zones. It also shows that the uncertainty associated with this projection was less than 5% for all zones with the exception of our west resource zone where the uncertainty was higher, but still less than 10%. The plot indicates that while the west zone (where our surface water reservoirs are primarily located) is classed as medium vulnerability the other three resource zones and the region as a whole fall into the low vulnerability to climate change category.

Figure 4-31: Magnitude-sensitivity plot of deployable output to climate change



As outlined in Table 4-13 and in Figure 4-31 the conclusion of our vulnerability assessment is that the Wessex Water region is at low risk from climate change.

In accordance with the 'decision tree' in the Water Resource Planning Guidelines a low vulnerability classifaction identifies four potential methodological aproaches to the next stage of the climate change assessment process – approaches 1.1, 1.2, 1.3 and 1.4.

Approaches 1.1 and 1.2 use the 20 sets of climate change and flow factors for the 2020s that were developed by the 2009 UKWIR[29] study; the Water Resources Planning Guidelines (October 2012) specifies that these factors are being updated for the 2030s and that they would be available for use by water companies in November 2012. The factors were sampled from the full set of UKCP09 climate projections using Latin Hypercube sampling methods for 70 river basins across the UK.

Approches 1.3 and 1.4 use the 11 sets of climate and flow data from the 2011 collaborative[30] *Future Flows and Groundwater Levels project.* The 11 scenarios are variants of the Hadley Centre Regional Climate Model HadRM3-PPE which underpins the UKCP09 analyses. The ensemble captures some of the main climate variability and climate modelling uncertainties. Factors for water industry practitioners to use to perturb climate and flow data to represent the 2030s were not published by the Future Flows and Groundwater Levels project but 11 transient time series of climate and flow data were made available that could be used by companies to develop their own factors.

A review of these methods in the context of the data available for use and the data requirements of our existing groundwater, reservoir and conjunctive-use water resource models led us to propose using:

- Approach 1.3 to perturb historical groundwater sequences within our groundwater models using rainfall and potential evapotranspiration data to develop factors for the 2030s from the 11 climate models.
- Approach 1.4 to perturb reservoir inflow sequences within our reservoir models using flow data from relevant 'donor' catchments to develop monthly flow factors for the 2030s from the 11 climate models.

We believe these analysis methods are proportionate to the risks from climate change faced by our supply area. We shared draft documentation on our vulnerability assessment with the Environment Agency during pre-consultation and discussed our proposed approach to the stage two analyses with them. They agreed the approach and we shared this information with Ofwat.

4.11.2. Stage 1 – 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.

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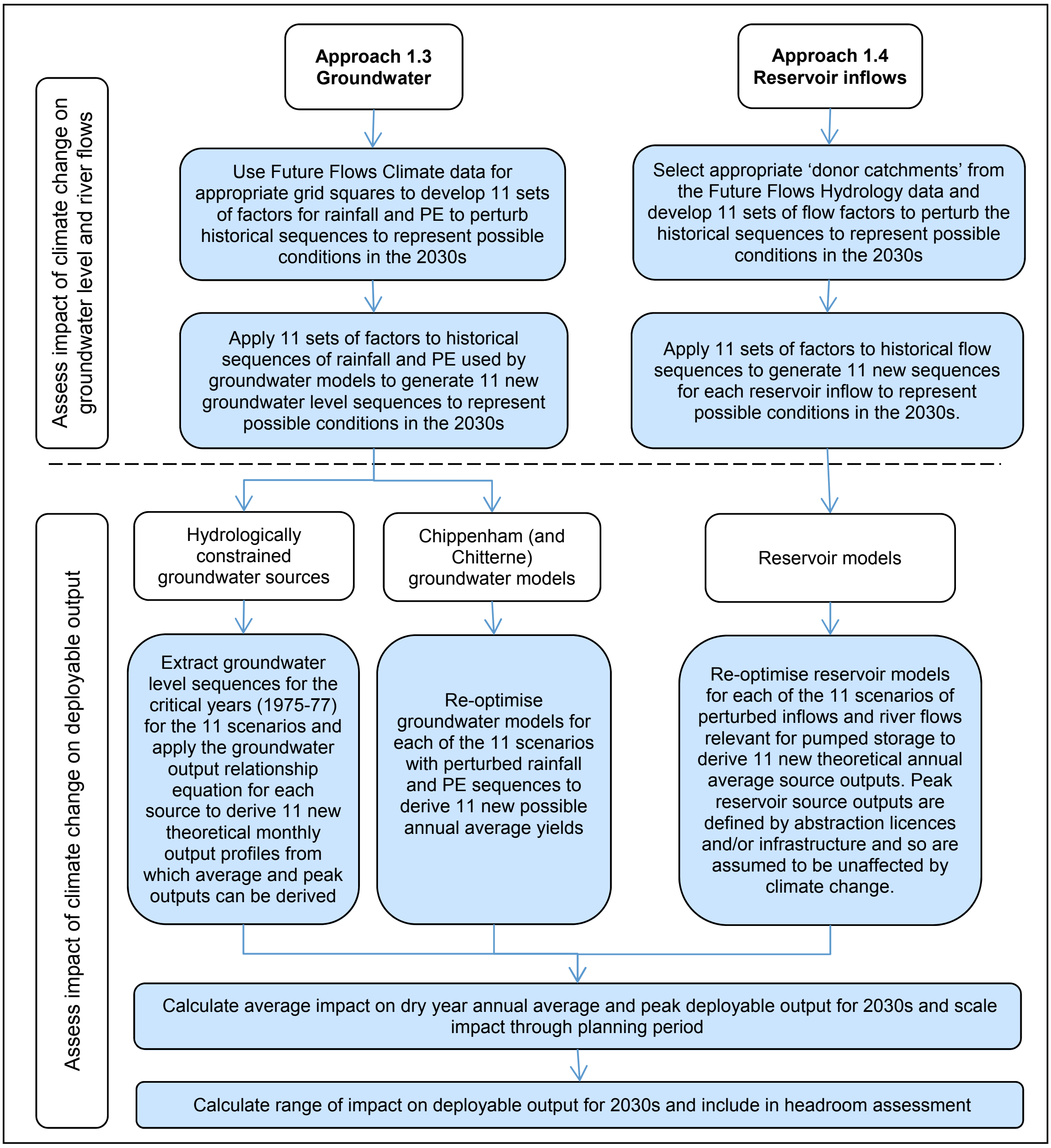
[29] UKWIR (2009). Assessment of the Significance to Water Resource Management Plans of the UK Climate Projections 2009 (09/CL/04/11)

[30] CEH Wallingford, British Geological Survey, Wallingford HydroSolutions, Defra, UKWIR and the Environment Agency (2001). Future flows and groundwater levels.

Figure 4-32: Climate change assessment process



The climate change analysis approaches known as 1.3 and 1.4 in the Water Resources Planning Guidelines use data from an ensemble of eleven variants of the Met Office's Hadley Centre HadRM3 regional climate model. The HadRM3 model was used to downscale global climate model projections as part of the UK Climate Impact Programme (UKCP09) project.

The 11-member regional climate model data provides projections for:

- Daily absolute climate (i.e. not climate changes)
- Individual 25 km grid squares
- A continuous time period of 1950-2099
- One (medium[31]) emissions scenario

[31] Consideration of only the medium emissions scenario in the context of climate change by the 2030s is appropriate as it is typically after the 2050s that the different emissions (e.g. high emissions) scenarios show deviation from each other.

The collaborative[32] *Future Flows and Groundwater Levels project* assessed the impact of climate change on river flows and groundwater levels across England, Wales and Scotland using the UKCP09 probabilistic climate projections from the Met Office Hadley Centre. The project developed two key datasets of use to water resources planning:

- Future Flows Climate (FF-HadRM3-PPE), an 11-member ensemble 1km gridded projection time series (1950-2098) of precipitation and potential evapotranspiration for Great Britain specifically developed for hydrological and hydrogeological application based on HadRM3-PPE run under the medium emission scenario (SRES A1B).
- Future Flows Hydrology (FF-HydMod-PPE), an 11-member ensemble projection of daily river flow and monthly groundwater levels time series (1951-2098) for 282 rivers and 24 boreholes in Great Britain.

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

We contracted consultants Hyder to analyse and process the data available from the Future Flows and Groundwater Levels project into suites of monthly factors to perturb the historical sequences of rainfall, potential evapotranspiration, river flows and inflows used by our groundwater and reservoir models. Full details of the methodology used to develop the factors are described in their technical report[33] which is available as an Appendix to this Plan and the key details are summarised below.

<u>Approach 1.3 for groundwater analysis</u>

The assessment of the possible impacts of climate change on groundwater levels followed the steps outlined below:

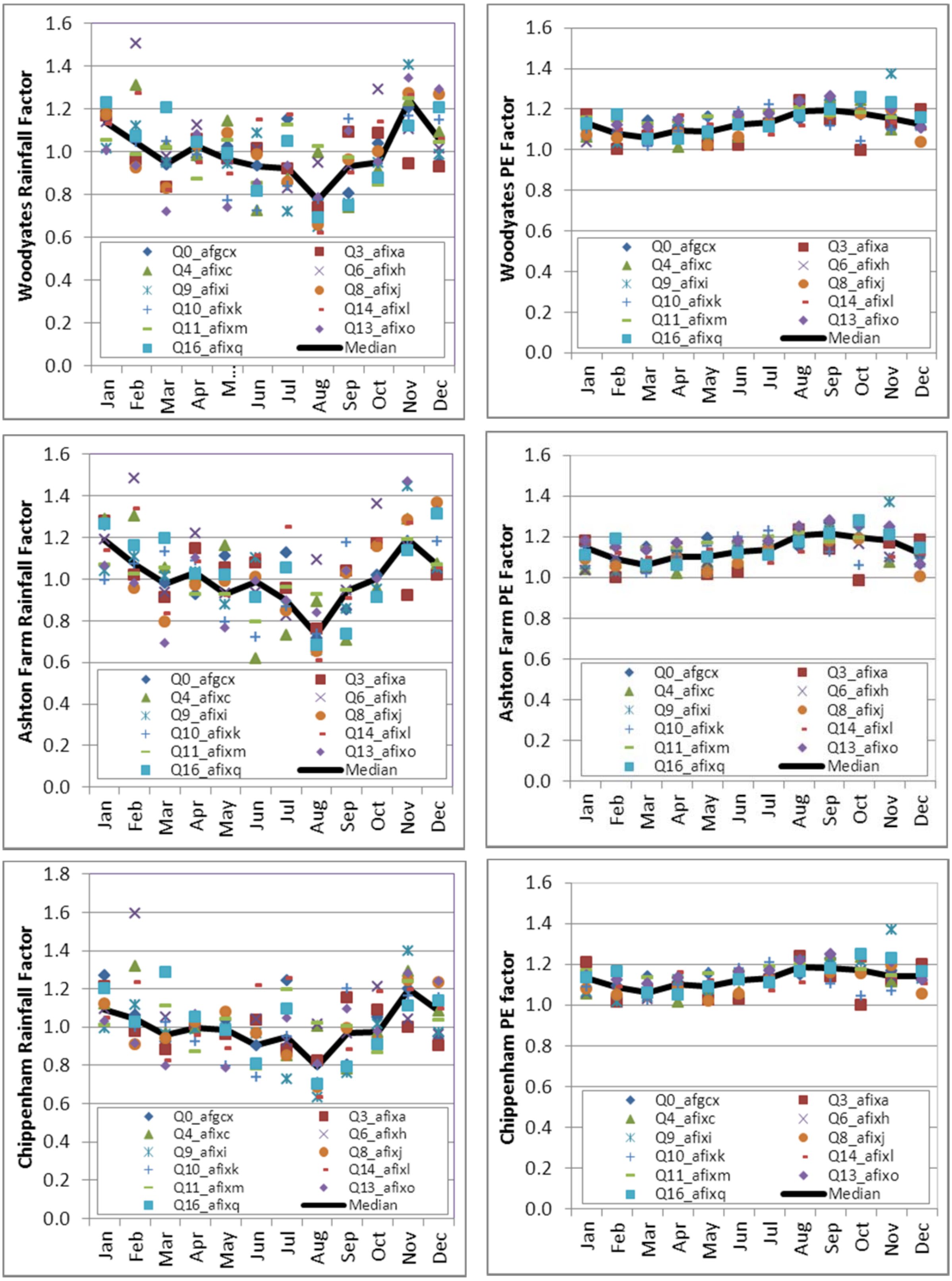
1. Select appropriate grid squares relevant to our groundwater models (Woodyates, Ashton Farm and Chippenham) from the Future Flows climate data
2. Obtain transient rainfall and potential evapotranspiration (PE) for the grid squares covering the period 1950 – 2098 and develop 11 sets of factors for rainfall and PE that relate the 1961-1990 period (pre climate change baseline) to the 2020-2049 period (to represent the 2030s).
3. Apply the factors to the historical sequences of rainfall and PE in our groundwater models to create 11 new versions of each model that represents the 11 climate change scenarios.

The factors for Woodyates, Ashton Farm and Chippenham (step 2 above) are shown in Figure 4-33 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.

[32] Future flows and groundwater level was jointly funded by CEH Wallingford, British Geological Survey, Wallingford HydroSolutions, Defra, UKWIR and the Environment Agency.

[33] Hyder (March 2013). Water resources planning future flows and groundwater levels method report.

Figure 4-33: Rainfall and potential evapotranspiration factors for Woodyates, Ashton Farm and Chippenham groundwater models for 11 climate change scenarios



In step three of the assessment, the factors are then used to perturb the rainfall and potential evaporation sequences in our groundwater models. The 11 new groundwater level sequences for the 1975-77 critical period for Woodyates and Ashton Farm are shown in Figure 4-34 and 4-35.

The full historic record of groundwater level changes at Woodyates and Ashton Farm suggest that the levels in these locations vary between 67 and 109 mAOD (range of 43 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 the winter of 1975-76 may be of the order or magnitude +/- 2 m for Woodyates (4.7% of the maximum range) and +/-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 4-34: Woodyates groundwater levels modelled for 11 climate change scenarios

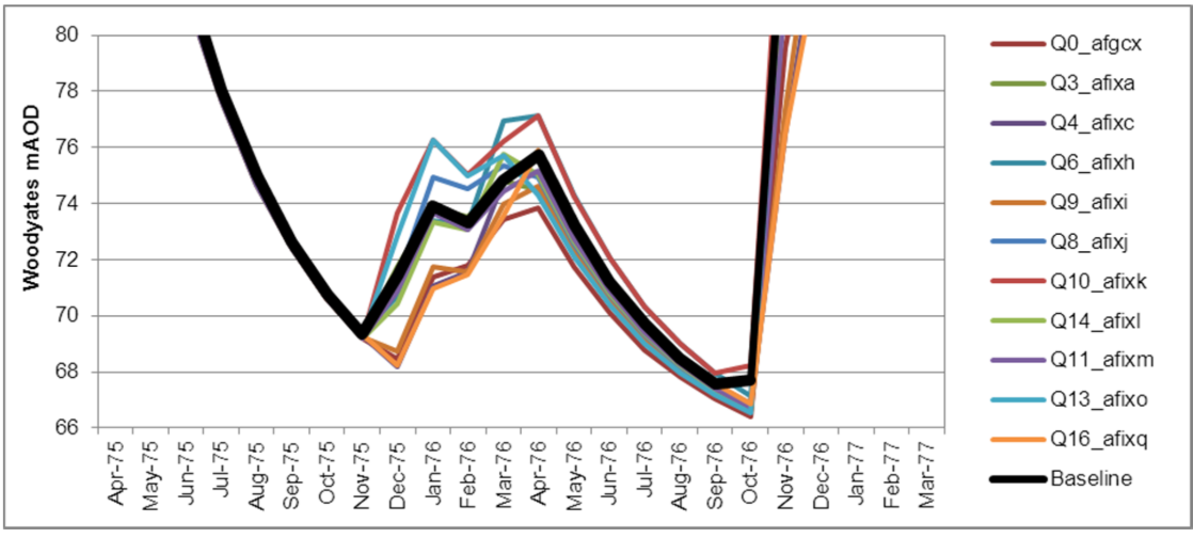
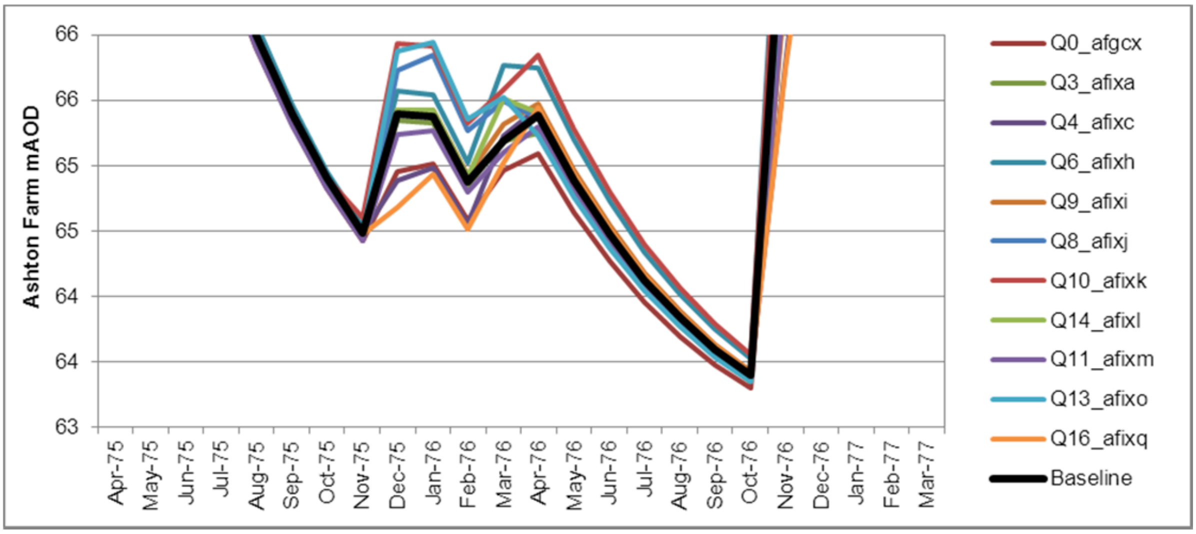


Figure 4-35: Ashton Farm groundwater levels modelled for 11 climate change scenarios



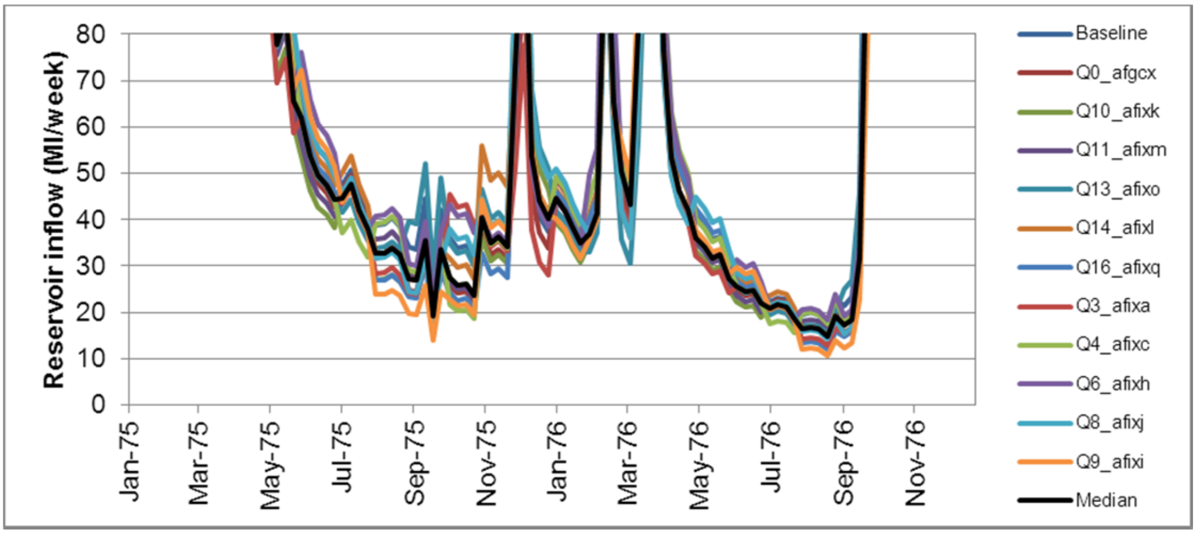
Approach 1.4: Reservoir inflows

The assessment of the possible impacts of climate change on reservoir inflows followed the steps outlined below:

1. Select appropriate 'donor catchments' from the Future Flows hydrology data relevant to our reservoirs
2. Obtain transient river flow data for the donor catchment covering the period 1950 – 2098 and develop 11 sets of factors for flows that relate the 1961-1990 period (pre climate change baseline) to the 2020-2049 period (to represent the 2030s).
3. Use an equation to relate the donor catchment to the inflow of interest and apply the factors to the historical sequences of reservoir inflows in our reservoir models to create 11 new versions of each model that represents the 11 climate change scenarios.

Figure 4-36 below shows the impact of the climate change scenarios on inflows to Durleigh Reservoir during the critical period of 1975-19176.

Figure 4-36: Inflows for Durleigh Reservoir under climate change scenarios



4.11.3. Stage 2 – 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 4.1).

As shown in Figure 4-32, 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:

1. Hydrologically constrained groundwater sources

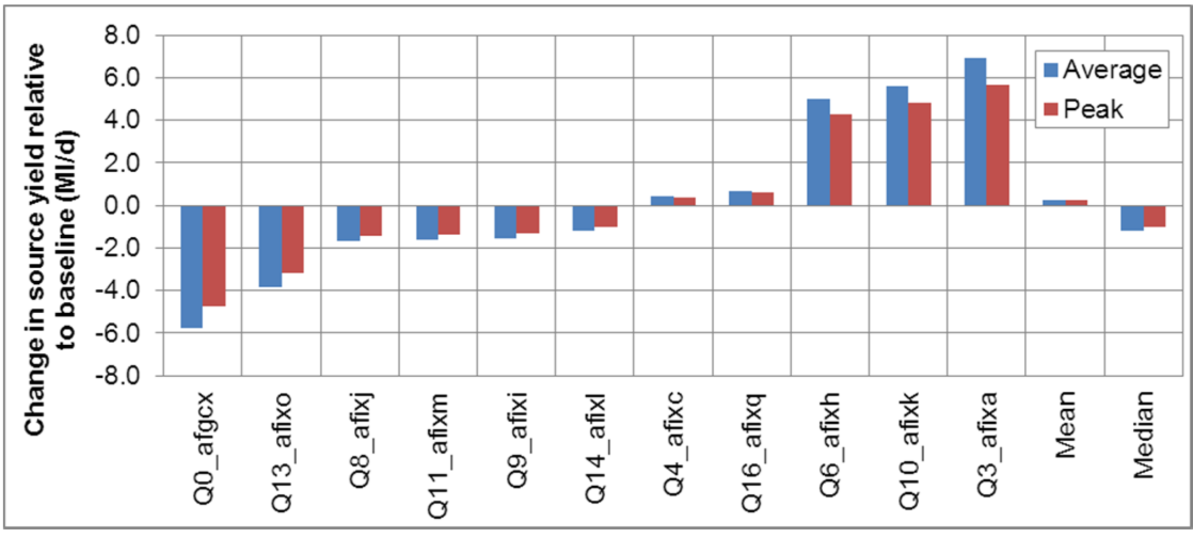
As outlined earlier in this chapter, 50 of our groundwater sources are hydrologically constrained (accounting for nearly 120 Ml/d and 30% of average deployable output) and their available output can be modelled using their output relationship equation against Woodyates or Ashton Farm (see Section 4.1). 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 4-37 below 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 -5.79 Ml/d to +6.95 Ml/d for average (approximately +/- 5% of the potential yield) and from -4.73 Ml/d to +5.69 Ml/d peak (approximately +/- 4% of the potential yield).

The mean impact of the 11 scenarios is a change in total average deployable output of +0.27 Ml/d and a change in total peak deployable output of +0.24 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 -1.17 Ml/d and a change in total peak deployable output of -1.00 Ml/d by the 2030s.

Figure 4-37: Summary of impact of climate change scenarios on average and peak yields hydrologically constrained groundwater sources



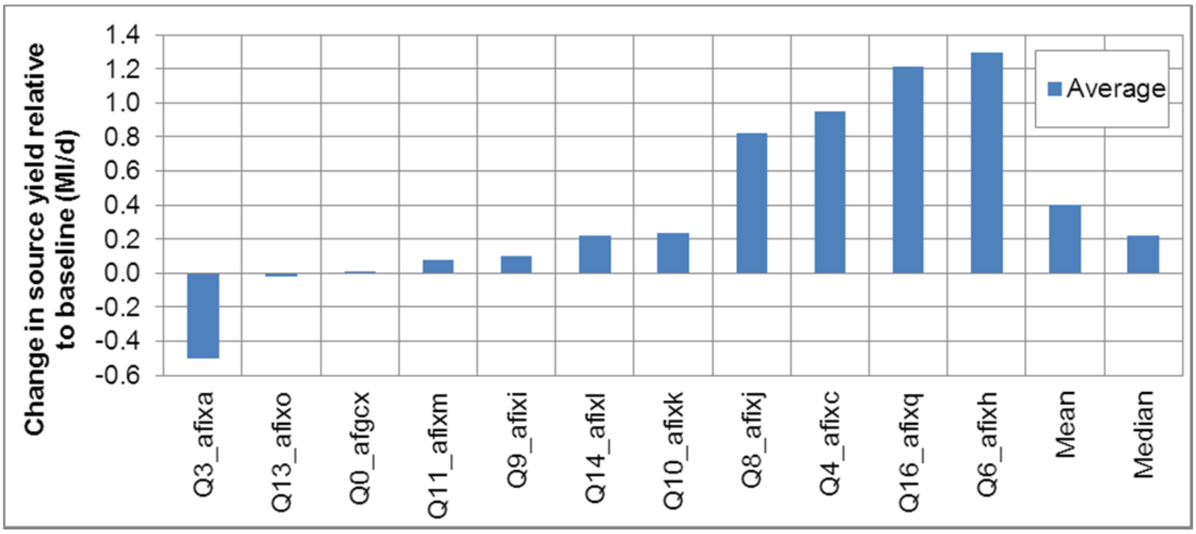
2. <u>Chippenham and Chitterne groundwater models</u>

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 of these sources; 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 4-38 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 -0.50 Ml/d to +1.30 Ml/d, with a mean of +0.40 Ml/d and a median value of +0.22 Ml/d (Q14-afixl).

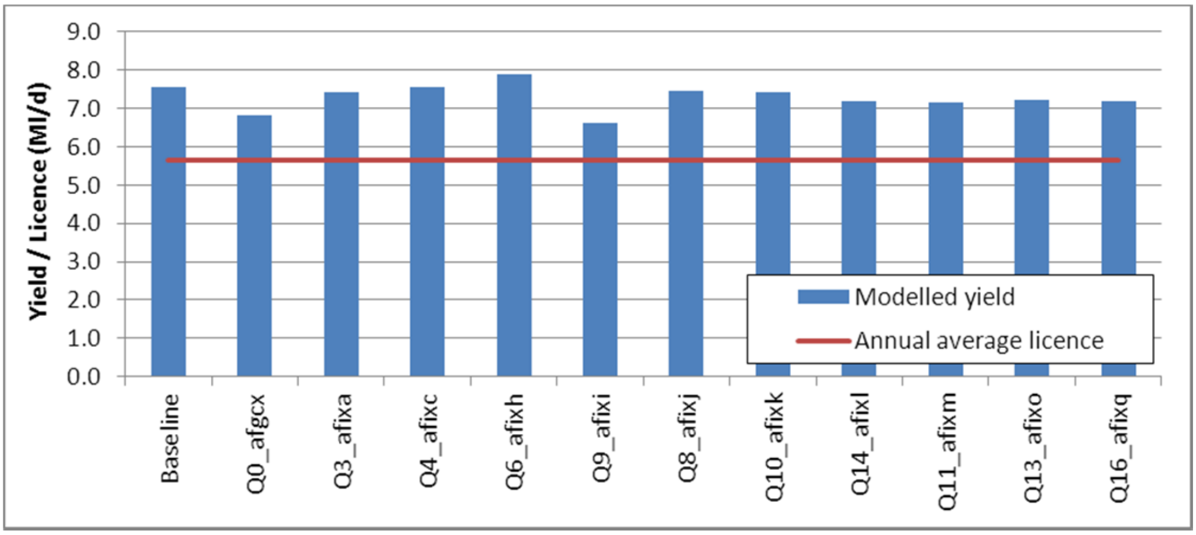
Figure 4-38: Impact of climate change scenarios on the average yield of the Chippenham aquifer sources



Chitterne
An analysis for Chitterne is presented here for completeness however following the formal reduction in the annual licence in 2011 (from 9500 Ml/a to 2072 Ml/a) the yield of this source is constrained by the licence rather than by hydrology and so in the context of this Plan its yield is assumed to be unaffected by climate change.

This is demonstrated by Figure 4-39 below which shows the outputs from modelling the 11 climate change scenarios using our single point groundwater model for Chitterne. It shows that the under the baseline scenario the modelled theoretical yield of the source exceeds the average daily equivalent annual licence (5.66 Ml/d). Although the modelled yield varies for each the 11 scenarios and some of them are less than the modelled baseline yield, none of them are less than the current licence indicating that the output of this source will be unaffected by climate change.

Figure 4-39: Baseline and climate change scenarios of modelled yields compared to licence at Chitterne

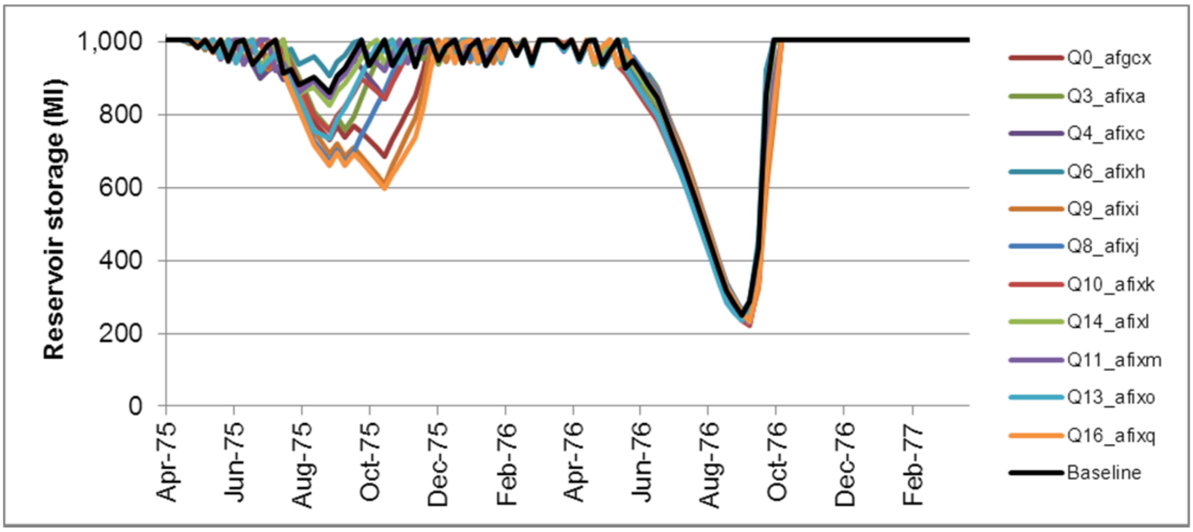


3. <u>Reservoirs</u>

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 4-40.

Figure 4-40: Storage in Durleigh Reservoir under climate change scenarios



Figures 4-41, 4-42 and 4-43 show that under all scenarios and for all reservoirs there is a bias towards a reduction in average yield relative to the baseline. Although all reservoirs indicate potential increases in yield under some scenarios.

Ashford and Hawkridge reservoirs are modelled together and show the largest absolute yield reductions of up to -2.4 Ml/d. Other reservoirs typically suggest more modest changes of between -0.8 to +0.5 Ml/d equating to between -7% to +5% of baseline yields. Figure 4-43 shows that the median overall change in reservoir yields is -2.11 Ml/d (sum of median change for each reservoir) and the mean change is -1.97 Ml/d.

Figure 4-41: Volumetric change in average yield relative to baseline by reservoir for 11 climate change scenarios

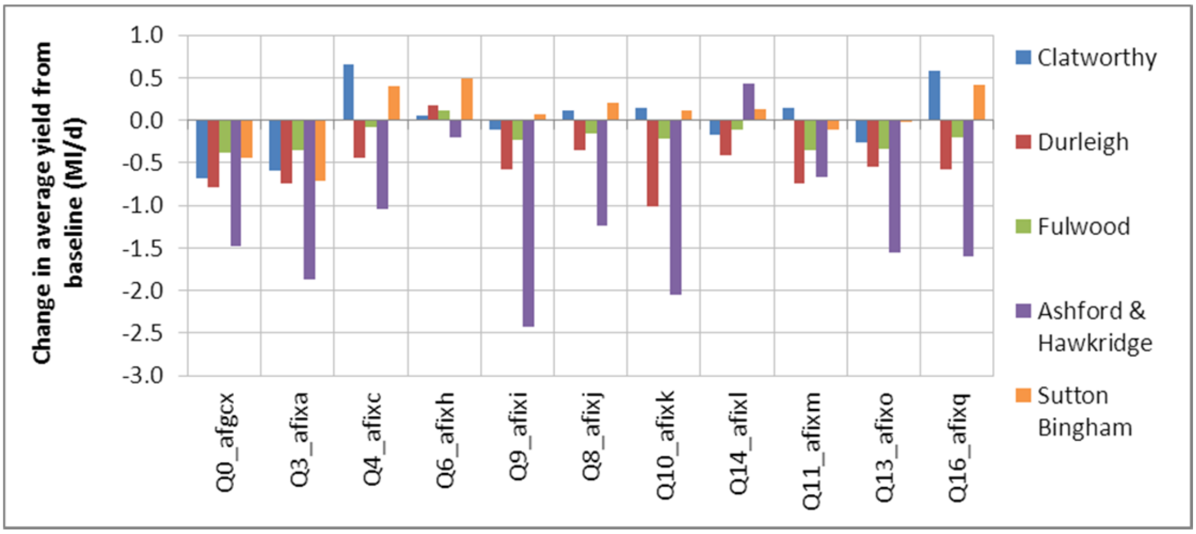


Figure 4-42: Percentage change in average yield relative to baseline by reservoir for 11 climate change scenarios

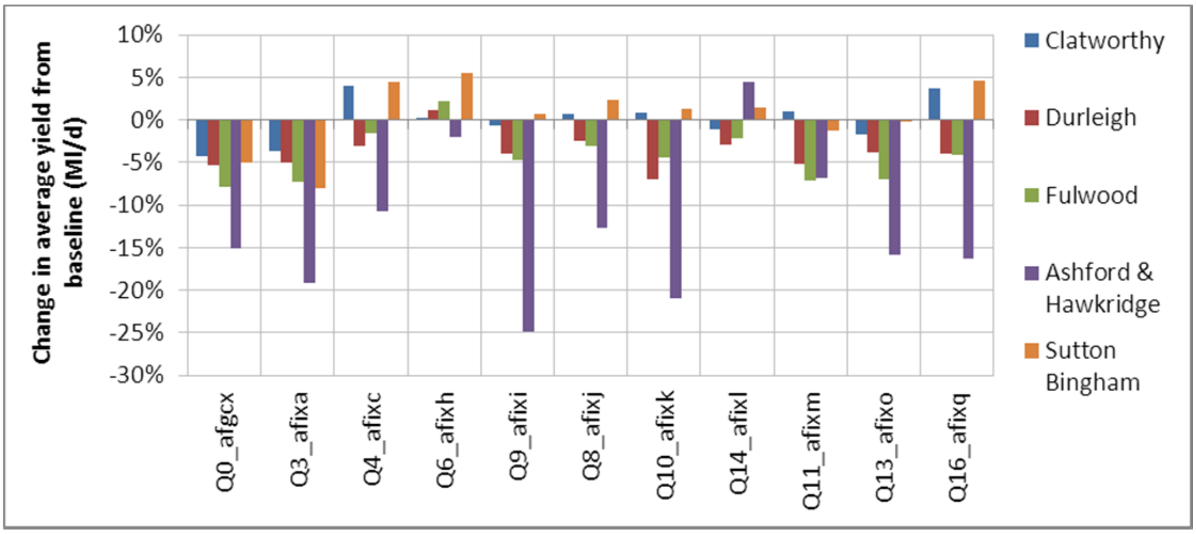
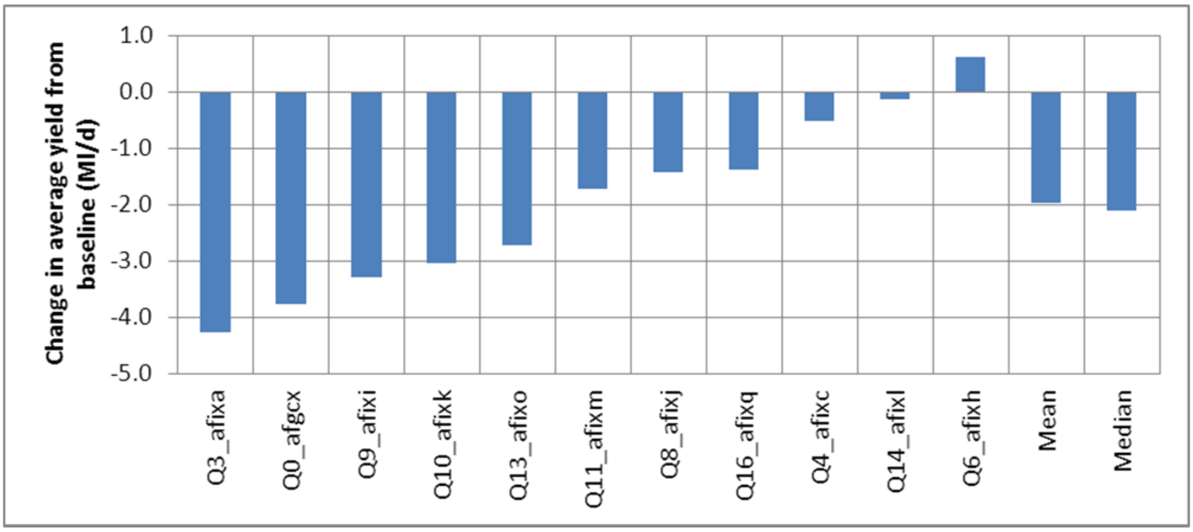


Figure 4-43: Cumulative change in average reservoir yields relative to baseline for 11 climate change scenarios



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 2030s is shown in Table 4-14.

Table 4-14: Average and peak climate change impacts on deployable outputs for the 2030s (2035/36)

Scenario name*	Average				Peak
	Hydrologically constrained groundwater	Chippenham	Reservoirs	Total	Hydrologically constrained groundwater
Q0_afgcx	-5.79	0.00	-3.77	**-9.56**	**-4.73**
Q3_afixa	6.95	-0.50	-4.27	**2.18**	**5.69**
Q4_afixc	0.41	0.95	-0.52	**0.84**	**0.34**
Q6_afixh	4.98	1.30	0.62	**6.90**	**4.30**
Q9_afixi	-1.57	0.10	-3.28	**-4.75**	**-1.32**
Q8_afixj	-1.68	0.82	-1.42	**-2.28**	**-1.42**
Q10_afixk	5.62	0.24	-3.03	**2.83**	**4.82**
Q14_afixl	-1.17	0.22	-0.13	**-1.08**	**-1.00**
Q11_afixm	-1.65	0.08	-1.73	**-3.30**	**-1.39**
Q13_afixo	-3.85	-0.02	-2.73	**-6.59**	**-3.17**
Q16_afixq	0.69	1.21	-1.37	**0.53**	**0.58**
Mean	**0.27**	**0.40**	**-1.97**	**-1.30**	**0.24**
Min	**-5.79**	**-0.50**	**-4.27**	**-9.56**	**-4.73**
Max	**6.95**	**1.30**	**0.62**	**6.90**	**5.69**
Median^	**-0.95**	**0.22**	**-2.11**	**-2.84**	**-0.83**

*Scenario names are as specified by the Future Flows and Groundwater Levels Project.
^Median impact is calculated as the sum of the median impact of the 11 scenarios for each source

The Water Resources Planning Guideline does not specify which of the 11 scenarios should be used to represent the best estimate of the impact of climate change on baseline deployable output. 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 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).

The Water White Paper and Water Resource Planning Guidelines encourage water companies where appropriate to take a longer term view than the standard 25-year planning horizon. This is recommended particularly in the context of climate change and resilient infrastructure developments. Given the relatively small impact of climate change that our assessments have forecast and our growing supply demand balance surplus throughout the 25-year period (see Section 7) we do not believe that extending our forecasts and planning further into the future is appropriate in the context of this Plan.

4.11.4. Stage 3 – scaling

As per the Water Resources Planning Guideline the change in deployable output calculated in Stage 2 for 2035 is scaled from the base year (zero effect) to 2034/35 and then extrapolated from 2034/35 to the end of the planning period (2039/40).

The scaled change in deployable output (using the formulae given in the guidelines) is presented in Table WRP1 BL Supply; this is also summarised in the table below.

Table 4-15: Best estimate of the impact of climate change on deployable output

	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
Dry Year Annual Average impact of climate change (Ml/d)	0.0	-0.30	-1.05	-1.80	-2.54	-2.80	-3.03
Dry Year Critical Period impact of climate change (Ml/d)	0.0	-0.11	-0.37	-0.63	-0.90	-0.99	-1.07

4.11.5. Stage 4 – uncertainty and headroom

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

4.12 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 in the preparation of the supply demand balance for the Water Resources Management Plan (WRMP) that sufficient allowance is made for such temporary reductions in deployable output throughout the planning period

4.12.1. Outage methodology and supporting information

We contracted consultants Mott MacDonald to assess an appropriate outage allowance for this Water Resources Management Plan using the standard methodology developed and published by UKWIR (1995[34]). Confirmation that we would be using this analysis method was provided to the Environment Agency during the pre-consultation period. Mott MacDonald's technical report[35] is available as an Appendix to this Plan; the key issues and findings are however discussed and reported in this Section.

The 1995 UKWIR outage assessment methodology involves defining probability distributions for magnitude and duration for all identified outage events and combining these in a Monte Carlo analysis (using @Risk software) to develop an overall probability distribution for the outage allowance.

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 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 also the company's internal management reporting requirements. The database contains over 1000 individual records of outage events at all sources since 2006/07; an example of the information recorded is shown in Table 4-16.

Table 4-16: Example extract from '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

[34] UKWIR/EA (March 1995), Outage Allowances for Water Resource Planning.
[35] Mott MacDonald (March 2013) Outage analysis and modelling.

Full details of the analysis methods are described in Mott MacDonald's report including how outage records were screened to identify inconsistencies and non-legitimate outage events that should be excluded from the analysis.

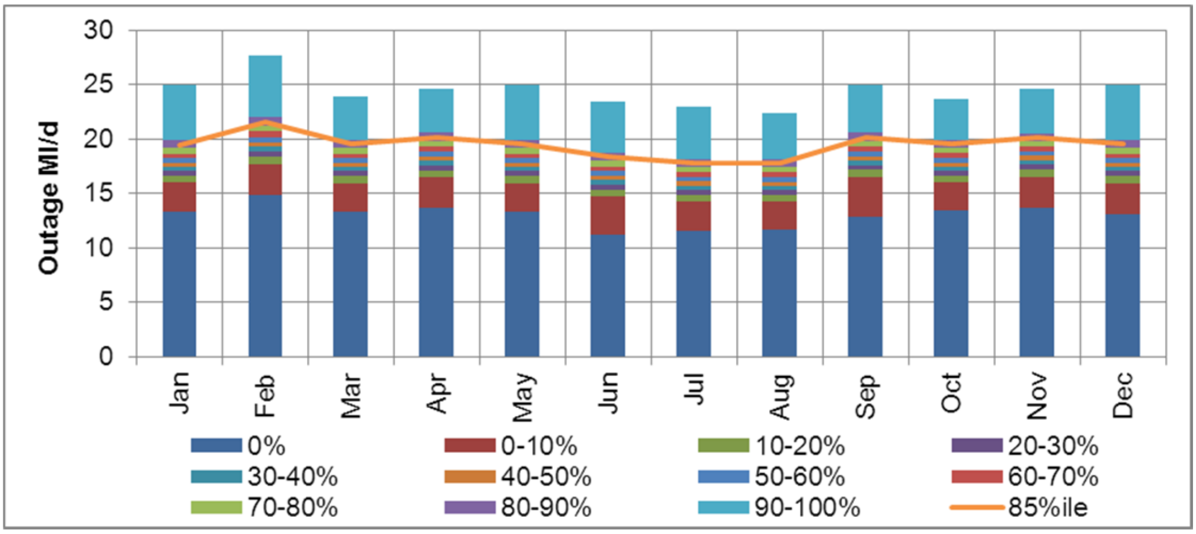
The outage assessment was performed for both average and peak conditions using 10,000 iterations per model simulation. Outage allowance has not been reassessed across the planning period as following the completion of our integrated grid in 2017/18 no further significant changes to the supply system are planned.

Outage has 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.

4.12.2. Outage results – dry year annual average

Results from the outage analysis can be presented in Ml/d and as a percentage of deployable output. Figure 4-44 shows monthly outage for the average condition; it indicates that monthly outage typically clusters between approximately 12 Ml/d and 22 Ml/d (which is *c.* 3 – 6 % of deployable output) depending on the risk percentile.

Figure 4-44: Cumulative outage comparison for average condition



We have selected to use the 85th percentile throughout the planning period for the dry year annual average condition which defines February as the critical month (the month with the highest modelled outage allowance). Table 4-17 shows the outage allowance in Ml/d and as a percentage of deployable output by risk percentile.

Selecting the 85th percentile gives us an outage allowance of 21.57 Ml/d, or 5.3% of deployable output.

Our last Water Resources Management Plan assumed a comparable dry year annual average outage allowance of 21.87 Ml/d.

Table 4-17: Average outage allowance in Ml/d and as a percentage of deployable output

Outage %	Outage allowance (Ml/d)	Outage as a % of DO
50%	19.70	4.85
60%	20.17	4.96
70%	20.67	5.08
80%	21.24	5.23
85%	21.57	5.31
90%	22.00	5.41
95%	22.73	5.59
100%	27.63	6.80
Average condition deployable output = 406.56 Ml/d		

Figures 4-45 and 4-46 show the contribution of outage types to overall monthly outage and for the critical month of February. These graphs indicate the significance of water quality issues, and in particular turbidity, affecting available source outputs.

Figure 4-45: Contribution of outage type to total outage for the average scenario

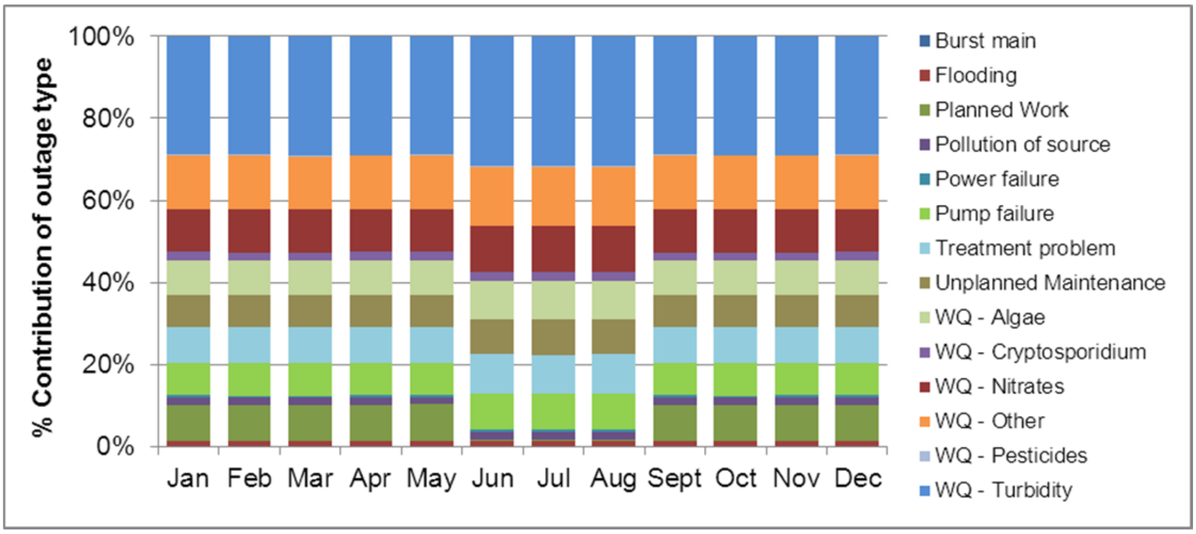
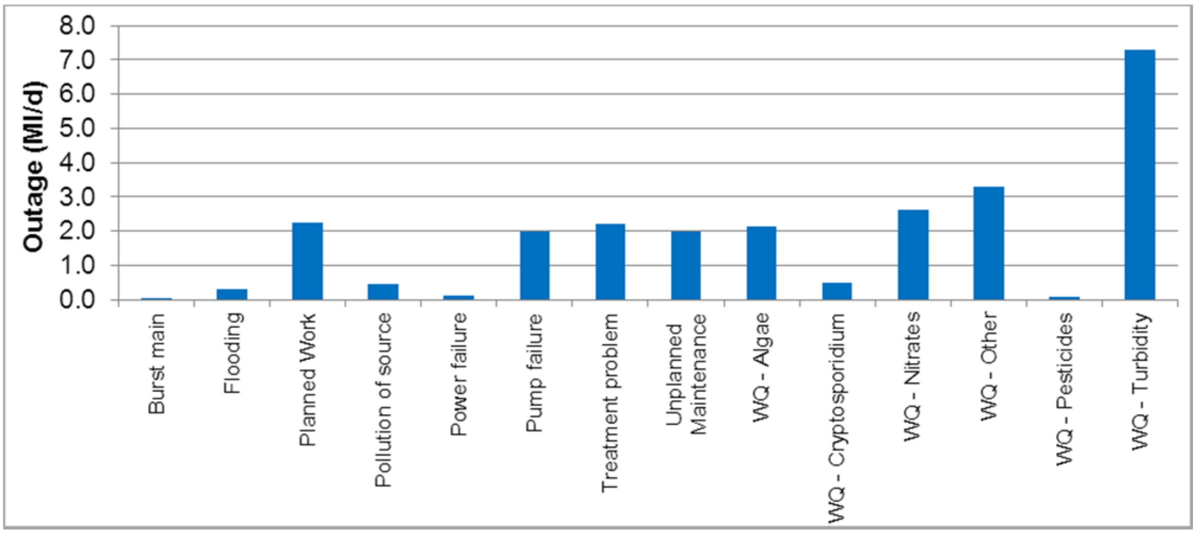


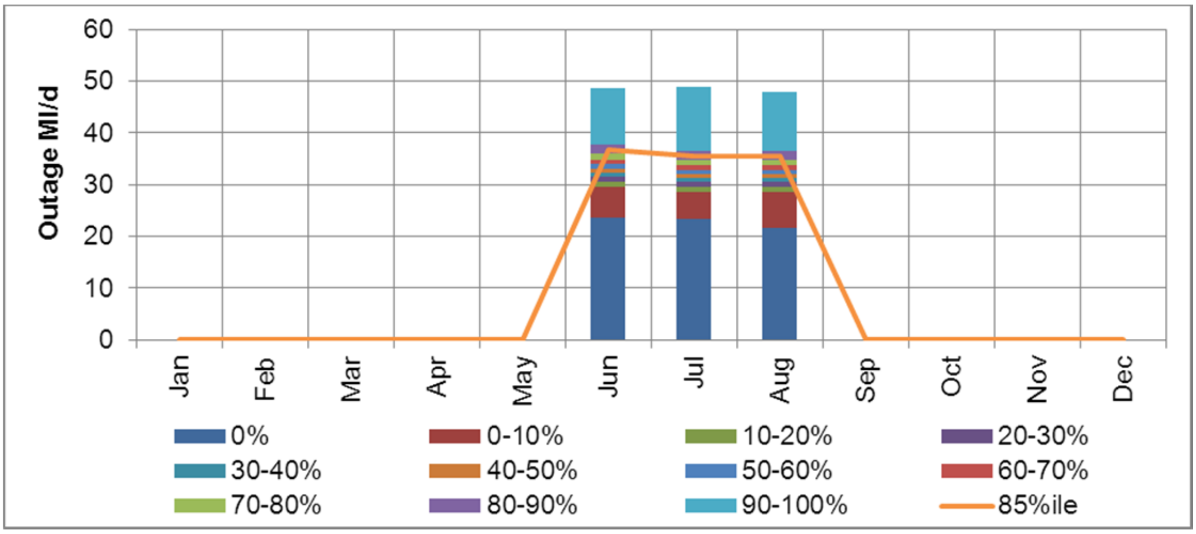
Figure 4-46: Total outage (Ml/d) for the 95th percentile for the critical month (February) under average conditions



4.12.3. Outage results – dry year critical period (peak)

Figure 4-47 shows monthly outage for the peak condition; it indicates that monthly outage typically clusters between approximately 28 Ml/d and 38 Ml/d (which is *c.* 6 – 8 % of deployable output) depending on the risk percentile.

Figure 4-47: Cumulative outage comparison for peak condition



We have selected to use the 85th percentile throughout the planning period for the dry year critical period condition which defines June as the critical month (the month with the highest modelled outage allowance). Table 4-18 shows the outage allowance in Ml/d and as a percentage of deployable output by risk percentile.

Selecting the 85th percentile gives us an outage allowance of 36.80 Ml/d, or 7.5% of deployable output.

Our last Water Resources Management Plan assumed a slightly lower dry year critical period outage allowance of 27.83 Ml/d.

Table 4-18: Peak outage allowance in Ml/d and as a percentage of deployable output

Outage %	Outage allowance (Ml/d)	Outage as a % of DO
50%	33.15	6.75
60%	33.96	6.92
70%	34.88	7.11
80%	36.06	7.35
85%	36.79	7.50
90%	37.69	7.68
95%	39.19	7.98
100%	48.94	9.97
Average condition deployable output = 490.72 Ml/d		

Figures 4-48 and 4-49 show the contribution of outage types to overall monthly outage and for the critical month of February. These graphs indicate the significance of water quality issues, and in particular turbidity and nitrates, affecting available source outputs.

Figure 4-48: Contribution of outage type to total outage for the peak scenario

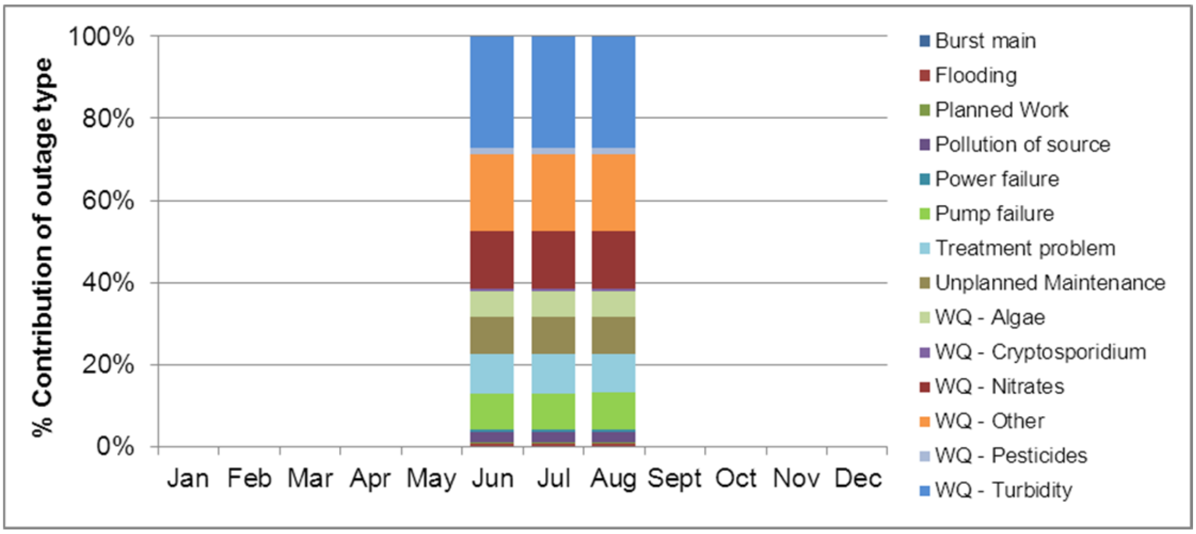
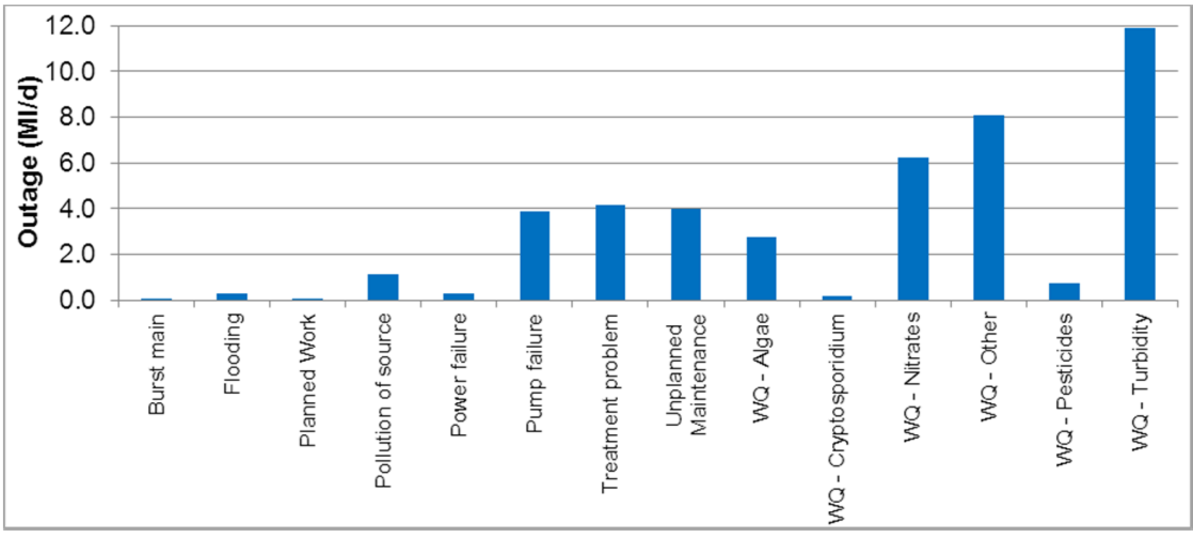


Figure 4-49: Total outage (Ml/d) for the 95th percentile for the critical month (June) under peak conditions



4.13 Overall baseline supply forecast

The tables below summarise the key elements of the baseline supply forecast that have been described throughout this chapter for the base year and the final year of each AMP period in the planning period.

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

Component of supply forecast	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
Baseline deployable output (A)	426.48	426.48	426.48	426.48	426.48	426.48	426.48
Imports (B)	16.27	16.27	9.30	9.30	9.30	9.30	9.30
Exports (C)	1.48	1.48	1.48	1.48	1.48	1.48	1.48
Reduction due to climate change (D)	0.0	0.30	1.05	1.80	2.54	2.80	3.03
Sustainability reductions (E)	0.00	0.00	22.21	22.21	22.21	22.21	22.21
Treatment works operational use (F)	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Outage (G)	21.57	21.57	21.57	21.57	21.57	21.57	21.57
Water available for use (WAFU) A + B – C – D – E – F – G	418.82	418.52	388.59	387.84	387.10	386.84	386.61

Table 4-20: Summary of dry year critical period supply forecast (all values in Ml/d)

Component of supply forecast	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
Baseline deployable output (A)	514.34	514.34	514.34	514.34	514.34	514.34	514.34
Imports (B)	16.78	16.78	9.81	9.81	9.81	9.81	9.81
Exports (C)	1.77	1.77	1.77	1.77	1.77	1.77	1.77
Reduction due to climate change (D)	0.0	0.09	0.31	0.53	0.74	0.82	0.89
Sustainability reductions (E)	0.00	0.00	26.00	26.00	26.00	26.00	26.00
Treatment works operational use (F)	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Outage (G)	36.79	36.79	36.79	36.79	36.79	36.79	36.79
Water available for use (WAFU) A + B – C – D – E – F – G	491.68	491.59	458.40	458.18	457.97	457.89	457.82

4.13.1. Uncertainty and sensitivities

The key uncertainties in our supply forecast are analysed as part of our headroom assessment (Section 6). These include the impact of climate change, the impact of deteriorating water quality, the security of bulk supply agreements and the accuracy of data inputs.

The impact of potential new bulk supply exports from our supply system to neighbouring companies has been examined in the context of the overall sensitivity of the supply demand balance in Section 9.

The risk to overall water supplies related to increasing concentrations of nitrates is modelled in the headroom allowance to account for the likely probability distribution of impact/risk for each source. The allowance made amounts to 1 Ml/d for the average scenario and 5 Ml/d for the peak scenario. Section 4.6 highlighted that the total loss of deployable output that could occur should all sources fail at the same time would be over 85 Ml/d for nitrates and over 35 Ml/d for pesticides. This would have a significant impact on our supply forecast and water available for use.

One uncertainty that is not directly modelled in the headroom assessment but could impact on our future supplies is the impact of climate change on drought frequency and magnitude. The impact of climate change that we assessed in Section 4.11 followed best practice guidance but it involved the perturbation of historical sequences and so our predictions of impact are inherently based on the frequency and severity of droughts that have occurred in the past. While this is the best available source of information at present; we look forward to future outputs from the UK Climate Impacts Programme which may seek to address this area of uncertainty for water resources planning in due course.

5. Demand forecast

This Section outlines the development of our demand forecast up to 2039/40 that is consistent with the 25 year planning period of the Water Resources Management Plan. It follows the joint regulator Guidance and uses UKWIR reports and methodologies where appropriate. 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.

The structure of this chapter is as follows:

- Section 5.1 provides an overview of actual demand patterns in recent years to set the context
- Section 5.2 outlines the scenarios that have been forecast including an explanation of our peak factors and how the base year (2011/12) has been normalised
- Sections 5.3, 5.4 and 5.5 explains the development of the population, property and household water use forecasts – including the discussion of the effects of different approaches to 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
- 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. However since the mid-1990s this trend has reversed – the demand for water and therefore the volume of water that we need to abstract from the environment has been falling. Figure 5-1 shows weekly, monthly and annual average ‘water into supply’ (demand) since 1981. It shows that over the last 15 years or so peak week demands have fallen from approximately 525 Ml/d to less than 400 Ml/d, and annual average demands have reduced from around 425 Ml/d to less than 350 Ml/d.

The reduction in the demand for water has occurred despite an overall increase in the population we serve from 1.14 million people in 1994/95 to 1.27 million in 2011/12, as a result of:

- Leakage reduction – we have reduced leakage from the network by half from 140 to 69 Ml/d
- Customers switching to a metered supply – the proportion of metered households in our region has increased from less than 10% to more than 50% 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 5-1: Weekly, monthly and annual average water into supply (demand)

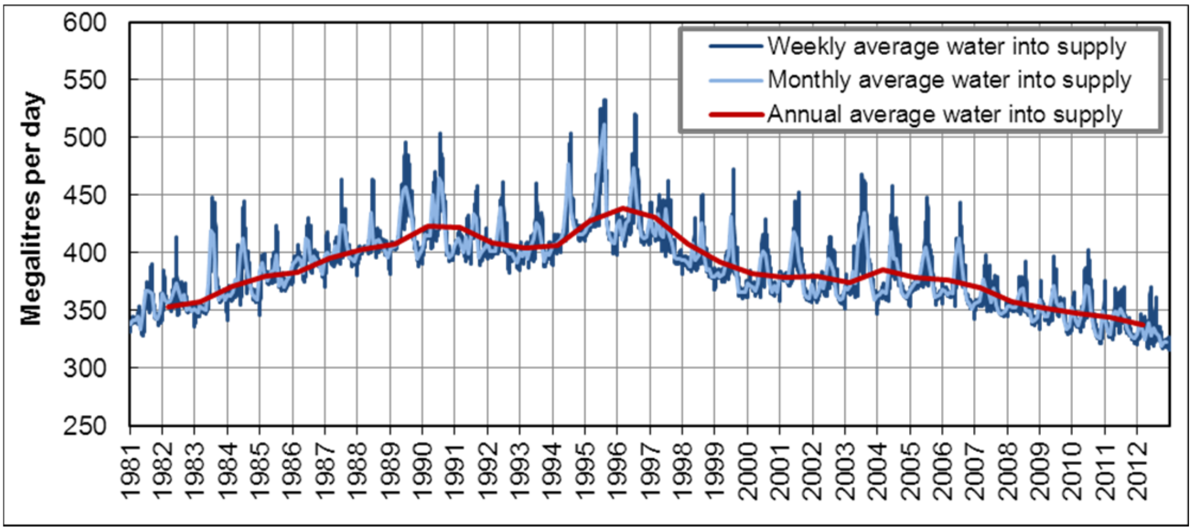
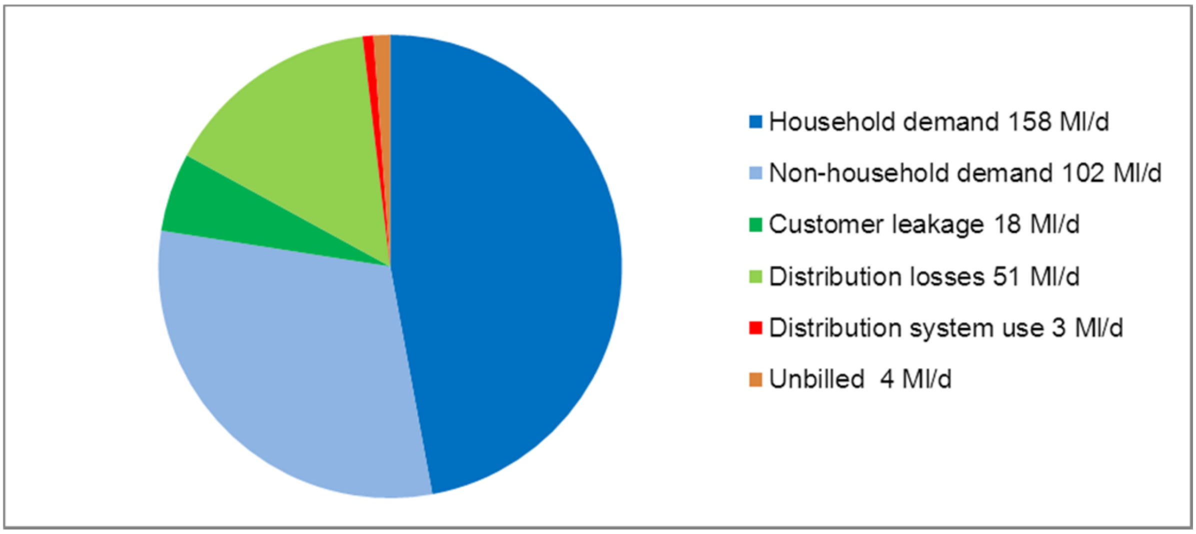


Figure 5-1 shows the in-year variability in the demand for water; during the summer the demand for water generally increases as our customers use more water in their gardens for plants and leisure and also inside their homes for showering and clothes washing. Water use by businesses also increases in the summer months particularly in areas popular for tourism. 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 is visible in Figure 5-1 in the winters of 2008/09, 2009/10 and 2010/11.

Figure 5-2 shows total water demand (334 Ml/d) in 2011/12 segmented into key categories. For this Plan, 2011/12 was used as the base year, from where we made a projection of future demands. Figure 5-2 indicates that nearly half of the water we supply is for households; non-household (commercial) demands comprise nearly a third of the total; leakage from customer pipes represents 5% and water leaking from our distribution mains amounts to around 15% of the water we supply. Water used within the distribution system for operational purposes and water that is taken and unbilled both amount to around 1% of total demand.

Figure 5-2: Segmentation of total water demand in the 2011/12 into key categories



5.2 *Forecasting scenarios and peak factors*

Table 5-1 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 5-1: Forecasting scenarios developed

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

Baseline demand forecasts assume a continuation of current policies relating to metering, leakage and water efficiency throughout the 25-year planning period. Specifically for Wessex Water this means our baseline forecast assumes optional metering, current distribution leakage (51 Ml/d) and the continuation of water efficiency activities.

Final planning demand forecasts include the impact of our proposed options and particularly the introduction of a policy of change of occupier metering from 2015 – see section 5.6.4 and Section 8.

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 **average year annual average** (AYAA) condition is developed as a basis on which to calculate the DYAA and DYCP forecasts. As explained in Section 5.2.2 it is also used to derive the **weighted average demand**.

The Guidelines also suggest the development of a normal year demand forecast. Since our approach does not use this in the calculation for the DYAA, DYCP or weighted average demand, we have not calculated or reported this forecast.

5.2.1. Peak factors

Peak factors are used to uplift components of the AYAA demand forecast to the dry year annual average and dry year critical period scenarios. For the preparation of the draft plan we reviewed the peak factors used in our last plan particularly in the context of the detailed consumption information available from our tariff trial project[36]. During summer 2013 we experienced a period of high demand and so were able to undertake further analysis and update the household peak factors again to ensure we have used the most up to date

[36] Wessex Water (2012), Towards sustainable water charging – conclusions from Wessex Water's trial of alternative charging structures and smart metering.

information available for our planning. The full findings of the peak factor analysis are available as appendices[37] to this Plan and the key details are summarised here.

Table 5-2 presents the factors used for each component of demand for the base year (2011/12) and at the end of the planning period (2039/40)

Table 5-2: Factors used to uplift normal year demands to dry year annual average and dry year critical period

Component of demand	Normal year annual average : Dry year annual average		Normal year annual average : Dry year critical period	
	Base year	2039/40	Base year	2039/40
Measured household	1.041	1.049	1.197	1.225
Unmeasured household	1.065	1.060	1.484	1.406
Measured non-household billed monthly	1.04	1.04	1.208	1.208
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	1.055	1.052	1.587	1.515
Distribution system operational use	1.00	1.00	1.00	1.00
Leakage	1.00	1.00	1.00	1.00

Distribution 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.

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 4.9% and the factor for unmeasured households falls marginally to 6.0% by 2039/40. 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 our last Plan; 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 19.7% and 48.4% 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 22.5% and the factor for unmeasured households falls to 40.6% by 2039/40.

[37] Tynemarch (June 2012). Wessex Water Tariff Trial Project - dry year peak factors methodology (Final Report).
Tynemarch (Oct 2013). Dry year household peak factors update.

- 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 20.8% 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.

A key change from our last Plan is the reduction in the factor used for the dry year critical period forecast for measured households. Analysis undertaken for our last Plan indicated that measured and unmeasured households would exhibit similar peak water demand behaviour (a peak week increase of approximately 54%); however evidence provided by our tariff trial has led us to reduce the factor for measured households down to approximately 20%.

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 though 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. We have examined the sensitivity of our demand forecast to the alternative peak factors in Section 5.9.2.

5.2.2. Weighted average and base year normalisation

The **weighted average demand** forecast is required as the basis of the revenue forecast for Ofwat's price review for the Business Plan. This forecast is intended to account for likely average revenue on the basis that not all years are dry years (with higher demands) and not all years are wet years (with lower demands). The weighted average demand forecast needs to take into account the variation in demand that we experience as a result of different weather conditions.

Of the various components of demand only two are affected by changes in the weather – water delivered to household customers and water delivered to non-household customers. Leakage[38], water taken unbilled, and distribution system operational use are assumed to not vary with the weather. To understand how household and non-household demands vary with weather we developed a simple methodology to model household and non-household demand as a function of a long-term average trend and a weather variable.

Our methodology involved the following steps:

- Plot historical non-household and household actual outturn demand data (as per Table 10 of June Return[39]) – see Figures 5-3 and 5-4. The graphs show that there

[38] Leakage is recognised to vary with winter weather conditions as extreme freeze-thaw conditions can result in an increased leakage (winter breakout) – see Section 5.7. 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.

[39] Data since 1995 has been used and there have been no restrictions during this period of record that would make the data unsuitable for this analysis without correcting to account for the impact of restrictions.

have been considerable changes in these demands over time. These changes are quite separate, and a lot more significant, than any variations in demand as a result of the weather. In the case of non-household demand this would include the impacts of industrial decline and for household demand it would include new houses, PCC changes and customers switching to metered supplies.

- Separate out the underlying long-term trends from any weather effects by fitting a second order polynomial trend line through the data to represent the aggregate (average) of these long term trends – as shown in Figures 5-3 and 5-4.
- Assume that any variation in historical demand, either side of the trend lines, was due to weather effects.
- Develop a model to describe the demand in any one year as the demand from the long-term average trend plus or minus an additional amount of demand that is dependent on a weather variable. In the development of the models we examined several weather variables (e.g. rainfall; temperature) and also variables that serve as a proxy for 'weather' (e.g. Soil Moisture Deficit, SMD). We found that maximum monthly SMD in a year minus average maximum monthly SMD was the most suitable variable to include. SMD is a good proxy of overall weather as it is a manifestation of both rainfall and temperature conditions. The SMD variable was multiplied by a factor. The factor was selected to achieve the best fit between the modelled and historic data.
- The impact on demand of the variable weather ('weather effect') was then added together for household and non-household demand and ranked (see Figure 5-5) to allow the distribution of the weather effect to be examined.

Figure 5-3: Actual outturn and modelled non-household demand

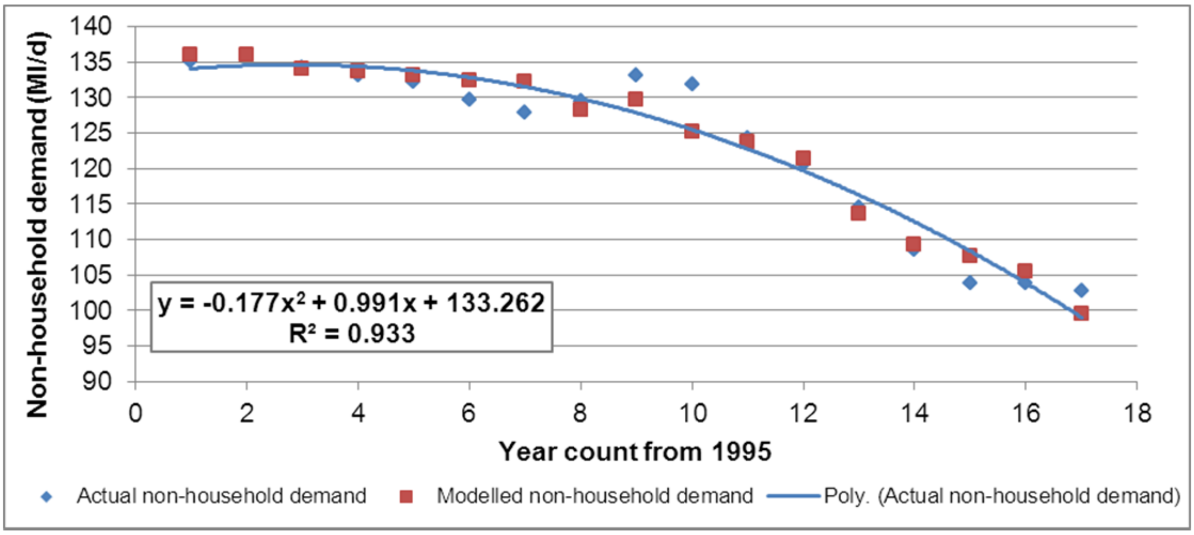


Figure 5-4: Actual outturn and modelled household demand

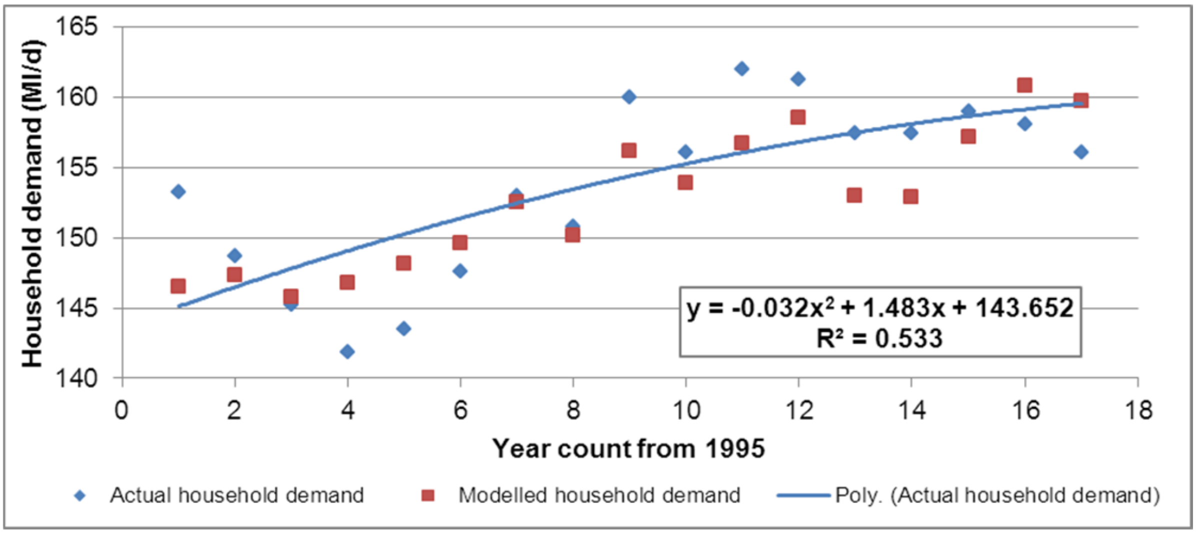
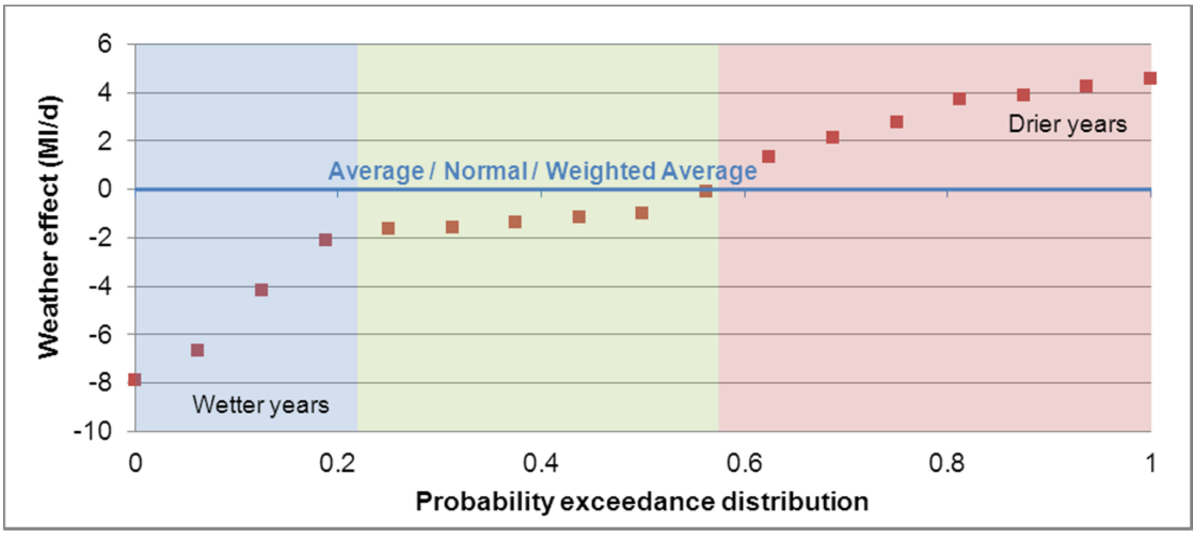


Figure 5-5: Combined weather effect for household and non-household demand



By definition, average (or normal) demand is given by the long-term trend (i.e. average weather effect) as its position takes account of the variations in demand as a result of wetter and drier years (and probably other factors too which have not been explicitly modelled).

Therefore to **normalise base year demands** actual outturn household and non-household demands in for 2011/12 have been corrected so that they correspond to the average demand calculated by the model. This has involved increasing household demand by 3.07 Ml/d and reducing non-household demand by 3.73 Ml/d.

Average demand calculated in this way is equivalent to the weighted average demand required for the revenue forecast. Therefore no weighting is required between the "normal" and "dry" scenarios to obtain weighted average demand.

We discussed this approach to calculating the weighted average demand forecast with Ofwat during the pre-consultation period and they were satisfied with the proposal. The Environment Agency was also made aware of our discussions with Ofwat.

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 is divided up between determines the occupancy rate of homes and this impacts on demand.

5.3.1. Base year properties

Household properties – base year

Measured household properties for the base year (267,279) are derived from our billing system property records and are as reported in Table 7 of the Regulatory Return in 2012.

Unmeasured household properties for the base year (252,394) are derived from our billing system property records and are as reported in Table 7 of the Regulatory Return in 2012.

Non-household properties – base year

Measured non-household properties for the base year (46,557) are derived from our billing system property records and are as reported in Table 7 of the Regulatory Return in 2012.

Unmeasured non-household properties for the base year (5,417) are derived from our billing system property records and are as reported in Table 7 of the Regulatory Return in 2012.

Void properties – base year

Void properties are properties that are connected to our supply system but are not charged for water services as they are not occupied.

Numbers of void properties are derived from our billing records following a standard reconciliation process. Non-household voids (1,819), measured household voids (6,235) and unmeasured household voids (6,023) in the base year are consistent with Table 7 and 10B of our Regulatory Report for 2011/12.

The total number of void properties varies slightly from year to year; the average for the period 1997/98 to 2011/12 was 14,437, which is comparable to the total outturn data for 2011/12 (14,078) – it is reasonable therefore to keep the number of voids constant throughout the planning period.

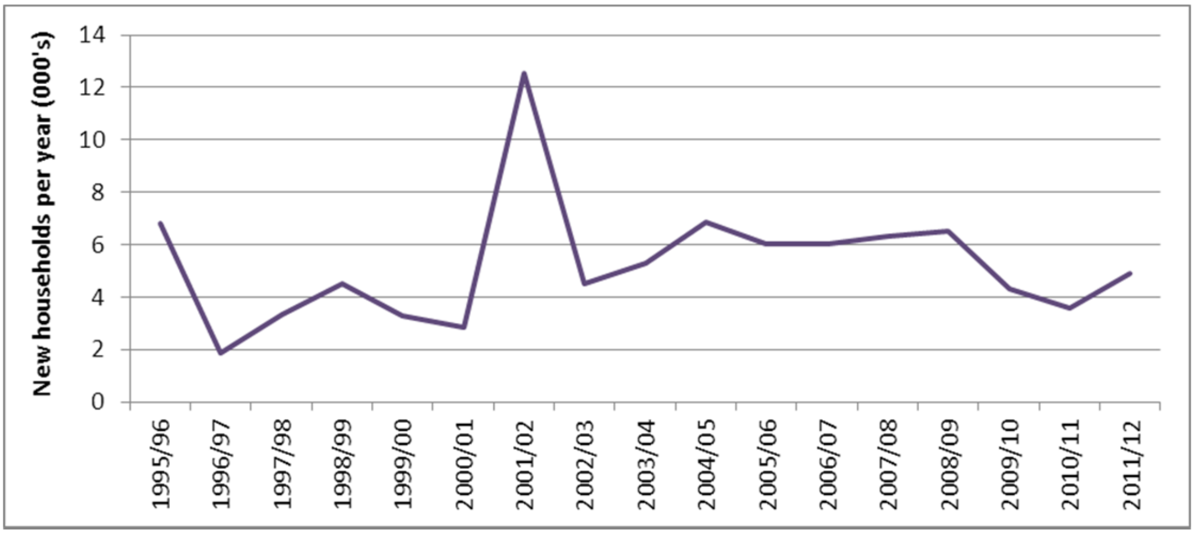
Standpipes and troughs

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.

5.3.2. Property forecasts

House building rates are an important factor in the development of a water demand forecast. Figure 5-6 shows the number of new households in our region that have connected to our supply system each year since 1995/96. The average number of new households per year through this period is approximately 5300. Throughout much of the 2000s our region experienced property growth of around 6000 new properties each year; however the effect of the slowdown in the economy since 2009/10 can be seen as in more recent years new household connections per annum have been approximately 4000.

Figure 5-6: Annual rates of new household connections



There are several sources of information available for water companies to use to develop forecasts of property growth through the water resources planning period including local government plans, official statistics and water company specific data for recent years.

The Government's approach to spatial planning in England changed in November 2011 with the introduction of the Localism Act (2011). The Act revoked the Regional Spatial Strategies that were introduced in 2004 thereby removing the existing regional housing targets; Local Authorities were thereby empowered to reassess housing forecasts for their areas.

There are 20 Local Authorities (LAs) with all or part of their area covered by Wessex Water's water supply area:

- Bath and North East Somerset
- East Devon
- Mendip
- New Forest
- North Dorset
- Purbeck
- South Gloucestershire
- Taunton Deane
- West Dorset
- Weymouth and Portland
- Cotswold
- East Dorset
- Mid Devon
- North Devon
- Poole
- Sedgemoor
- South Somerset
- Test Valley
- West Somerset
- Wiltshire

At the time of preparing our forecasts LA plans were at various stages of review and completeness. LA plans currently typically cover the period until 2025 and many are shorter. We have a good working relationship and regular liaison with the LAs in our region – see the 'case study' box in this chapter for further details.

To forecast property and population changes in our area for the 25-year planning period we contracted consultants Experian to develop forecasts as part of a collaborative project with eight other water companies[40]. The project developed three sets of forecasts for total population, household population, communal population and households. The three forecasts are:

- Plan based – using information provided by Local Authorities
- Trend based – using the latest information from official statistics
- Most likely – Experian's expert view on likely outcomes based on information available.

The project was structured to provide outputs in two phases to support the development of the Water Resources Management Plan. Phase 1 outputs were produced by Experian in July 2012 to support the draft Plan and a Phase 2 analysis to incorporate the outputs from the 2011 Census was undertaken in May 2013 and so the updated results were incorporated into the revised draft Water Resources Management Plan. No further changes were made before we published the final Plan.

Projections were developed in accordance with the Water Resource Planning Guidelines (2012) and the Environment Agency's methodology[41]. Experian's reports[42] from the project are available as technical appendices to this Plan; the key elements of their work are summarised below.

<u>Forecasting methodology summary</u>

- To develop the plan based household forecasts Experian requested information from LAs on our behalf using the template in the in the EA methodology report in April/May 2012. 45% of the LAs in our region provided information from their Local Plans to support the exercise. Where information was not provided by the LAs, it data was obtained from alternative sources including County Councils, Local Authority Plans, Core Strategies, Local Development Frameworks or Annual Monitoring Plans. Plan based population forecasts were then developed by converting dwelling figures from each of the plans to households and added on to the base year to produce a plan-based household forecast.
- The trend based forecasts were developed from a combination of the most up-to-date sub-national estimates and population projections (2010) from ONS applied to DCLG projections of average household size to derive a district level projection of the number of households.
- The approach taken to develop the most likely forecasts was to assume that the trend-based population projections are achieved (which is supported by stochastic analysis that shows that the projections have generally been very close to outturn) and to develop a model of the rate of household formation and average household size to develop a household property forecast.

[40] Companies involved in the collaborative project were: Southern Water, Thames Water, Wessex Water, Sembcorp Bournemouth Water, Portsmouth Water, South East Water, Sutton and East Surrey Water, Affinity Water (Central, East and South East) and Welsh Water.
[41] Environment Agency (2012). Methods of estimating population and household projections: update 2012.
[42] Experian (July 2012). Population, household and dwelling forecasts for WRMP14: Phase 1. Experian (June 2013). Population, household and dwelling forecasts for WRMP14: Phase 2.

- All forecasts were produced at the Census Output Area level which could be aggregated into water resource zone area (i.e. company area) projections.

The remainder of this section outlines the household forecasts; see Section 5.5 for discussion of the population forecasting work that was undertaken as part of the same project.

No adjustments have been made to the property forecasts to account for new connections that were previously private supplies; analysis of company records has shown that there has been typically fewer than 20 such connections per annum in recent years and so the impact on the demand forecast will be immaterial.

<u>Household properties – forecasts</u>

The plan, trend and most likely property forecasts developed by Experian in Phase 1 and Phase 2 and actual historical numbers of new households are shown in Figure 5-7; the data are also summarised and compared in Table 5-3.

Figure 5-7: Actual historical and alternative property forecasts

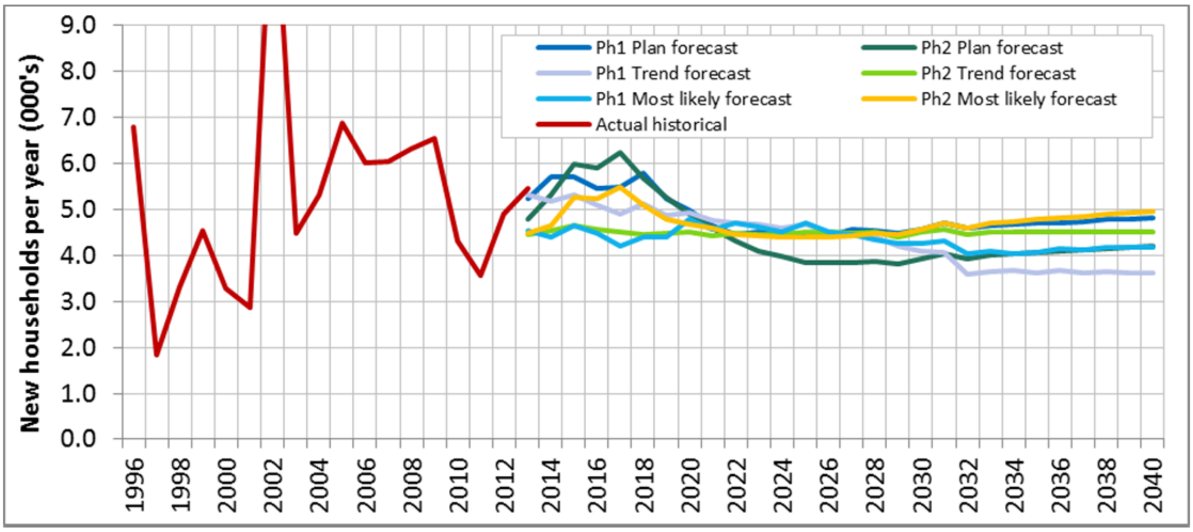


Table 5-3: Comparison of the key features of the alternative property growth projections (including voids)

Forecast		Actual 1994/95 – 2011/12	AMP6 2015/16 – 2019/20	Full planning period 2011/12 – 2039/40
Actual		+5.3k h'holds average per yr 532k h'holds in 2011/12	-	-
Phase 1	Plan	N/A	+5.2k h'holds average per yr 574k h'holds in 2019/20	+4.6k h'holds average per yr 662k h'holds in 2039/40
	Trend	N/A	+4.8 h'holds average per yr 571k h'holds in 2019/20	+4.1k h'holds average per yr 650k h'holds in 2039/40
	Most likely	N/A	+4.3k h'holds average per yr 567k h'holds in 2019/20	+4.2k h'holds average per yr 650k h'holds in 2039/40
Phase 2	Plan	N/A	+4.5k h'holds average per yr 594k h'holds in 2019/20	+4.4k h'holds average per yr 677k h'holds in 2039/40
	Trend	N/A	+3.7k h'holds average per yr 586k h'holds in 2019/20	+4.5k h'holds average per yr 679k h'holds in 2039/40
	Most likely	N/A	+4.1k h'holds average per yr 589k h'holds in 2019/20	+4.7k h'holds average per yr 685k h'holds in 2039/40

Figure 5-7 and Table 5-3 show that Experian's forecasts all look broadly reasonable in the context of the historical figures although all forecasts suggest a lower rate of house-building in our region than we have experienced in the past.

In the first few years of the Phase 2 forecasts (up to 2020) the plan based forecast suggests the highest levels of house building of approximately 4,500 properties per annum, while the most likely and trend forecasts suggest more modest rates of growth of approximately 4,100 properties and 3,700 properties per annum. The resulting difference between the highest and lowest of Experian's three Phase 2 forecasts by 2019/20 is 8,000 properties which is less than 2% of total household properties in the base year, which would have a small impact on the overall demand forecast.

The trend and most likely Phase 2 forecasts are very similar through the period 2020 to 2030, while the plan forecast is somewhat lower; by the end of the planning period the overall difference between the three forecasts developed by Experian remains at less than 2 % of the base year properties.

We selected to use Experian's most likely Phase 2 forecast for our central demand forecast because it was felt the period up to 2020 could most reasonably follow the recent actual house-building rates our area has experienced.

CASE STUDY: Liaison with local authorities – a business as usual activity

As a water company we require population and property projections at two scales – on one hand, information is needed on development hot-spots at a spatially refined level and, on the other hand, information is needed on the overview of population and property growth over a 25 year horizon to meet regulatory water resource planning needs (Environment Agency, June 2012). Within Wessex Water two teams within the same Directorate oversee these two complimentary planning needs and associated processes.

Liaison with local authorities to discuss planning and development issues is a regular activity for Wessex Water. Our Planning Liaison Team has a good working relationship with the 20 local authorities in our area. At a technical level the team closely monitors local development plans/core strategies with meetings held as required. Individual authorities and developers are also engaged with to discuss and review specific planning issues.

At a strategic level we host a quarterly 'Services and Planning' customer liaison panel. Membership of this panel comprises local authority planning officers, councillors and building developers. The Panel meetings usually involve presentations from Wessex Water staff on topical issues and offer an opportunity for external delegates to ask questions and discuss our approach to various issues. Recently the Panel were involved in reviewing and challenging the early drafts of our Strategic Direction Statement and they have also been consulted on the development of this Water Resources Management Plan during the pre-consultation phase.

Non-household properties – forecasts

The number of **unmeasured non-household properties** decreases through the planning period from just over 5,400 in the base year to just over 1,500 in 2039/40 as a result of customers becoming metered either optionally or selectively.

- **Non-household optional metered customers:** 12 years of data from 2000/01 to 2011/12 was analysed – on average 166 or 2.4% of unmeasured non-household customers opt to move to a metered supply every year. This detail has a minor influence on overall non-household demand but for forecasting purposes it is assumed that 2.4% 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. For forecasting purposes it is assumed that 2% of unmeasured non-household customers become metered each year of the planning period.

The number of **measured non-household properties** increases through the planning period from approximately 45,500 in the base year to approximately 47,000 in 2039/40 as a result of unmeasured non-household customers becoming metered and new non-household connections net of non-household account closures. An analysis of data reported in Table 7 of regulatory returns since 2007/08 reveals that on average there are 542 new non-household property connections each year. However, during the same period there has been a net decline in overall non-household properties, as a result of disconnections, amounting to 122 less properties on average each year – this value is used for forecasting.

5.4 Population

Population in the south-west has grown at a greater rate than any other region of the UK over the last twenty years. This growth has been caused by inward migration to the region from other areas of the UK, particularly London and the south-east. International migration, particularly from other EU countries has led to a recent net positive increase in population.

Since 1994/95 population in the Wessex Water supply area has grown from around 1.14 million people to approximately 1.27 million in 2011/12. This represents a long-term average growth rate of 0.6% per annum.

5.4.1. Base year population

Total population – base year

Total population in 2011/12 as reported in Table 7 of our Regulatory Return in 2012 was 1,264,800 people. This was calculated as follows:

- The starting point for the 2011/12 data is the Office of National Statistics' (ONS) data publication of mid-year 2010 population data which is the most recent information available at Local Authority area level.
- The Local Authority populations are apportioned according to the percentage of their area in Wessex Water's company area using 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; this is 8,800 properties.
- 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 (330 people).
- An upward adjustment of 0.6% was also made to account for population growth in the 15 months since mid-2010 to the middle of reporting year 2011/12. This growth factor was calculated by Cambridge Econometrics; they provide us with annual population growth factors specific to the Wessex Water area.

However, the information from the 2011 Census that was published following the submission of our draft Water Resources Management Plan has enabled us to restate population figures for the base year of our Plan to take account of the new information. Total population in 2011/12 that was used for the revised draft (now final) Plan was 1,290,208. The Census 2011 therefore identified an additional 25,408 people (2%) in the Wessex Water region in 2011 than had previously been estimated by ONS for the year. The new population figure that we are using for the base year of our Plan, takes account of Local Authority area apportionment, private supplies and inset appointments as above.

Household population – base year

The **measured household population** for the base year (509,621 people) is consistent with the updated population estimates in light of the 2011 Census (and is therefore higher than the figure reported in Table 7 of our Regulatory Return for 2011/12; 491,129 people).

The **unmeasured household population** for the base year (645,557 people) is consistent with the updated population estimates in light of the 2011 Census (and is therefore higher than the figure reported in Table 7 of our Regulatory Return for 2011/12; 632,493 people).

Household occupancy survey information was used to derive the split of total household population into measured and unmeasured categories for the base year.

Non-household population – base year

Measured non-household population reflects the communal population (sheltered housing, guest accommodation, student accommodation and prisons). Measured non-household population for the base year (45,191 people) is consistent with the updated population estimates in light of the 2011 Census (and is therefore higher than the figure reported in Table 7 of our Regulatory Return for 2011/12; 44,304 people).

Unmeasured non-household population contains the balance of the connected population not contained in any other category; the base year value (89,839 people) was calculated using the updated population estimates in light of the 2011 Census.

We do not consider that our supply area has a significant proportion of unaccounted-for population (e.g. clandestine / illegal population) that would have a material impact on our supply-demand balance and so we have not included an allowance for any unaccounted-for population in our base year or forecasted data.

5.4.2. Population forecasts

Total population - forecast

Experian assisted us in the development of our population growth forecast for the planning period as part of the collaborative project described in Section 5.4.2 (property forecasts). Full details of the work they undertook are available in their reports[43]; their methodological approach is summarised in Section 5.4.2 and the population forecast outputs are summarised below.

Figures 5-8 and 5-9 show the Phase 1 and Phase 2 plan, trend and most likely forecasts for **total population** in comparison with actual population since 1995 and a projection forward of the historical growth trend (0.6%) in terms of absolute population (Figure 5-8) and annual growth rates (Figure 5-9).

[43] Experian (July 2012), Population, household and dwelling forecasts for WRMP14: Phase 1 draft final report.
Experian (June 2013). Population, household and dwelling forecasts for WRMP14: Phase 2.

Figure 5-8: Historical total population and alternative projections of future total population

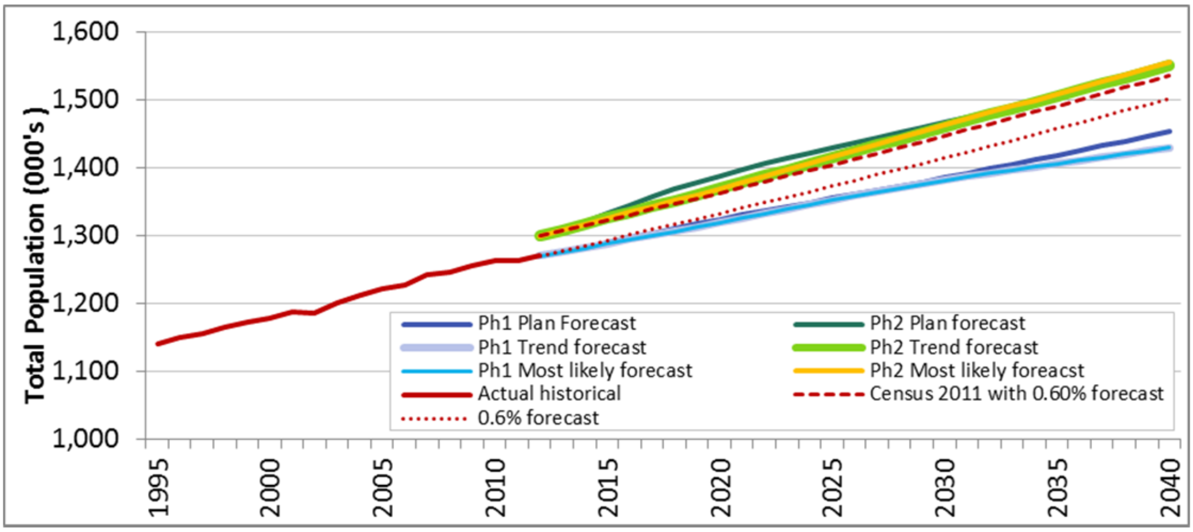
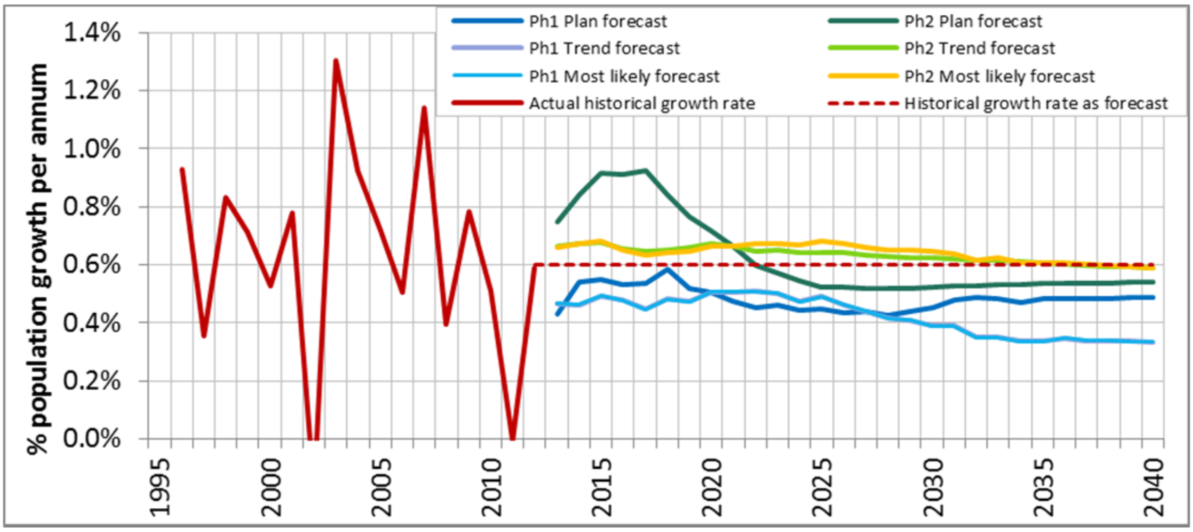


Figure 5-9: Historical total population growth and alternative future population growth rates



The charts above show that Experian's Phase 2 projections suggest higher population growth rates than their Phase 1 forecasts. Of the Phase 2 projections the trend and most likely most closely correspond to the historical average growth rate for our region (0.6% per annum). Experian comment that previous trend based forecasts for the UK have been broadly achieved and where they have been inaccurate the errors are biased to the upside – i.e. population is more likely to be higher than projected rather than lower. There also appears to be little evidence of population growth abating in recent statistics[44].

Table 5-4 below summarises the key features of each forecast. It suggests that that at the end of the planning period the difference in total population between Experian's three Phase 2 forecasts cumulatively amounts to approximately 10,000 people (approximately 0.8% of the current population) which would have a small impact on the overall demand forecast.

We have selected to use the Phase 2 trend based population forecast in our baseline demand forecast and have accounted for the uncertainty surrounding population growth rate

[44] Experian (July 2012), Population, household and dwelling forecasts for WRMP14: Phase 1 draft final report.

forecasts by allowing for a 0.5% and a 0.8% lower and upper growth rates in our headroom modelling – see Section 6 for further details.

Table 5-4: Comparison of the key features of the alternative population projections*

Forecast		Actual 1994/95 – 2011/12	AMP6 2015/16 – 2019/20	Full planning period 2011/12 – 2039/40
Actual		+0.6% average per yr +7.6k people average per yr 1.27m people in 2011/12 1.29 people in 2011/12 rebased for Census 2011	+0.6% average per yr +6.3k people average per yr 1.37m people in 2019/20	+0.6% average per yr +8.0k people average per yr 1.51m people in 2039/40
Phase 1	Plan	N/A	+0.45% average per yr +5.6k people average per yr 1.34m people in 2019/20	+0.50% average per yr +6.3k people average per yr 1.45m people in 2039/40
	Trend	N/A	+0.40% average per yr +4.9k people average per yr 1.32m people in 2019/20	+0.43% average per yr +5.5k average per yr 1.43m people in 2039/40
	Most likely	N/A	+0.40% average per yr +4.9k people average per yr 1.32m people in 2019/20	+0.43% average per yr +5.5k people average per yr 1.43m people in 2039/40
Phase 2	Plan	N/A	+0.67% average per yr +8.9k people average per yr 1.37m people in 2019/20	+0.66% average per yr +8.5k people average per yr 1.53m people in 2019/20
	Trend	N/A	+0.53% average per yr +7.0k people average per yr 1.36m people in 2019/20	+0.67% average per yr +8.6k people average per yr 1.53m people in 2019/20
	Most likely	N/A	+0.52% average per yr +6.9k people average per yr 1.36m people in 2019/20	+0.68% average per yr +8.7k people average per yr 1.54m people in 2019/20

* All population figures are for total resident population and so have not been corrected to allow for unconnected population (i.e. private supplies and inset appointments).

Household population and occupancy – forecasts

Measured household population is forecast in its constituent sub categories as below and reported in Table WRP2a:

- **New properties population** is a function of the forecast number of new properties in the year and their assumed occupancy with an annual adjustment for the change in overall household occupancy. New properties are assumed to have the overall average household occupancy which is 2.22 in 2012/13 (the first year of the forecast) falling to 2.11 in 2039/40.
- **Meter optants population** is a function of the number of new optant households in the year and their assumed occupancy with an adjustment for the change in overall household occupancy. To derive the occupancy of optant households for the base year we analysed a sample of 3,469 customers that opted to become metered between April and September 2010. Average optant household size was found to be 1.67 which was used for 2012/13 (the first year of the forecast). It is reasonable to assume that optant household size will increase through the planning period as the smallest households opt first as they potentially have more to gain and so optant households progressively become larger, thus driving the average size upwards. Optant occupancy is modelled to increase each year by the magnitude of change in overall average household size so that in 2039/40 it is 1.77.
- **Metering on change of occupancy population** – our baseline forecast does not assume any households are metered on change of occupancy – we have however examined the impact of this policy as an option. The population that would be

metered on change of occupancy is modelled as a function of the number of households being metered each year and their assumed occupancy with an adjustment for the change in overall household occupancy. The occupancy of these selectively metered households is assumed to be the overall average household occupancy which is 2.22 in 2012/13 (the first year of the forecast) falling to 2.11 in 2039/40.

- **Selective metering population** – our baseline and final planning forecasts do not propose to compulsory meter any households during the planning period.
- **Compulsory metering population** – our baseline and final planning forecasts do not propose to compulsory meter any households during the planning period. The policy is however considered in Section 8.3 and for this purpose the population is modelled as a function of the number of households being metered each year and their assumed occupancy (overall average) with an adjustment for the change in overall household occupancy.

Unmeasured household population 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. Over the planning period the unmeasured household population is forecast to reduce from around 646,000 in the base year to around 308,000 in 2039/40 as properties become progressively metered (optants only in baseline forecast). Over the planning period the average occupancy of an unmeasured household increases from 2.56 in the base year to 4.31 in 2039/40.

Figure 5-10 illustrates the changes in household occupancy through the planning period for the different customer types described above. The overall reduction in average household occupancy from 2.22 in the base year to 2.11 at the end of the planning period is a result of the growth rate for new properties exceeding the population growth rate.

Figure 5-10: Household occupancy changes (baseline demand forecast)

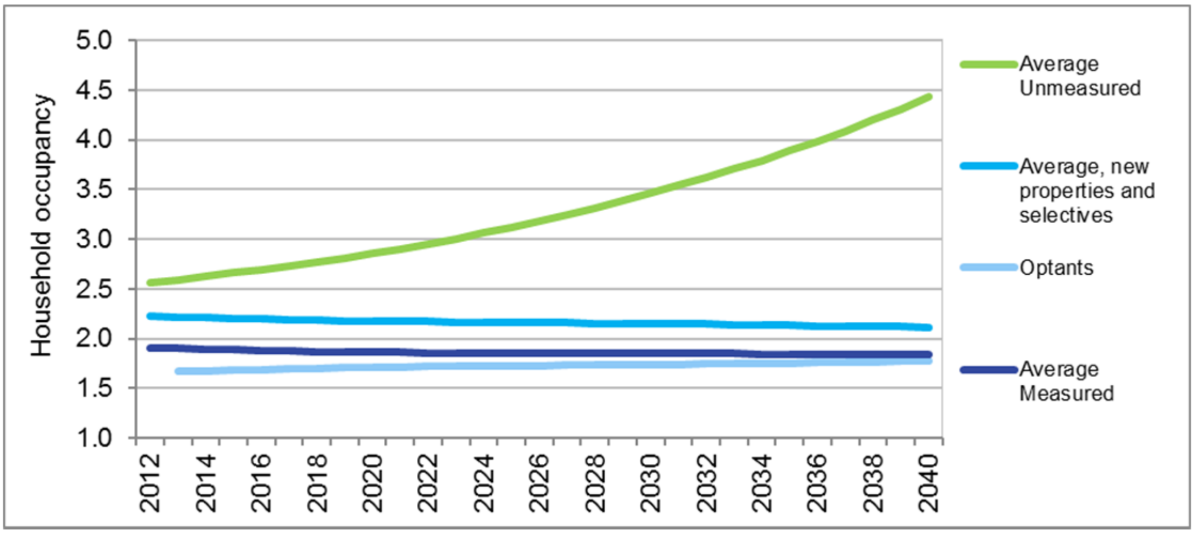


Figure 5-11 summarises population changes in the each of the household type categories through the (baseline) planning period, and Figure 5-12 shows the changes in terms of household property numbers.

Figure 5-11: Household population by customer type (baseline demand forecast)

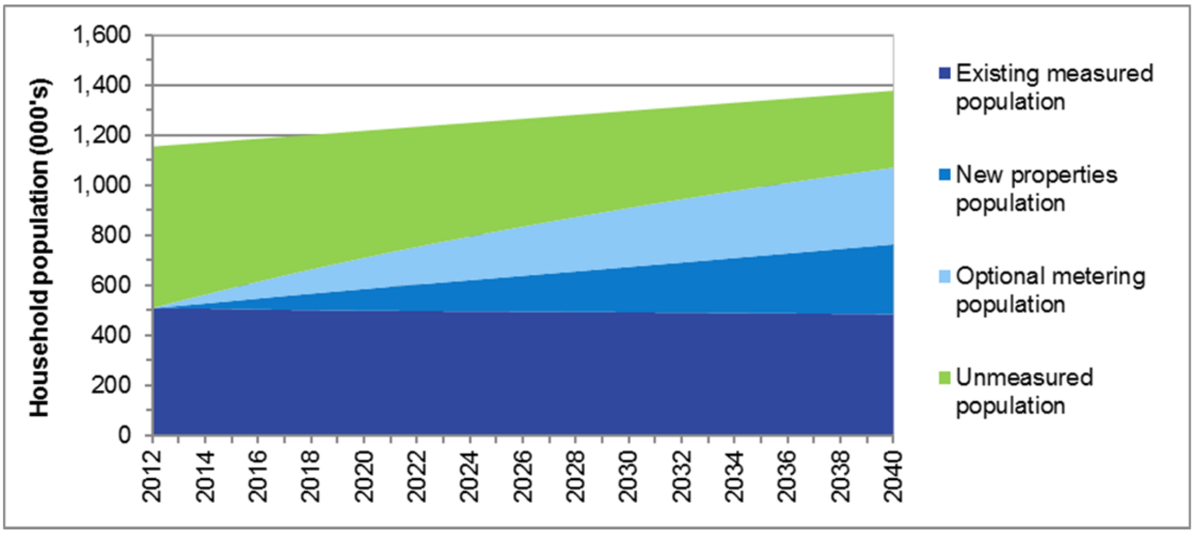
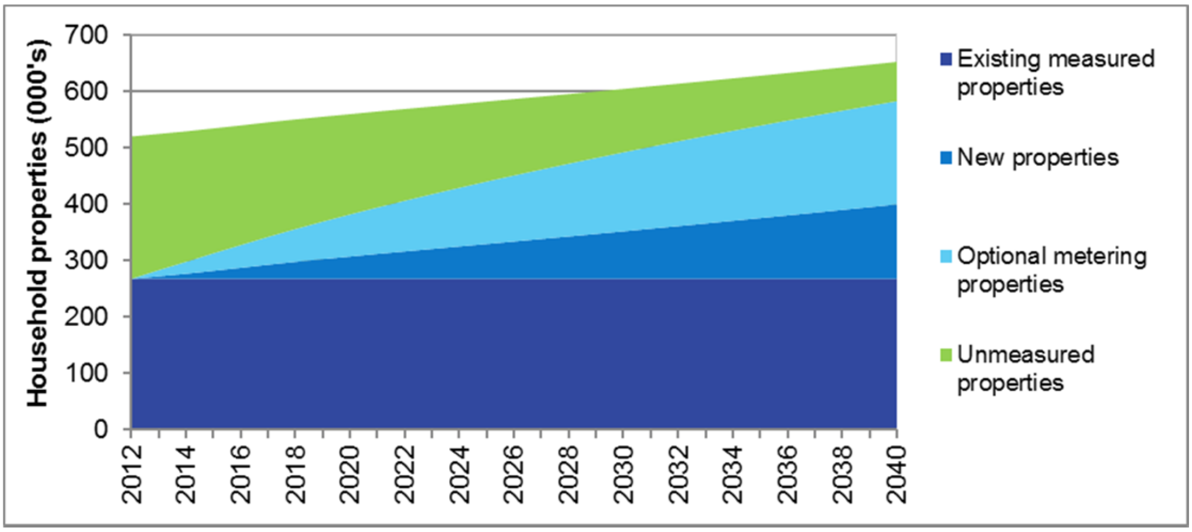


Figure 5-12: Household property numbers by customer type (baseline demand forecast)



<u>Non-household population – forecasts</u>

Non-household measured 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 45,191 people in the base year to 114,947 people in 2039/40.

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 89,839 people in the base year to 39,348 people in 2039/40.

5.5 Household water consumption

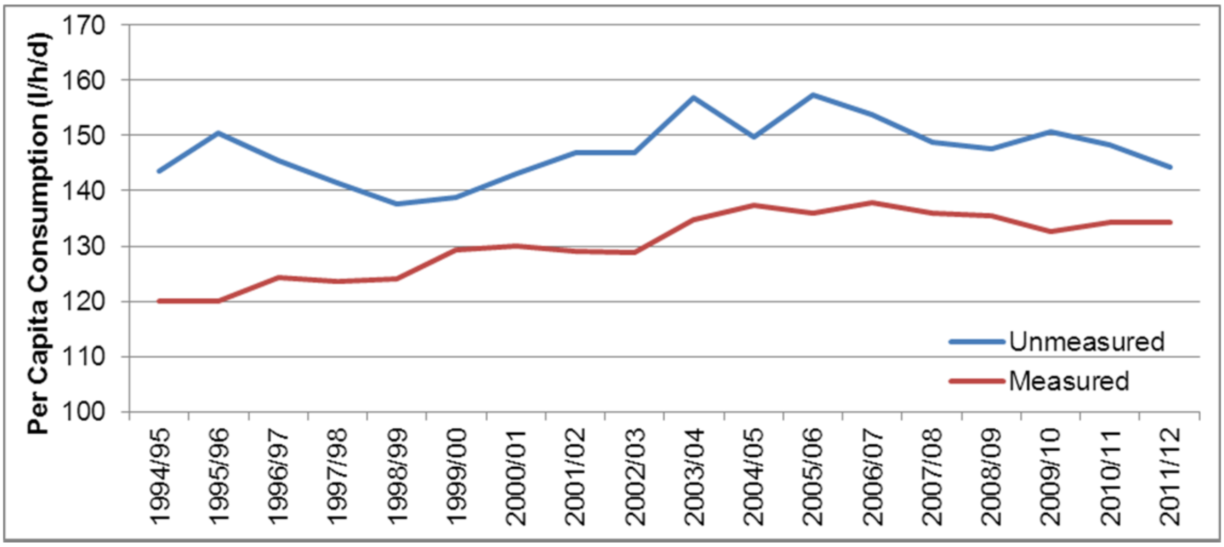
In parallel to determining the size of the population and the number of households we expect to need to supply in our region we need to consider how much water on average each person will require (per capita consumption) and how these demands may change through the planning period.

In this section we review per capita consumption (PCC) for unmeasured and measured households using a range of analysis approaches as referred to by the Water Resource Planning Guidelines (October 2012).

Actual outturn per capita water consumption in the Wessex Water region in 2011/12 reported in our Regulatory Return was 144 litres per head per day for unmeasured customers and 134 litres per head per day for measured customers. Weighted average PCC was 140 l/h/d.

Figure 5-13 shows the change in average PCC for unmeasured and measured households since 1994/95. There appears to be an overall upwards trend in both household types until the mid-2000's, and since then they have flattened out and started to decline.

Figure 5-13: Actual outturn per capita consumption in unmeasured and measured households since 1994/95



It is reasonable to expect an underlying increase in PCC in unmeasured households as each year several thousand of the unmeasured households 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 will exhibit an underlying downward trend in PCC as each year several thousand new homes are built[45] that are increasingly water efficient and measured customers are also more likely to take up water efficient behaviours and devices as they stand to financially benefit from reducing their water use.

However, it is important to note that the data shown in Figure 5-13 are actual outturn data (not normalised) and as such they are strongly influenced by several explanatory variables including weather patterns, which should be taken into account when interpreting any apparent trends. It is possible that the decline in PCCs since 2005 can be explained by

[45] All new houses are metered.

reoccurrence of wet summers which have acted to supress demand. For discussion of normalised demand patterns and explanatory variables see Section 5.2 on weighted average demand.

The new population estimates arising from the 2011 Census lead us to restate our base year PCCs – other things being equal more people living in the same number of properties and with the same volume of water delivered means each person uses proportionally less water and PCCs fall. Table 5-5 compares PCC values for the base year (2011/12) from the 2012 Regulatory Return, the draft Plan following the normalisation process outlined in Section 5.2 and the new figures used for the revised draft (now final) Plan that include the impact of the ONS's updated population estimates.

Table 5-5: Per capita consumption for 2011/12 for different reporting/ planning scenarios

All values in litres per head per day	Actual outturn Regulatory Return 2012	Draft Plan (normalised outturn)	Revised draft (final) – includes impact of 2011 Census and normalisation
Measured PCC	134.7	134.7	132.4
Unmeasured PCC	144.7	149.6	147.2
Weighted average PCC	140.4	142.3	139.5

Per capita consumption values reported in this report relate to the average year scenario. Values that are reported in the water resource planning tables are for the dry year annual average and dry year critical period scenarios.

5.5.1. Unmeasured per capita consumption – base year

Unmeasured PCC values reported in our annual Regulatory Returns are derived from our domestic unmeasured consumption monitor set up over 10 years ago. The monitor design, data collection and analysis methods follow the UKWIR best practice guidance[46] (1999). Key features of the monitor are listed below:

- The households that are included in the monitor were selected to be representative of the region's mix of property types, ACORN[47] categories, household sizes, council tax bands and geographic locations.
- We aim to maintain the monitor to include approximately 1,000 households; when customers leave the monitor (i.e. they may opt to become a standard measured customer) additional customers are recruited.
- Households on the monitor are fitted with a meter and logger that captures water consumption data at 30-minute intervals. Data is downloaded to our systems monthly using 'drive-by' meter reading technologies. The consumption data is reviewed and where supply pipe leaks are suspected the property is excluded from the analysis, so that true consumption is not overestimated.
- PCC is calculated (on a per property basis) by dividing the overall household consumption by the household occupancy. Occupancy data is collected through a survey when households sign up to be on the monitor. This information is reviewed and updated as necessary at least every two years.

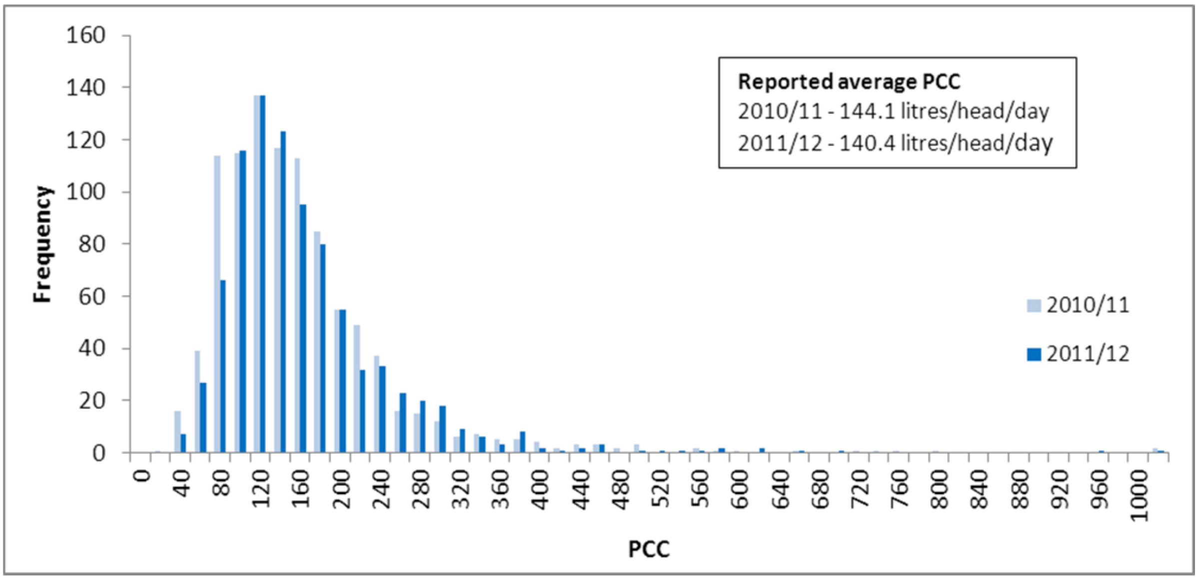
[46] UKWIR (1999). Best practise for unmeasured per capita consumption monitors.
[47] ACORN is a geodemographic information system categorising UK postcodes into various types based on census data and other information. The population is divided into 5 categories from *Wealthy Achievers* to *Hard Pressed.*

- The reweighting method outlined in the best practice guidance is applied to ensure that the households on the monitor, and therefore the reported PCC, are representative of the company's wider customer base. Monthly PCCs are calculated for different household sizes and then the proportion of each household size in the monitor is reweighted to reflect the overall composition of households in the Wessex Water area.
- Adjustments are also made to account for 'meter under registration' and average supply pipe leakage. The meter under registration adjustment is the addition of 1.3% to the average PCC – this is less than our standard meter under registration adjustment (2.38%) as most of the meters used in the consumption monitor are younger than the average meter age owing to a replacement programme in 2008/09. Average supply pipe leakage is assumed to be 46 litres per property per day which is apportioned to the PCC value by the average occupancy (see Section 5.7 for more information on supply pipe losses).

It is important that we review our consumption monitor to understand variability around the average PCC particularly in the context of housing type, occupancy and other socio-economic influences. An analysis of the unmeasured PCC reported for 2010/11 and 2011/12 (base year) is presented below. Figures 5-14 to 5-16 show the range of PCC values from the monitor, how PCC varies by household size and by ACORN classification.

Figure 5-14 illustrates that the distribution of PCC values for households in the monitor in 2010/11 and 2011/12 are similarly distributed. They are positively skewed which is to be expected as the distributions are bounded by a minimum value (zero) but are not bounded by an upper value. Both years have PCCs concentrated around the average reported PCC with a limited spread of high PCC values.

Figure 5-14: Unmeasured consumption monitor PCC distribution for 2010/11 and 2011/12



N.B. The high values presented in this histogram were left in the analysis. They represent plumbing losses and therefore actual consumption.

Figure 5-15 shows average PCC by household size for 2010/11 and 2011/12. Again this data show relative consistency between the different years of information and illustrate a trend of decreasing PCC with increasing household size. This trend is linked to the 'economies of scale' on a per person basis that larger households have when undertaking activities such as garden watering, cleaning and dish washing – i.e. the water used for these activities is shared amongst more people and so their per capita use is lower.

Figure 5-15: Average PCC by household size in 2010/11 and 2011/12

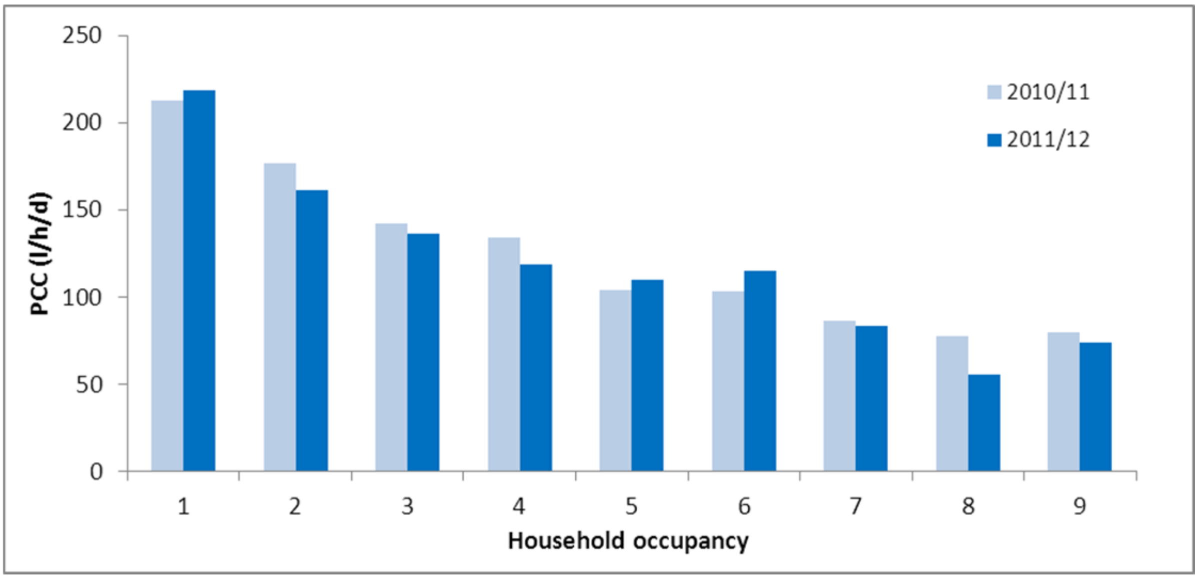
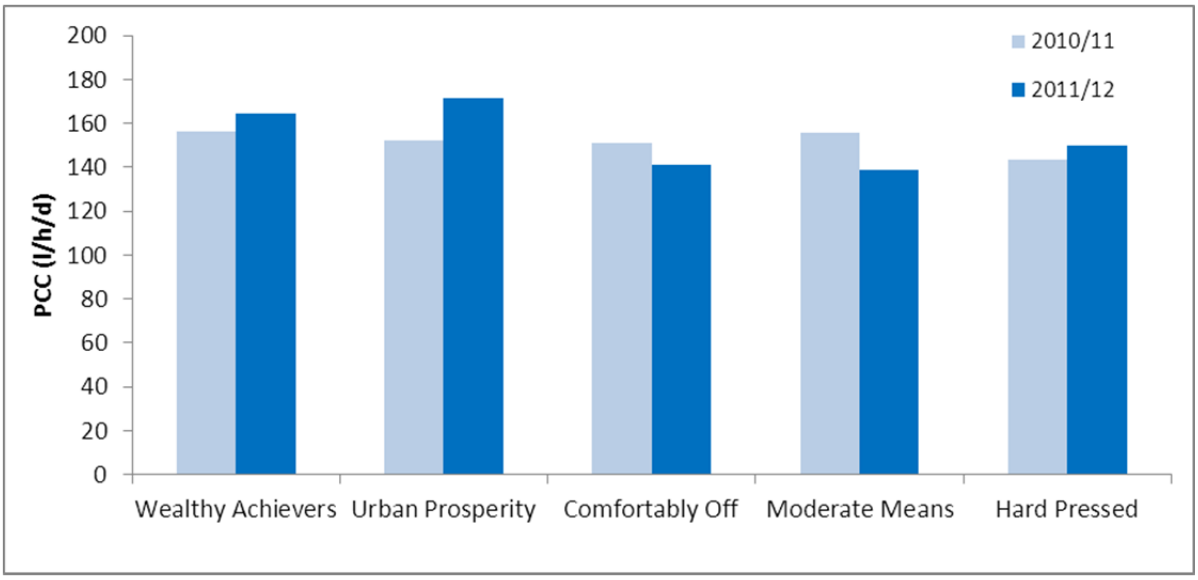


Figure 5-16 shows that per capita consumption does not typically vary across the ACORN categories; this is comparable to the findings of our Tariff Trial which found no statistically significant differences in consumption between different ACORN groups.

Figure 5-16: Average PCC by ACORN categories in 2010/11 and 2011/12



A comparison of the size and the ACORN categories of households in the monitor in 2011/12 is presented in Figures 5-17 and 5-18.

Figure 5-17: Household occupancy rates for company area and consumption monitor

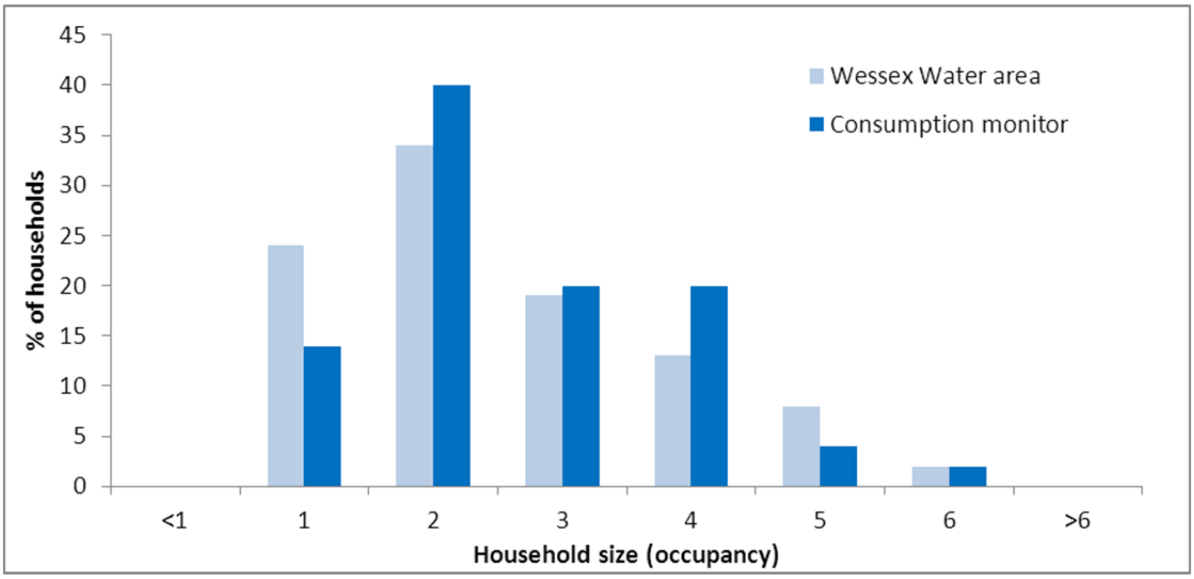
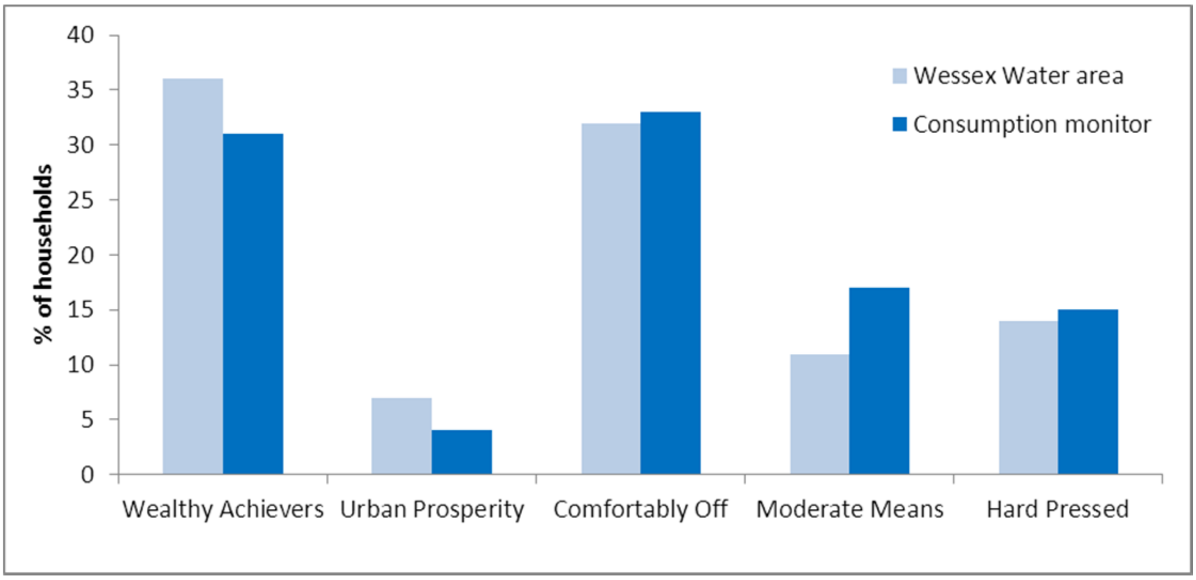


Figure 5-17 shows that the monitor is not fully representative of the overall mix of household sizes in the Wessex Water area – there are fewer one person households on the monitor and more four person households. This reflects the tendency for smaller households to opt to be metered. As explained earlier this issue is overcome by following a reweighting process as outlined in the best practice guidelines.

The average occupancy of properties on the monitor in 2011/12 was 2.67. Average unmeasured occupancy for the whole area in 2011/12 was 2.56.

Figure 5-18 demonstrates that the customers currently on the consumption monitor are representative of the wider Wessex Water area in terms of ACORN classification.

Figure 5-18: Comparison of customers in each ACORN category in the full Wessex Water area and the unmeasured consumption monitor



5.5.2. Measured per capita consumption – base year

Measured per capita consumption in the base year (132.4 l/h/d) was 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 2011 Census.

5.5.3. Forecasting per capita consumption

Micro-component modelling

The micro-component approach to forecasting domestic water demand is a way of understanding customer water use in the context of individual water using devices and behaviours and how these might change in the future.

The approach we used was consistent with the approach outlined by the 2012 UKWIR project on household consumption forecasting[48] and the Water Resource Planning Guidelines.

The methodology requires a micro-component approach segmented by measured and unmeasured households to identify how consumption will vary for each micro-component over the forecast period. It is a very detailed bottom-up approach involving a large amount of underpinning information and assumptions.

The approach consists of the following key elements:

- Subdivision of household water consumption into different activities and categories
- 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.

For the development of this Water Resources Management Plan we contracted consultants Tynemarch to develop the structure of a new micro-component model for our measured and unmeasured customers, to replace and improve on the model we used to support the previous two Plans. Tynemarch's technical report[49] is available as an appendix to this Plan.

In parallel to developing a new model for our micro-component analysis we also undertook a full review of data inputs for the model. We developed our input assumptions from a variety of data sources including company specific records (e.g. information from responses to our Energy Saving Trust water use calculator) and national data sets (e.g. Defra's Market Transformation Programme of trends in water using appliances and behaviour). We followed the best practice guidance outlined by the relevant recent UKWIR project on household consumption forecasting and our research. Analysis and commentary is provided as a technical appendix to this Plan[50].

[48] UKWIR (2012) A good practice manual and roadmap for household consumption forecasting, Tynemarch and Blue Marble (CU02)
[49] Tynemarch (2012). Wessex Water demand forecast analysis for WRMP and PR14.
[50] Wessex Water (March 2013), Review of data sources for micro-component modelling to support the household consumption forecast.

The starting point for the micro-component forecasting is defining the base year split of water use. Figures 5-19 and 5-20 show how water is used by measured and unmeasured domestic customers in the base year (average year scenario).

The pie charts show that the vast majority of water use is in the bathroom; for toilet flushing and personal washing.

- For both measured and unmeasured customers personal washing forms the biggest component of household water use (46% and 44% total use respectively).
- Toilet flushing makes up 21% and 19% in measured and unmeasured households.

The other components of use are smaller, with clothes washing and dishwashing forming 11% and 5% of use in measured households, and 10% and 5% of use in unmeasured households. The miscellaneous use category includes a range of uses; cleaning, drinking and plumbing losses, and this is reflected in the values.

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

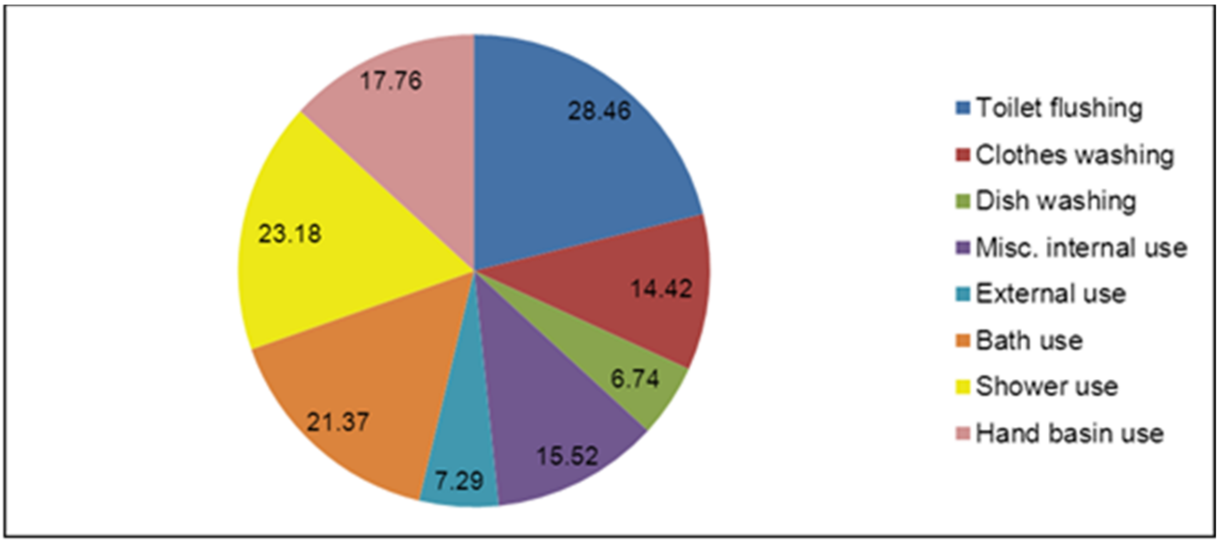
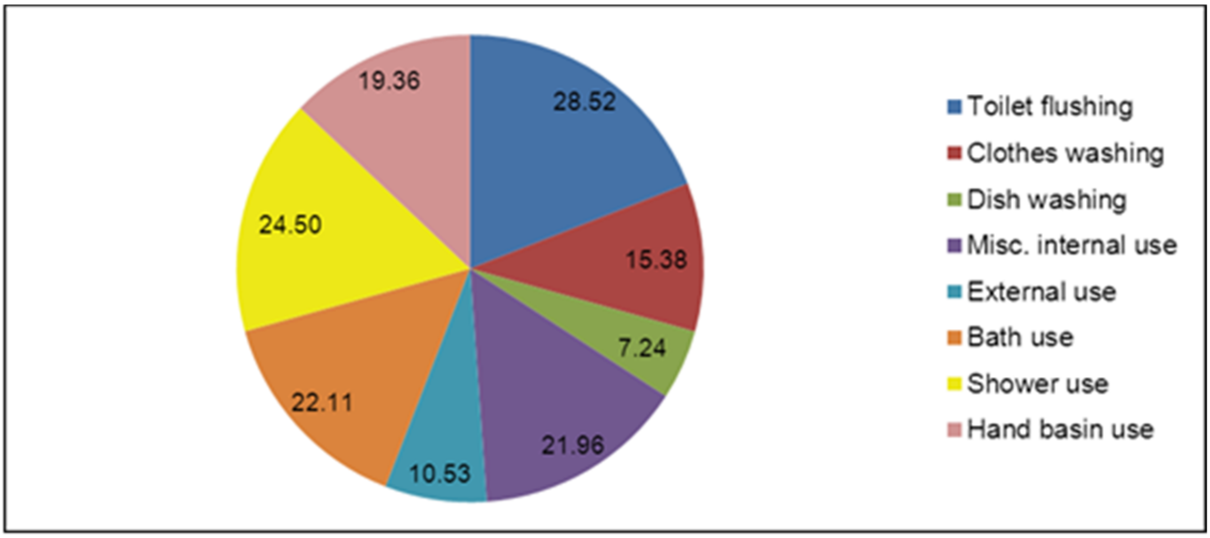


Figure 5-20: Unmeasured customer base year water use by micro-components in litres



A summary of the changes in ownership, frequency and volume of each of the key micro-components included in the model is provided in Table 5-6. For further details please refer to the technical appendix.

Table 5-6: 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	→	→	→	→	→	→
Overall trend		↓			↓↓	

* The 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 to table:
→ Change of less than 5% between 2011/12 and 2039/40
↓ Decrease of up to 5% between 2011/12 and 2039/40
↓↓ Decrease of between 5% and 10% between 2011/12 and 2039/40
↑ Increase of up to 5% between 2011/12 and 2039/40
↑↑ Increase of between 5% and 10% between 2011/12 and 2039/40

Key trends and explanatory factors:

- Toilet volume decreasing owing to increasingly small cistern sizes available
- Showering volume increasing due to more people showering, and for longer
- Bathing volume decreasing due to decreased bath ownership and frequency of use
- Dishwashing volume decreasing due to increased efficiency of machines
- Clothes washing volume decreasing due to increased efficiency of machines
- Unmeasured external use decreases due to increasing unmeasured household size.

Our baseline demand forecast assumes a continuation of current water efficiency activities throughout the planning period. The micro-component model therefore incorporates savings from our current (baseline) water efficiency activities relating to the distribution of devices such as save-a-flushes and shower flow regulators.

The information available to us to support our micro-component modelling for this Plan was greater than was available at the time of preparing our last Plan, as a result of our investment in customer research linked to our water energy calculator (in partnership with the Energy Saving Trust) and our tariff trial[51]. Nevertheless, in our review of available data sources we identified a number of data-gaps that would benefit from further research to support demand forecasts for the next planning period. These include:

- WCs - use frequency and volumes (existing and future stock)
- Showering - ownership by type, frequency, time and flow rates

[51] Tynemarch (February 2012), Wessex Water tariff trial project household consumption analysis final report

- Basin tap use - frequency of use
- Dishwasher use- ownership and efficiency, and frequency of use
- Washing machine ownership efficiency
- Hand-washing clothes – frequency and volume
- Miscellaneous use
- Impact of peak week scenarios on personal washing – bath and shower frequency.

The UKWIR (2012) study on 'Customer behaviour and water use' recommended further improvements to forecasting through further research of the relative importance of behaviour, property characteristics and household profile; household segmentation and the use of good practice to ensure consistent future data collection. We support these recommendations and look forward to taking part in UKWIR projects that will provide new information and approaches to the industry in time for the next Price Review (PR19).

We are also supportive of the water efficiency collaborative research fund which is likely to generate further information that can be used to support demand forecasting assumptions for the next Plan.

In addition, we intend to review opportunities for further data collection exercises specific to Wessex Water customers. We anticipate that our Smart Dorchester study, evolving partnerships with organisations such as the Centre for Sustainable Energy and existing work with the Energy Saving Trust will provide opportunities for research.

Meter optants, new properties and overall baseline per capita consumption forecast

Optional meter PCC at the start of the planning period was derived from the analysis of 1,333 households that opted to become metered between April and September 2010. The study calculated that average (post opting) PCC was 124.14 l/h/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 132 l/h/d (i.e. they are already more water efficient than the average unmeasured customer).

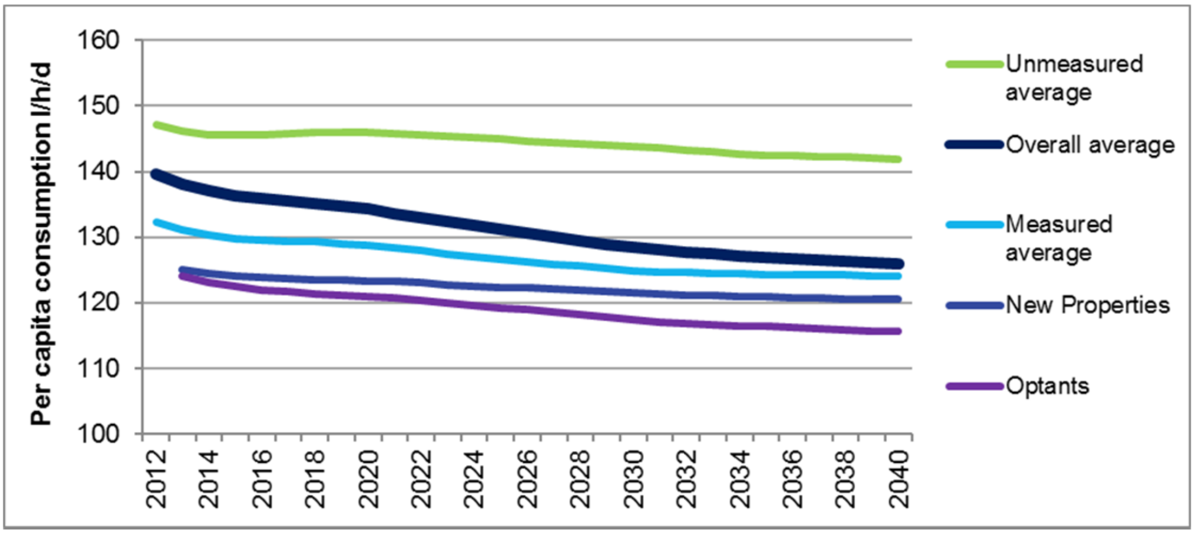
Post-opting PCC is assumed to marginally fall through the planning period (to 116 l/h/d in 2040) which is a result of the rising occupancy of this category of customer (from 1.67 in the base year to 1.77 in 2040) and that these households are expected to experience the same underlying change in PCC as the average existing measured customer, as derived by the micro-component analysis.

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[52]. 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 120 l/h/d by 2040.

[52] 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).

The overall changes in PCC by customer group are shown in Figure 5-21. It shows that measured average PCC is forecast to fall to 124 l/h/d by 2040 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 126 l/h/d in 2040.

Figure 5-21: Per capita consumption changes by customer group – baseline (average year) forecast



5.5.4. Impact of optional metering scenario (baseline forecast)

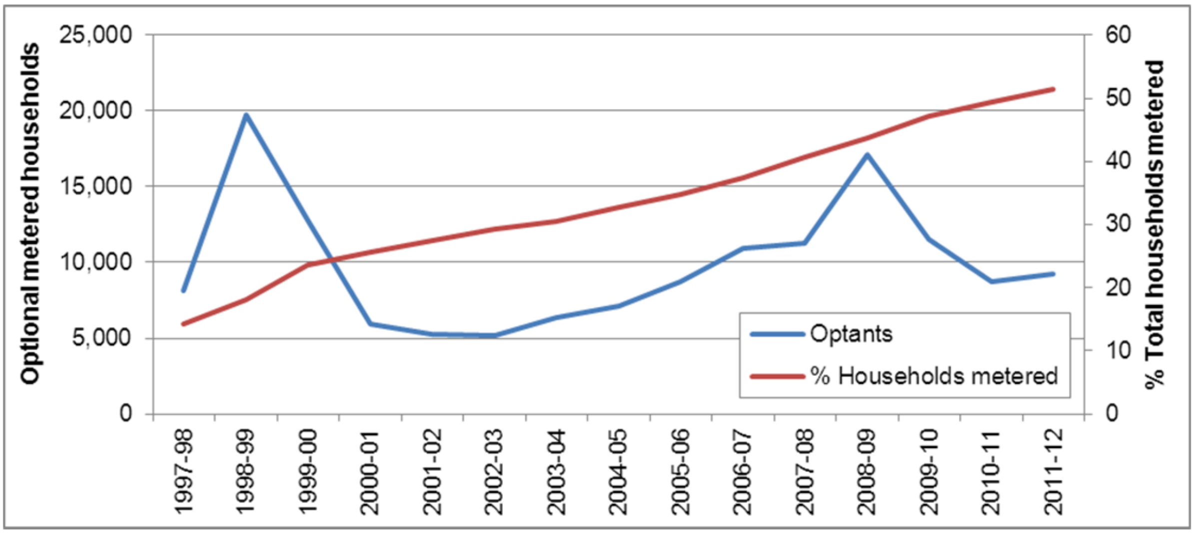
Our baseline demand forecast assumes a continuation of current policies and therefore only includes an optional metering policy. In the development of our Water Resources Management Plan we have also assessed the impact of introducing metering on change of occupier and compulsory metering – see Sections 5.5.5 and Section 8.3 for further details.

At present, just over 50% of the households we supply pay for their water services by metered volume. We have provided customers with the option of switching from an unmeasured supply to a metered supply for free[53] since 1996 and the proportion of our customer base that is metered has been steadily growing as a result.

Figure 5-22 shows that approximately 10,000 households opt to have a meter installed each year. There were particular peaks in meter optants in 1998/99 and 2008/09 as a result of increased promotion in those years of the benefits of choosing to be on a meter.

[53] 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 5-22: Meter optants and overall proportion of customers metered since 1997



To forecast the proportion of the unmeasured customer base that will opt to switch to metered charges each year of the planning period we commissioned consultants Tynemarch to develop a predictive model. Their technical report[54] is available as an appendix to this Plan and a summary of their work is provided below.

To develop a model the following information 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.

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

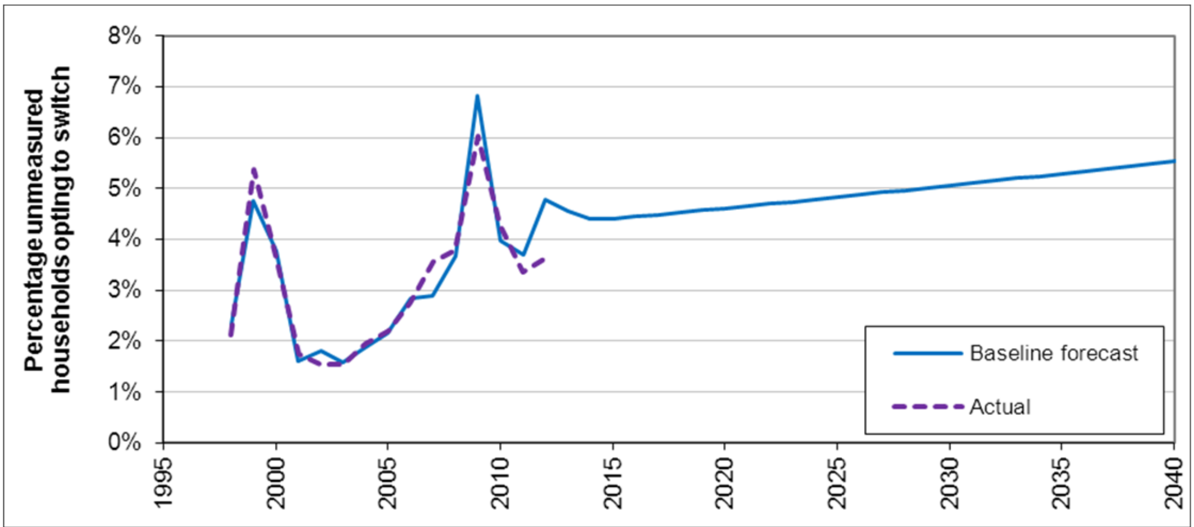
- Targeted promotion of meter opting as in 1998-99 and 2008-9 significantly increases the number of optants. There is also evidence to suggest it had an impact on the types of customers opting.
- There is some evidence to suggest that the level of opting is positively correlated with household income. 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.

The model developed 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 m^3 per year)
- Whether there was/is promotion of meter opting

Figure 5-23 shows the forecast of meter switching through the planning period as a proportion of the remaining unmeasured customer base and demonstrates the model's ability to accurately predict the actual historical proportion of meter optants. It suggests that the proportion of unmeasured customers opting each year will steadily increase from approximately 4.5% in the base year to 5.5% in 2040. This baseline forecast assumes no specific promotion (over and above current levels) and that customer bills will increase by inflation only.

Figure 5-23: Forecast percentage of unmeasured households switching to a metered supply



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. It the cost exceeds £1000 we offer to put the customer onto an 'assessed charge' instead meaning that instead of installing a meter we apportion the unmeasured charge for their property to account for the number of occupants and other water use defining characteristics. We currently have around 4,000 customers on an assessed tariff. An analysis of the numbers of optants and the number of customers moving onto assessed charges in each of the last ten years indicates that approximately 3.6% of potential optants have moved onto assessed charges instead. When factored up to the remaining unmeasured properties in our area it can be assumed that around 10,500 properties are 'unmeasureable' and this has been accounted for in the forecasting.

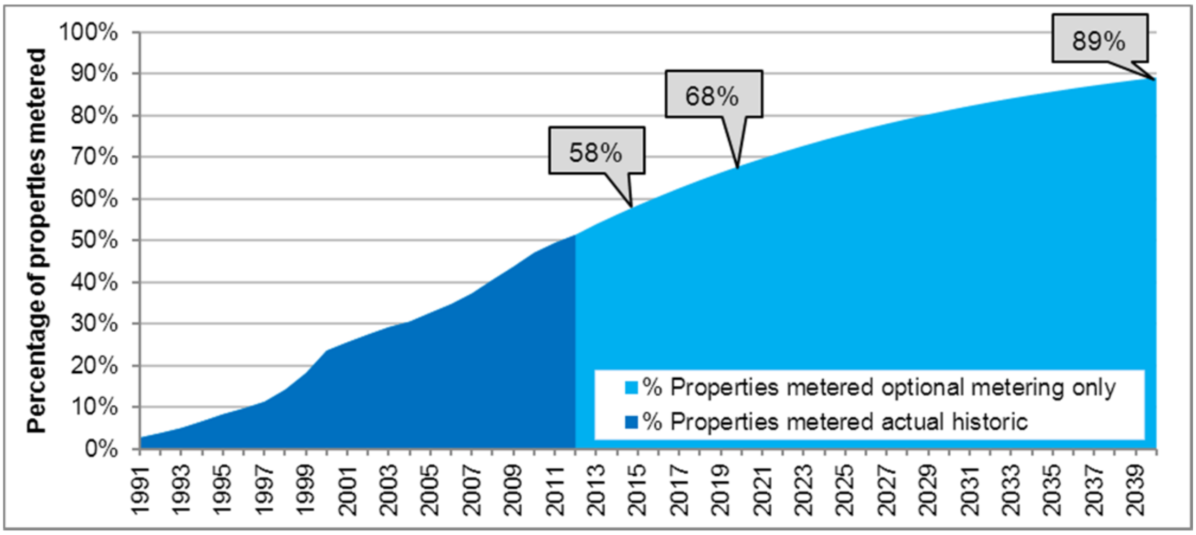
Table 5-7 indicates the numbers of households that the model forecasts will opt in each 5-year AMP period until 2040 (taking account of 'unmeasureable properties') and Figure 5-20 shows the impact this will have on overall meter penetration. The absolute number of optional meters installed each year will reduce through the planning period as the total number of unmeasured customers reduces.

Table 5-7: Baseline forecast of optional meters installed each AMP period

	AMP6 2015-20	AMP7 2020-25	AMP8 2025-30	AMP9 2030-35	AMP10 2035-40
Optional meters installed (000's)	43.6	36.1	29.5	23.8	19.0

Our baseline forecast of optional metering suggests that by 2019/20 the proportion of households in our area that are metered will rise to 68% and by 2039/40 this will have increased to 89% (Figure 5-24).

Figure 5-24: Historic and forecast meter penetration



We have assumed that households opting to move from an unmeasured supply to a metered supply will reduce their consumption by a 6% in response to the new price signal and their increased awareness of water efficiency. This is consistent with NERA's 2002/03 UKWIR report[55] which found average savings of between 2 and 14% and is also in line with Tynemarch's analysis of our customers that opted to be metered that were initially part of the unmeasured control group of our recent tariff trial (5.7% savings).

Table 5-8 indicates the impact on the annual average and critical period demand (distribution input) forecast of the water savings associated with optional metering. These savings are implicitly accounted for in the baseline demand forecasts.

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[55] UKWIR (2003). A framework methodology for estimating the impact of household metering on consumption – main report.

Table 5-8: Impact of optional metering within baseline demand forecasts (i.e. relative to a 'no optional metering scenario')

	2019/20	2024/25	2029/30	2034/35	2039/40
Impact on dry year annual average (Ml/d)	-2.8	-4.0	-4.6	-4.5	-4.3
Impact on dry year critical period (Ml/d)	-6.9	-9.4	-10.7	-10.7	-10.0

5.5.5. Impact of change of occupier metering an enhanced water efficiency programme (final planning scenario)

The baseline demand forecast includes only a continuation of our current optional metering policy however for our final planning forecast we have also undertaken an assessment of the impact of introducing a policy of change of occupier metering from 2015/16 (the start of AMP6) coupled with an enhanced water efficiency programme to assist customers to manage and reduce their water use.

The provision of water efficiency measures alongside an enhanced metering programme is in line with Government expectations outlined in the Water White Paper and Guiding Principles for the Water Resources Management Plan. In particular meets customer expectations identified through our customer research (see Section 8).

The change of occupier metering policy would mean that a meter would be installed on unmeasured households when we are notified of a new occupier (providing the cost of installation was less than £1000, for cost higher than this we would offer the customer assessed charges). The Water Industry Act 1991 gives water companies the power to install meters on a selective basis such as a result of a change in occupier providing unmeasured charges have not been raised for the customer against the property.

This section outlines the impacts of a change of occupier metering policy and enhanced water efficiency programme on the baseline demand forecast. Issues relating to customer preferences, costs and benefits are discussed in Section 8.

To forecast the impact on demand of a change of occupier metering policy assumptions are required regarding:

- The proportion of unmeasured households that change occupier each year
- The change in water consumption that occurs when a household moves from being unmeasured to being metered at the time that new occupiers move in.

To define our assumption on the proportion of unmeasured households that change occupier each year information was collected from our billing system and from national published statistics – a summary is presented in Table 5-9.

Table 5-9: Information on household changes in occupier from billing records and Office of National Statistics

	2003/4	2008/9	2009/10	2010/11
Total measured household properties	143,904	200,734	240,401	254,813
Total unmeasured household properties	327,037	284,060	269,981	260,306
Moves into a measured house in year	28,044	28,786	31,399	29,742
Moves into an unmeasured house in year	20,930	16,917	18,731	17,420
% measured households with change in occupier	19.5%	14.3%	13.1%	11.7%
% unmeasured household with change in occupier	6.4%	6.0%	6.9%	6.7%
% all households with change in occupier	10.4%	9.4%	9.8%	9.2%
ONS data – household moves in UK in year as a percentage of total households†	10.33%	9.10%	8.15%	-

Note the information in this table represents change in occupier not change in ownership.
† Data source: English Housing Survey 2009/10 and 2010/11 reports.

The information from our billing records shows that between 6.0 and 6.9% of unmeasured homes has a new occupier each year. Measured households have a higher change in occupier rate of between 11.7 and 19.5% with the lower rates being in more recent years indicating the impact of the economic downturn and slowdown in the housing market. The data from our billing records is comparable to data from the Office of National Statistics' English Housing Surveys for change in occupier for all households which varies between approximately 8 and 10%.

It is appropriate to assume that not every household that changes occupier in the Wessex Water region would have a meter installed under a change of occupier metering policy; the property may not be suitable for a meter owing to the physical characteristics of the connection pipework or the customer might vehemently refuse to accept metered charges.

Taking all of the above information into account, to forecast the impacts of a change of occupier metering policy, we have assumed 6% of unmeasured households will have a new occupier each year of the planning period.

We have assumed that introducing a change of occupier metering policy would have an impact on the proportion of unmeasured customers opting to have a meter (even if they are not moving house). We expect this to occur inadvertently as a result of our promotion of the new policy which would serve to promote the benefits of metering to all customers. The optional metering model developed for the baseline forecast allows us to model the promotional effect to produce an alternative optional metering forecast as shown in Figure 5-25. The assumption is that the promotional impact of the change of occupier policy is greatest in the first year it is introduced and gradually decreases throughout AMP6.

Figure 5-25: Forecast percentage of unmeasured households switching to a metered supply if a change of occupier metering policy was also introduced (final planning scenario)

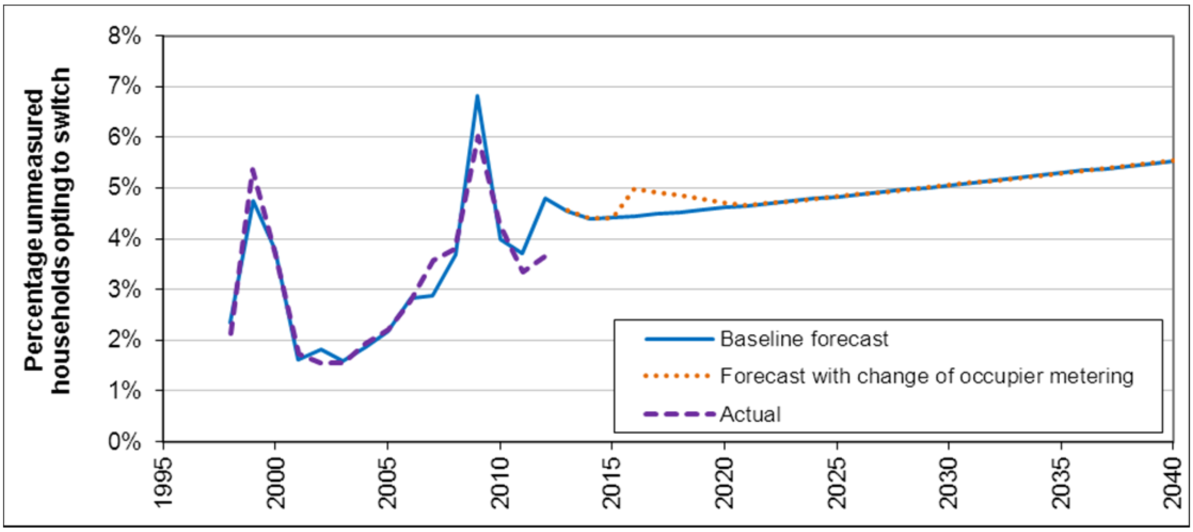


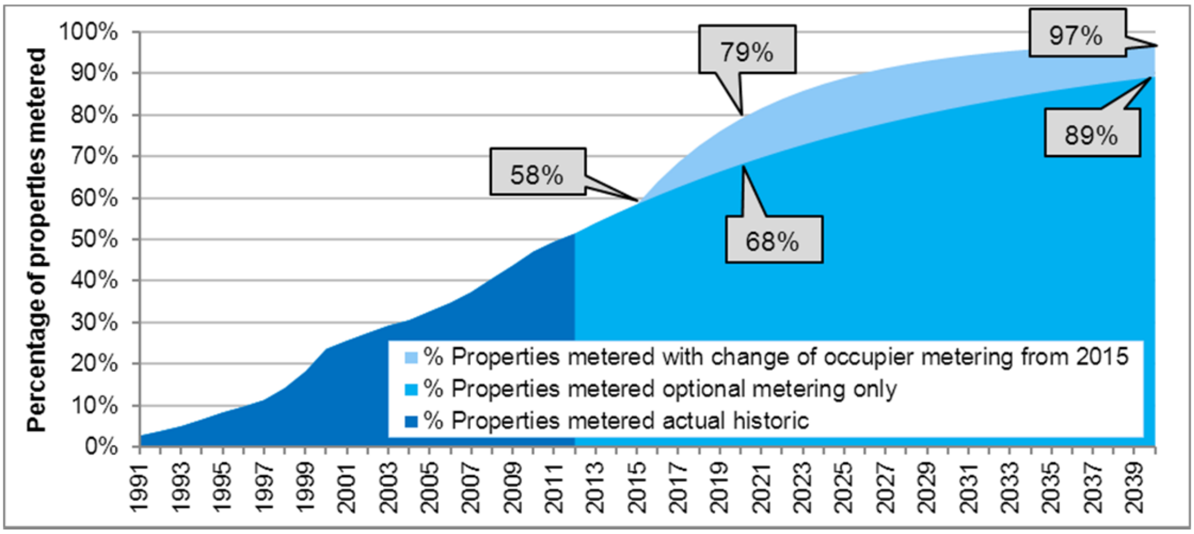
Table 5-10 indicates the number of households that will become metered on a change of occupier basis and as optants in each 5-year AMP period until 2040 (taking account of 'unmeasureable properties' as described 5.5.4) and Figure 5-22 shows the impact this will have on overall meter penetration relative to the baseline scenario.

Table 5-10: Final planning forecast of optional meters installed each AMP period

	AMP6 2015-20	AMP7 2020-25	AMP8 2025-30	AMP9 2030-35	AMP10 2035-40
Change of occupier meters installed (000's)	65.2	32.9	16.6	8.2	4.0
Optional meters installed (000's)	39.7	19.5	10.3	5.3	2.7

Our final planning forecast (including metering on change of occupier) suggests that by 2019/20 the proportion of households in our area that are metered will rise to 79% and by 2039/40 this will have increased to 97% (Figure 5-26).

Figure 5-26: Historic and future changes to the proportion of metered and unmetered customers



Our recent tariff trial study (2008 – 2011) has informed our assumptions surrounding the water savings that households make upon becoming metered when they move house.

The study involved monitoring the differences in consumption between a control group of unmeasured customers and four groups of households that were metered on a change in their occupier and charged on the basis of four alternative tariff structures.

Nearly 6000 properties were involved in the trial and the key conclusions were derived from analysis of meter flow data, complaint volumes and also through focus groups and in-depth interviews with customers on the trial. Consultants Tynemarch were commissioned to analyse the metered data[56] and Blue Marble[57] undertook the customer research; their technical reports are available as appendices to this Plan and we also produced a summary report of the research[58].

The study found that metering properties on change of occupier led to an annual average reduction in water use of 15% rising to a 25% saving in the peak demand week. Savings in water consumption were seen across all income levels indicating the strength of the policy as a demand management tool. The magnitude of demand reduction is at the top-end of findings evidenced in previous industry studies of compulsory metering. We believe this is linked to behavioural theories around ‘moments of change’, such as moving house, when existing habits are broken and new habits more easily formed than at other times of our lives.

Water companies have a statutory duty to promote water efficiency and since 2010 Ofwat has set each company an annual water efficiency target. The target is based on achieving savings amounting to 1 litre per property per day, which for us equates to 0.55 Ml/d. Savings are achieved by encouraging the uptake of water efficient devices and behaviours by our customers and by providing educational services to schools and businesses.

Our water efficiency strategy[59] which reviews current activities and sets out our proposal for activities from 2015 onwards is available as a technical appendix to this Plan. Our current initiatives include a combination of information provision and device promotion. This includes:

- Distribution of free water saving devices: over 22,000 devices per year with assumed savings of around 225,000 litres a day
- Information provision for all households through our customer magazines, billing and metering literature, website and social media
- Water energy calculator: approximately 2,000 uses a year, assumed savings of 12,000 litres a day
- Schools education service around 13,000 pupils a year, assumed savings of approximately 200,000 litres a day
- Home water audits: around 50 each year
- Promotion of water saving products, including water butts (3000 to 4000 water butts each year with assumed savings of approximately 10,000 litres a day)

[56] Tynemarch (2012), Wessex Water Tariff Trial Project Household Consumption Analysis (final report).
[57] Blue Marble (2010), Management summary – Tariff trial: the customer perspective.
[58] Wessex Water (2012), Towards sustainable water charging – conclusions from Wessex Water’s trial of alternative charging structures and smart metering.
[59] Wessex Water (March 2013). Water efficiency strategy 2013 – Review of current activities and strategy for the future.

- Commercial services: audits and services for business customers, including schools audits which delivered approximately 70,000 litres/day measured savings in 2012/13.

In addition to, and in conjunction with, the change of occupier metering policy our final planning demand forecast includes the effect of an enhanced water efficiency programme. The programme is described fully in Section 8 of this Plan but will include the following measures leading to an overall reduction in demand of 2 Ml/d by 2040:

- **Large scale domestic device retrofit scheme** – involving visits to 4000 households each year to provide a free audit and device fitting service; this scheme will be particularly promoted to households that are being metered on change of occupier.
- **Social housing retrofit scheme** – a partnership project to install water efficient devices in housing association properties
- **Water efficiency community fund** – to pay for devices and their installation in schools and other not-for-profit social organisations such as hospitals, councils and local services.
- **Enhanced community engagement programme** – to enhance customer awareness of the links between their water use and their environment by working with community groups and organisations such as Transition Towns.

Table 5-11 indicates the impact on the annual average and critical period demand forecast of the water savings associated with the combined effect of change of occupier metering and the enhanced water efficiency programme relative to the baseline (optional metering and baseline water efficiency only) scenario. These savings are accounted for in the final planning demand forecasts.

Table 5-11: Impact of change of occupier metering and enhanced water efficiency on the demand forecasts (i.e. comparison between baseline and final planning forecast)

Forecast	2019/20	2024/25	2029/30	2034/35	2039/40
Impact on dry year annual average (Ml/d)	-7.2	-9.7	-10.2	-9.5	-8.5
Impact on dry year critical period (Ml/d)	-14.3	-19.1	-19.5	-17.7	-15.4

The impact of the change of occupier metering policy and enhanced water efficiency can also be examined in terms of changes to per capita consumption. Figure 5-27 shows the (average year) changes in per capita consumption by customer group through the planning period.

Figure 5-27: Per capita consumption changes by customer group – final planning (average year) forecast

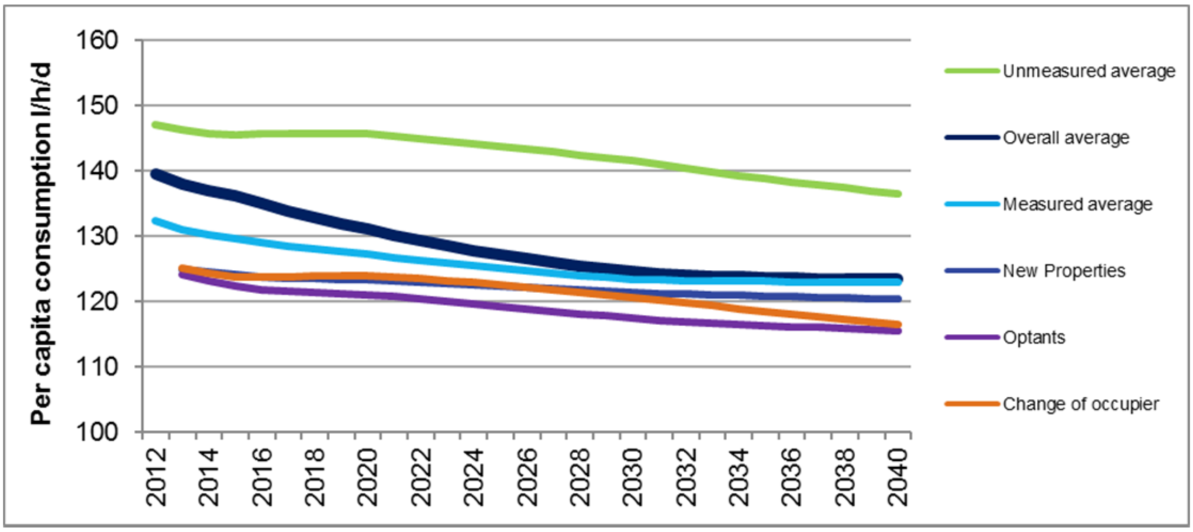


Table 5-12 compares the overall average per capita consumption for an average year in the baseline and final planning forecasts to show the impact of the change of occupier metering policy and enhanced water efficiency. It shows that with the change of occupier metering policy and enhanced water efficiency average per capita consumption would be 3.2 litres lower by the end of AMP6 (2019/20) and 4.0 litres lower by 2024/25.

Table 5-12: Overall average (average year) per capita consumption comparison

Scenario	2019/20	2024/25	2029/30	2034/35	2039/40
Baseline – optional metering only (l/h/d)	134.3	131.1	128.4	126.9	126.0
Final planning – change of occupier (l/h/d)	131.1	127.2	124.5	123.7	123.4
Difference (l/h/d)	-3.2	-4.0	-3.8	-3.2	-2.6

Increased metering through a change of occupier policy will also impact upon leakage – see Section 5.7 for further details. Also Section 5.9 for a summary of the overall difference between the baseline and final planning forecasts.

5.5.6. Impact of climate change on household demand for water

As described in Section 4.11 the climate of the south-west of England is changing. 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.

The impact that a changing climate may have on water consumption is uncertain at the present time and it is likely that other factors will have greater influence on water demands in most situations (Water Resources Planning Guideline, 2012).

It is reasonable to assume however that household water use patterns and behaviours may alter with the climate. For example, with warmer weather people perspire more leading to an increased frequency of personal washing. Discretionary water use for garden watering, filling paddling pools and car washing may also increase during hotter drier periods.

In 2013 UKWIR published a new study on the *impact of climate change on water demand*[60] and so since publishing our draft Plan (which used information from a 2003 study[61]) we have been able to update our forecasts to incorporate the latest available information.

The UKWIR study 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 forecasting 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 are available for each year between 2012 and 2040 to reflect the uncertainty associated with the climate change projections.

Table 5-13 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 5-13: Estimates of climate change impacts on domestic demand (% change relative to the base year) for the south-west of England. Reproduced from UKWIR (2013)

	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
Severn Trent 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 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 and we selected to use the Severn Trent outputs for our forecasting because they ensure we incorporate the marginally larger factors in our planning.

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.

Table 5-14 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

[60] UKWIR (2013). Impact of climate change on water demand. CL/04.
[61] Downing, T.E., Butterfield, R.E., Edmonds, B., Knox, J.W., Moss, S., Piper, B.S., Weatherhead, E.K., (and the CCDew project team) (2003). Climate change and demand for water, Research report, Stockholm Environment Institute Oxford Office, Oxford.

unmeasured combined) representing a very small proportion of overall distribution input (*c.* 0.5%).

Table 5-14: Changes to per capita and overall household consumption (baseline forecast) with climate change. (AYAA = average year annual average)

Customer type	Demand category	2014/15	2019/20	2039/40
Measured household	AYAA PCC without CC (l/h/d)	129.7	128.8	124.1
	AYAA PCC with CC (l/h/d)	129.9	129.1	125.3
	AYAA consumption without CC (Ml/d)	76.4	91.5	132.9
	AYAA consumption with CC (Ml/d)	76.5	91.7	134.2
Unmeasured household	AYAA PCC without CC (l/h/d)	145.5	146.0	142.0
	AYAA PCC with CC (l/h/d)	145.6	146.4	143.4
	AYAA consumption without CC (Ml/d)	85.8	74.2	43.7
	AYAA consumption with CC (Ml/d)	85.9	74.4	44.1
Total household	Increase in demand due to climate change (Ml/d)	0.2	0.4	1.7

In accordance with the planning guidelines no adjustment has been made to peak demands to account for climate change.

5.6 Non-household (commercial) demand

5.6.1. Non-household demand trends

Since privatisation the water demand from metered non-household properties in the Wessex Water region has steadily decreased as shown in Figure 5-28. In 2011/12 measured non-household water delivered out-turned at 84 Ml/d which was over 30 Ml/d lower than the demand in 1994/95 (117 Ml/d), representing nearly a 30% reduction over 17 years.

Figure 5-28: Water delivered to measured non-household customers

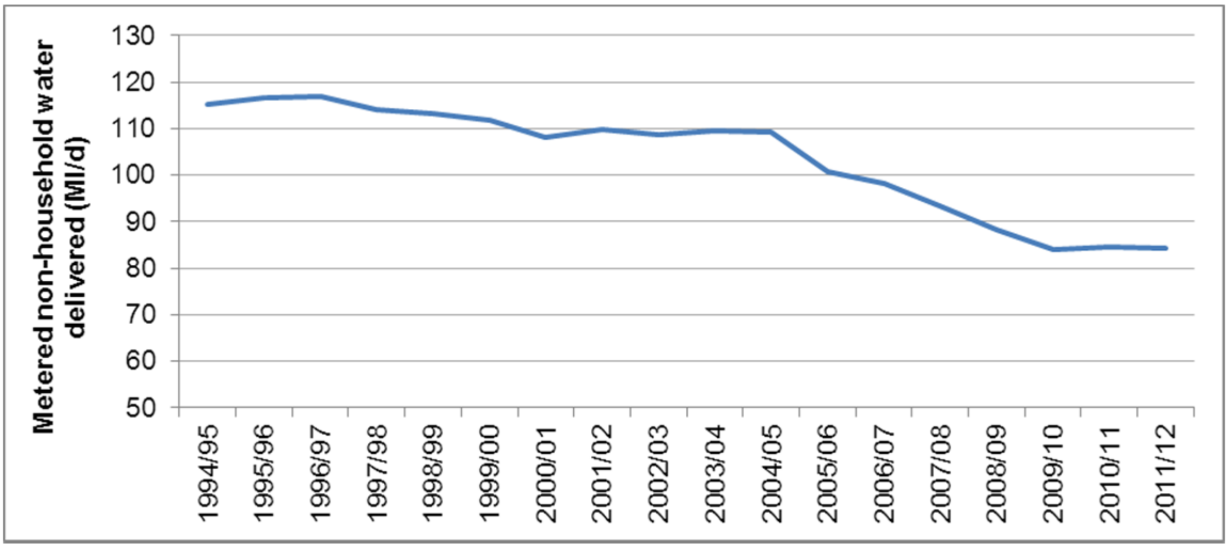


Figure 5-29 shows the breakdown of measured non-household demand by eight industrial sectors. Each sector is an aggregation of several industry codes used to classify non-household customer types in our billing system. The codes used are similar but not identical to Standard Industry Codes (SIC). These eight sectors are the same as those reported in our last Water Resources Management Plan (2010).

Figure 5-29: Historical measured non-household demand by industrial sector

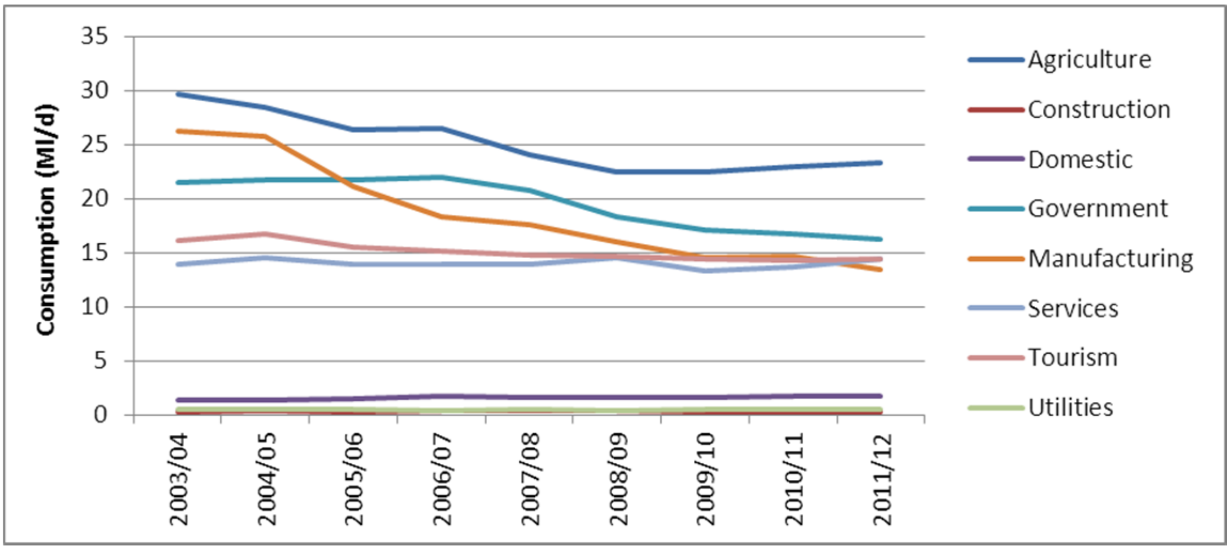


Figure 5-29 shows that the agricultural sector is the largest component of measured non-household demand accounting for approximately 23 Ml/d in 2011/12 which is 7% of total distribution input and 27% of measured non-household demand. Other important sectors in the Wessex Water region in the base year (2011/12) are government (16 Ml/d), the service sector (14 Ml/d), tourism (14 Ml/d) and manufacturing (13 Ml/d). Driving down overall non-household demands in recent years have been the reductions seen in the manufacturing, agriculture and to a lesser extent government sectors.

5.6.2. 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 2012.

The initial outturn data for regulatory reporting is derived from raw meter reading data and the following adjustment steps:

- a positive adjustment is made to metered non-household consumption recorded in the year to account for water delivered to customers by 31 March of the reporting year which had yet to be read on the meter by the year end. In addition, metered non-household consumption recorded in the year is reduced for the estimate made in April 2006 of water delivered that had not been read at 31 March 2006.
- An adjustment is also made to reduce billed water delivered by the net financial adjustments made in the year that related to volumetric charges to metered non-household customers.
- 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.
- Based on the results of a study carried out in the base year, non-household meters are assumed to under-register the throughput of water by 3.85%. The figure relates to both positive displacement meters and turbine meters used on non-household properties.

Following the approach outlined in Section 5.2, non-household demands are normalised for the base year by making a downward adjustment of 3.73 Ml/d. A further downward adjustment of 0.47 Ml/d to account for the impact of the household demand base year normalisation process on unmeasured non-household demand is also made.

Our methodology for calculating **unmeasured non-household demand** for annual regulatory reporting and therefore in the base year is unchanged since 1995/96. We calculate the population attributable to the unmeasured non-household category by splitting our assessment of total connected population into its constituent parts. Household populations are derived from unmeasured and measured survey information to assess average occupancy rates. Measured non-household population reflects population attributed to communal properties in the Census. Unmeasured non-household population contains the balance of the connected population not contained in any other category. The population is the balance of the total population supplied in our region derived from Office of National Statistics' data that has not been attributed to either of the other household occupied and billed categories at mid-year (via our assessment of average household size by category) or to measured non-household population via the Census analysis of communal population. It will include genuine population in unmeasured households that at mid-year are identified as void because there is always a time-lag between a customer moving into a property and informing us of their details. The consumption of this population must be accounted for somewhere in water delivered however it cannot be included in the unmeasured household or either of the measured categories.

We apply the average unmeasured per capita consumption as calculated in our unmeasured household consumption monitor to the population allocated to unmeasured non-household. We then add a discretionary 225 m^3 per annum per property as an estimate of actual non-domestic usage at these properties. This compares with average water delivered at each of our measured non-household properties of approximately 800m^3 per annum and reflects the fact that most non-domestic customers that use significant amounts of water have already been metered.

5.6.3. Non-household demand forecast

Measured non-household baseline demand forecast

We commissioned Tynemarch to analyse historical measured non-household consumption data and develop a model that could be used to forecast this component of the demand forecast over the planning period. Their technical report[62] is available as an appendix to this Plan. The approach taken was consistent with the joint regulator's Water Resources Planning Guideline as it follows the methods set out in the UKWIR (1997) report: *Forecasting water demand components.*

The following data was analysed:

- Historical quarterly consumption data by industry (sector) code (2003-2012) and historical time-series of total measured non-household water delivered (1991-2012). 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.
- Historical tariffs data (volumetric rates), including optional large user tariffs (1991-2013)
- Economic data for the Wessex Water region, including employment and Gross Value Added (GVA) by industry sector and with forecasts to 2020. GVA is a measure of the value of goods and services produced in an area, industry or sector of the economy.
- Historical non-household consumption disaggregated according to billing frequency (2003-2012)
- Soil Moisture Deficit (SMD) for the Wessex Water region
- Input prices by industry sector.

The analysis found that the following variables 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, representing the price-elasticity of demand.
- Some industries showed a negative relationship between the number of employees and the water consumption. This is counter-intuitive, but is feasible if the increased demand results from increasing mechanisation replacing labour inputs.

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

- 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.

Predictive models were developed for the eight industry sectors (using data since 2003/04). A single model was also developed for overall measured non-household water consumption (using data since 1991/92).

Table 5-15: Variables included in the non-household demand forecasting models

Sector	GVA*	SMD	Tariffs***	Employees*	Time Trend
Agriculture	✓	✓			✓
Construction	✓				✓
Domestic**					✓
Government				✓	
Manufacturing			✓		
Services	✓				✓
Tourism			✓		
Utilities				✓	
Overall model	✓			✓	✓

* The GVA and/or employee count included was for the relevant industry sector and the Wessex Water region.
** The domestic sector represents non-household properties including nursing homes.
*** Tariff variables considered included the standard marginal rate, the optional tariff marginal rates and a weighted average of the standard and optional rates based upon the proportion of the sector charged the optional tariffs.

Forecasting assumptions included in the modelling are as follows:

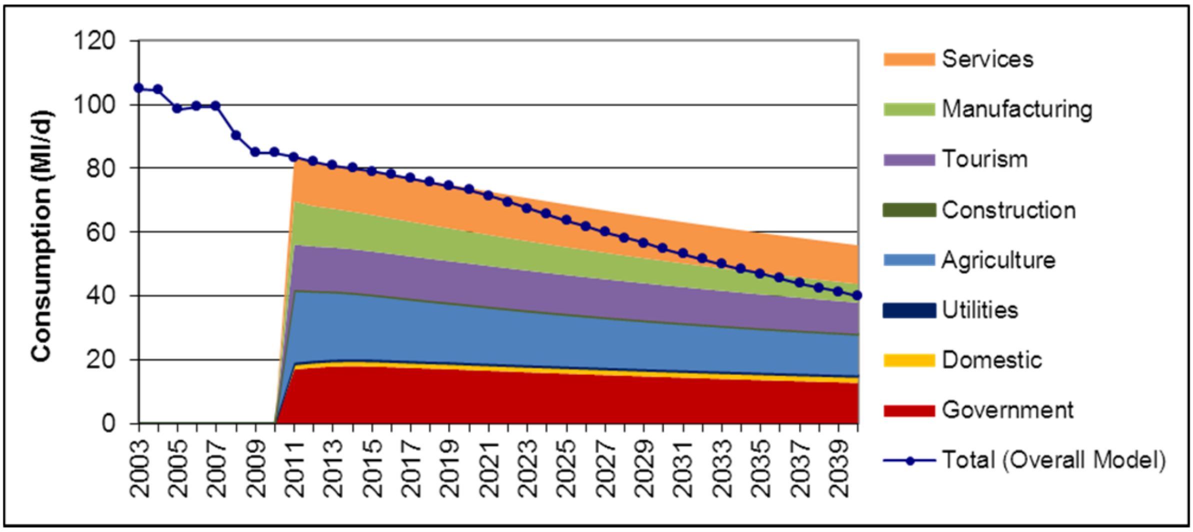
- Forecasts of tariff variables have been developed on the basis of +0.5% K[63] and 2.5% RPI annually.
- Forecasts of macro-economic variables (GVA and employees) have been provided to 2020. For the remainder of the forecast period, these have been assumed to increase or decrease at the average rate in the available data period.
- SMD has been assumed as the average observed in the available data period which is appropriate for developing an average forecast.

Individual model performance statistics are available in Tynemarch's report.

The sum of the sector models in the base year is less than the overall model (for the reasons outlined earlier) so the sector model outputs have been rescaled to match the base year for the total model giving the forecasts shown in Figure 5-30. The two approaches derive similar forecasts in the short term (up to approximately 2020) but then the total model declines at a faster rate than the individual models which is most likely related to the time trend component of the model linked to the large historical decreases in demand.

[63] 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).

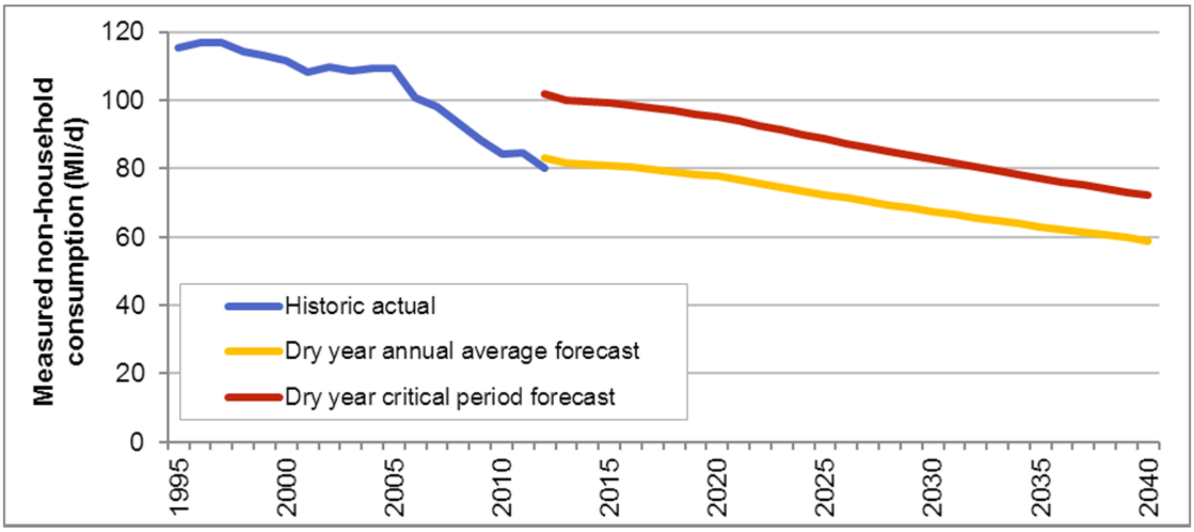
Figure 5-30: Measured non-household demand forecasts from the total and sector models



Our understanding of our non-household customer base leads us to select the higher forecast provided by the sum of the sector models as our projection of measured non-household demands for the demand forecast. We believe that the large reductions in historical demand as a consequence of large customers relocating out of the region or ending production are becoming progressively less likely as most of the largest customers in terms of water use 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 where the probabilities of closure and/or relocation are low.

Following the normalisation process outlined in Section 5.2, Figure 5-30 and Table 5-16 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



The peak factors used to develop the dry year annual average and dry year critical periods forecasts are explained in Section 5.2.

Table 5-16: Baseline measured non-household demand forecasts

Scenario	2011/12	2019/20	2039/40
Dry year annual average (Ml/d)	83.2	78.1	59.0
Dry year critical period (Ml/d)	102.0	95.7	72.3

The reforms to the Water Supply Licensing regime set out in the Water White Paper (December 2011) propose to make it easier for non-household customers to switch water supplier. Subject to the legislative timetable, these reforms are expected to come into effect during the planning period of this Water Resources Management Plan. It is difficult to accurately predict the impact these changes will have on this Plan but it may lead to increased water efficiency offerings to non-household customers as we and others strive to offer a wider range of value added services thereby reducing demand further than our current forecast suggests.

Unmeasured non-household baseline demand forecast

The starting point for the unmeasured non-household demand in the base year is the outturn data as reported in Table 10 of our Regulatory Return in 2011/12 which has then been subject to the normalisation process described in Section 5.2 and updated to account for the increased population estimate linked to the 2011 Census. Demands in key years of the planning period for each forecasting scenario are presented in Table 5-17.

Unmeasured non-household demand declines through the planning period as these properties progressively move to metered charging (see Section 5.2.3 for further details).

Table 5-17: Baseline unmeasured non-household demand forecasts

Scenario	2011/12	2019/20	2039/40
Dry year annual average (Ml/d)	16.6	11.3	6.2
Dry year critical period (Ml/d)	21.4	14.6	8.0

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).

Non-household final planning forecast

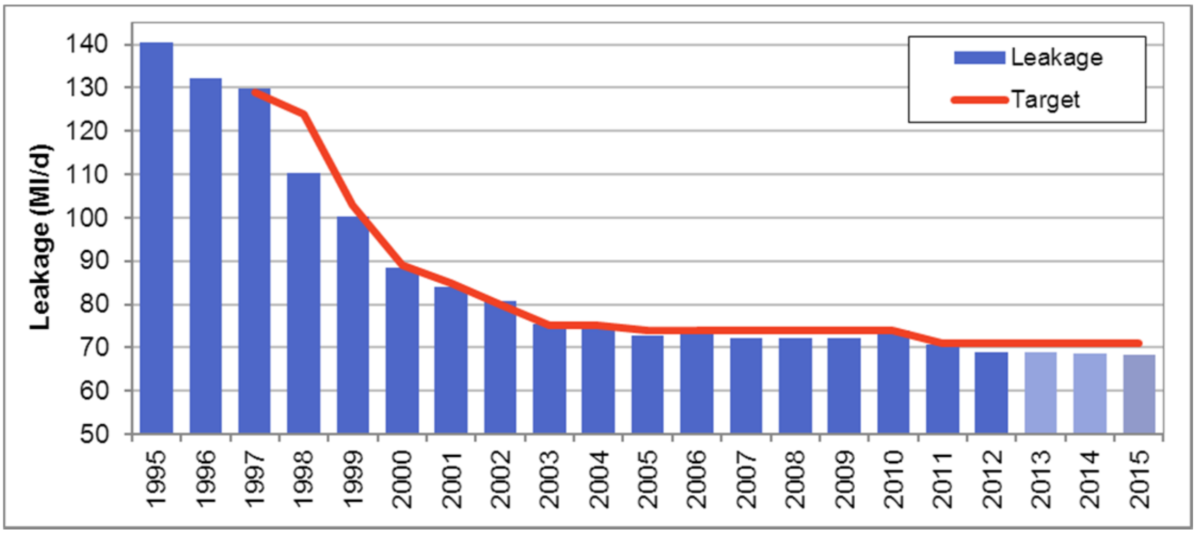
Our final planning demand forecast includes the impact of metering on change of occupancy for domestic customers and an enhanced water efficiency programme. The water efficiency programme includes a ‘community fund’ measure that will pay for water efficiency devices and their installation in schools and the premises of other not-for-profit organisations such as councils, charities and local services. This option is reviewed in Section 8.4 but to summarise we propose to work with approximately 100 organisations each year of AMP6 and have estimated that this option will deliver savings of 0.06 Ml/d each year so that cumulative savings by 2019/20 amount to 0.3 Ml/d.

5.7 Leakage

5.7.1. Historical trends and base year leakage position

Since 1995 we have halved leakage from our network reducing it from 140 Ml/d to 69 Ml/d in 2011/12 (Figure 5-32). We have consistently met the target set by our regulator even in years with severe winters – see case study box on 'winter leakage breakout and rapid recovery' in this Section.

Figure 5-32: Leakage reduction since 1995 in relation to regulatory targets



We spend £12m a year on our leakage strategy activities to manage and reduce leakage. Staff costs amount to approximately £1.8m, customer service pipe repair and replacement costs are approximately £2.1m and the remainder of the spend is associated with mains leakage repair costs and other leak detection apparatus. In addition we spend a further £7m each year replacing mains to prevent a future increase in leakage.

The work is carefully planned based on historical information and known risk factors. Every year we mend 12,000 leaks, of which about 60% are customer reported and 40% are company detected. We also renew approximately 50 km of our supply network each year. Key features of our active leakage control (ALC) strategy are summarised below and further details can be found in our report on the Sustainable Economic Level of Leakage[64] (SELL).

- We undertake continuous night flow monitoring of over 98% of properties in 658 District Meter Areas (DMAs). The data is transferred electronically to our bespoke computer systems (WRIMS and Waternet[65]) 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. New hydraulic models were built for the entire network over the period 2007 to 2009. These models have been 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 not

[64] Wessex Water (March 2013). Sustainable Economic Level of Leakage.
[65] 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.

high enough in most of the remaining areas to be capable of reduction without affecting service standards.

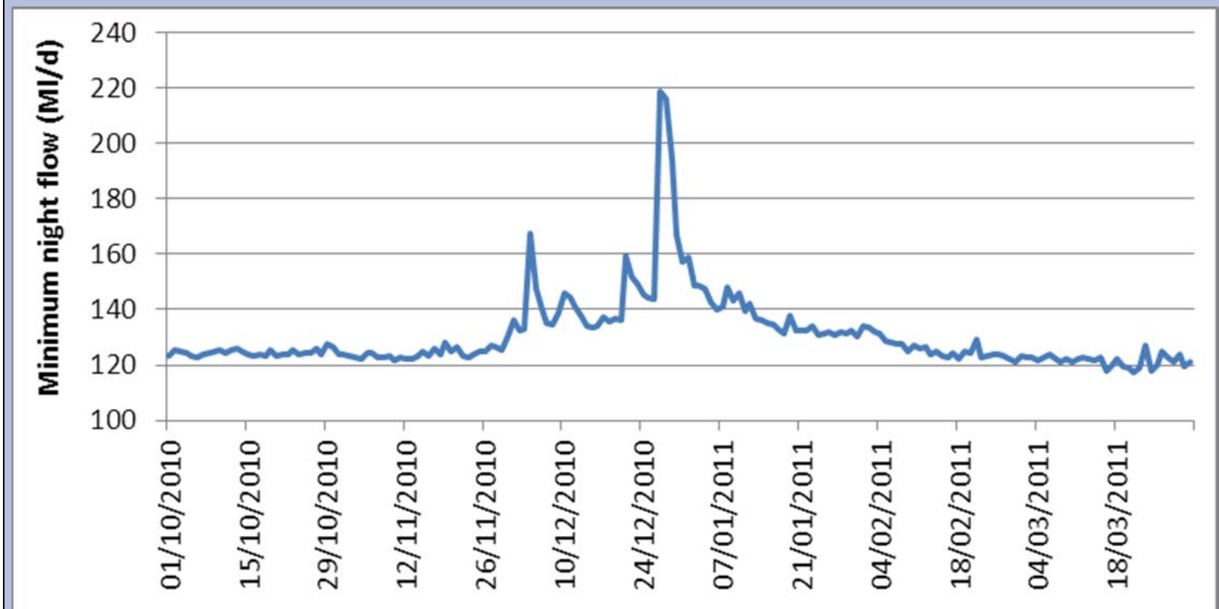
- The focus of improvement in recent years has been in reducing the time between leak occurrence, detection and repair. This has been achieved by improvements to monitoring to provide near real time data, fixing leaks as quickly as possible and performance driven incentives for leakage inspectors. For 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 free leak repair service which we believe is the best in the industry. We will detect and repair or replace, free of charge, 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 around 3000 free supply pipe repairs each year.

In international terms our leakage is low – the World Bank classifies leakage performance in bands A to D using the internationally accepted Infrastructure Leakage Index. The best performing countries and companies are in Band A and those with most to improve are in band D. Wessex Water is a band A company.

CASE STUDY: Winter leakage breakout and rapid recovery

Cold winter weather conditions can lead to short-term increases in leakage related to pipes freezing and bursting. In the recent winters of 2008/09, 2009/10 and 2010/11 we experienced episodes of severe winter leakage breakout but reacted rapidly to recover our leakage position so that we met our leakage target in each of these years. Our experiences in 2010/11 are described below to provide an example of our typical winter response.

Our region saw persistent sub-zero temperatures and extensive snow cover throughout much of December 2010. On the 26 December there was a sudden and rapid increase in temperature which triggered an unprecedented increase in minimum night flows detected in our distribution system as shown in the figure below. 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.



The rapid thaw on 26 December caused minimum night flows to increase by 90 Ml/d indicating a sudden increase in leakage. The increase was reversed dramatically after just a few days indicating that the majority of the rise was related to leakage from customer pipes and plumbing which could be quickly isolated and fixed. Many DMA night flows returned to normal levels without any active leakage control intervention which suggests that there were numerous private supply or internal customer leaks which were not reported.

Following the thaw, in-house leakage detection staff doubled their night work from one night a week to two and our teams worked alongside contractor detection staff every weekend where possible until the end of February. Other bursts and leaks were identified and repaired as quickly as possible and by the end of February 2011 minimum night flows had had been brought back down to November levels

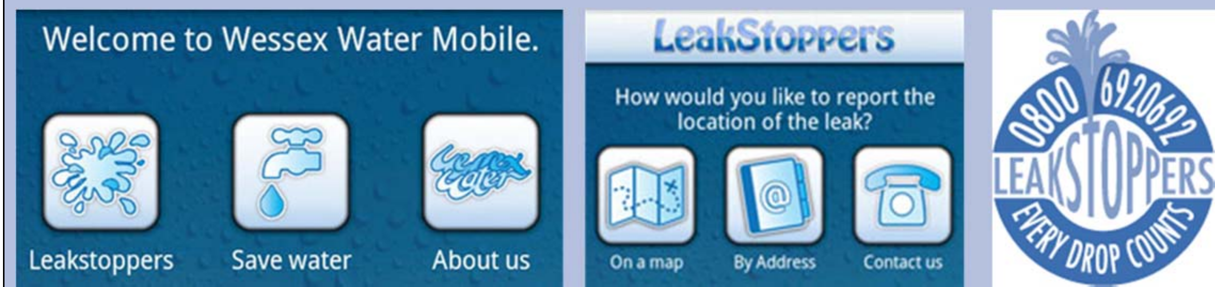
As a result of investment in leakage control Wessex Water remains well placed to respond to winter leakage breakout. Whilst it is not possible to prevent the increase in bursts caused by severe weather conditions, it is possible to minimise their impact by having control areas and systems in place to enable early identification, well trained and equipped leakage detection staff to pinpoint leaks quickly and an efficient and dedicated repair and maintenance team to repair leaks swiftly.

CASE STUDY: Next day repairs for customer reported leaks

Managing leakage is one of the most important measures to ensure a robust water supply at all times but particularly during dry weather. In early 2012 following the extended period of below average rainfall in 2011, and at a time when the country was preparing for a worsening drought situation we modified our leakage management strategy.

We moved from targeting the repair of customer reported leaks within 10 days down to targeting the repair for the same day or the next 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, with around 75% of all leaks repaired on the same day and 95% by the end of the next day. This has contributed to our continuing efforts to drive down leakage.

Some images from our mobile smartphone app are shown below as an indication of how we are using innovative technology to help customers report leaks.



Total leakage reported in Table 10B of our Regulatory Return in 2011/12 was 69 Ml/d. Of this total 51 Ml/d are distribution losses from our mains and 18 Ml/d are losses from customer supply pipes.

Base year leakage is calculated using the total integrated flow method – all the components of the water balance (household demands, non-household demands etc.) except leakage are calculated (or robustly estimated) and the residual (i.e. the difference between distribution input and water used) is assumed to be leakage.

The proportion of leakage that is related to customer supply pipe leakage is derived by allocating an estimate of the number of litres lost per property per day. Different losses are assumed depending on whether the property is externally metered (16.4 litres/property/day) or is internally metered, unmeasured or void (46.6 litres/property/day).

Impact of new Census 2011 information on leakage

The new population estimates arising from the 2011 Census (see Section 5.4.1) and other small changes in the distribution of population between different property types leads to a reduction in our leakage estimate for the base year from 69.0 Ml/d to 68.4 Ml/d. This is the case because a higher unmeasured population multiplied by the unmeasured per capita consumption (Section 5.5.1) leads to a higher volume of unmeasured household and non-household consumption meaning that the residual of the water balance, i.e. distribution losses, is lower. Distribution losses reduce from 50.7 Ml/d to 50.1 Ml/d. Consequently it is also appropriate to restate our AMP5 leakage target reducing it from 71 Ml/d to 70 Ml/d.

Sustainable economic level of leakage

We have assessed our sustainable economic level of leakage (SELL) using the methods specified in the Water Resource Planning Guidelines – in particular recent Ofwat[66] and UKWIR[67] publications. We have prepared a separate SELL report[68] to support this Plan and it is available as a technical appendix.

We have calculated our SELL at 92 Ml/d, which is both above our current (2011/12) level of leakage (69 Ml/d) and our current target of 71 Ml/d set by Ofwat for the current AMP5 period. This is because we do not have a supply demand deficit and therefore the value attached to reducing leakage equates to the marginal cost of producing water (approximately 6p/m^3), rather than the marginal cost of developing a new water resource (approximately 100p/m^3). It would therefore be wrong to let leakage rise as the potential value of the water we have available below the SELL would be lost. In addition rising leakage would undermine the company's and our customers' efforts to reduce their water use.

The guiding principles of the Water Resource Planning Guidelines states that the Government's view is that leakage should not be allowed to increase. This is consistent with best practice guidance (Ofwat's 2002 tripartite report[69]); and also with the view of our Board and most importantly the view of our customers.

Our baseline demand forecast therefore proposes to continue to maintain leakage below the SELL and not allow leakage to increase.

[66] Ofwat (October 2012). Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning.
[67] UKWIR (2011). Managing leakage 2011.
[68] Wessex Water (March 2013). Sustainable Economic Level of Leakage.
[69] Ofwat (2002). Tripartite 'Best Practice Principles in the Economic Level of Leakage Calculation.

5.7.2. Baseline leakage reduction forecast

Our baseline assumption is a continuation of current leakage strategies and policies which involves continual investment to optimise our approach to managing leakage at least cost but without any step change in leakage reduction measures. The baseline forecast therefore assumes that distribution losses will remain constant through the planning period. Reductions in leakage are nevertheless expected to occur as a result of households opting to become metered. Externally metered households experience lower leakage from their supply pipes than unmeasured households by approximately 30 litres per property per day. This occurs as a result of previously unnoticed leaks being fixed at the time the meter is installed and being detected thereafter when the meter is read and from anomalous bills.

Overall leakage is expected to decline from 68.4 Ml/d in 2011/12 to 67.0 Ml/d in 2019/20 and to 65.6 Ml/d in 2039/40 (Figure 5-33 and Table 5-18).

Figure 5-33: Baseline leakage forecast relative to historical trends and targets

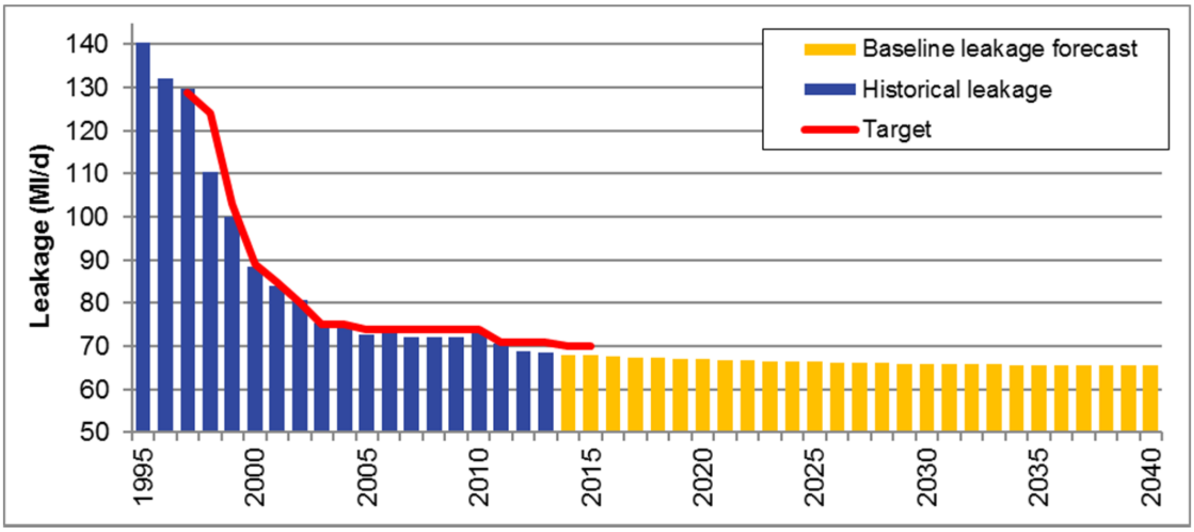


Table 5-18: Baseline leakage forecast through the planning period

Scenario	2019/20	2024/25	2029/30	2034/35	2039/40
Baseline (Ml/d)	67.0	66.4	65.9	65.7	65.6
Reduction below current target of 70 Ml/d	4.3%	5.1%	5.9%	6.1%	6.3%

5.7.3. Final planning leakage reduction forecast

Our final planning assumption includes the impact of the introduction of a change of occupier metering policy from 2015/16; it does not include any further leakage reduction measures (see Section 8 for further discussion of potential leakage options). Like the baseline forecast, the final planning forecast assumes that distribution losses will remain constant through the planning period but that reductions in total leakage will occur as a result of the enhanced metering policy. Figure 5-34 and Table 5-19 compares the final planning leakage forecast to the baseline forecast and shows that the change of occupier metering policy offers the opportunity to reduce leakage further and faster than the baseline forecast.

Figure 5-34: Final planning leakage forecast relative to historical trends and targets

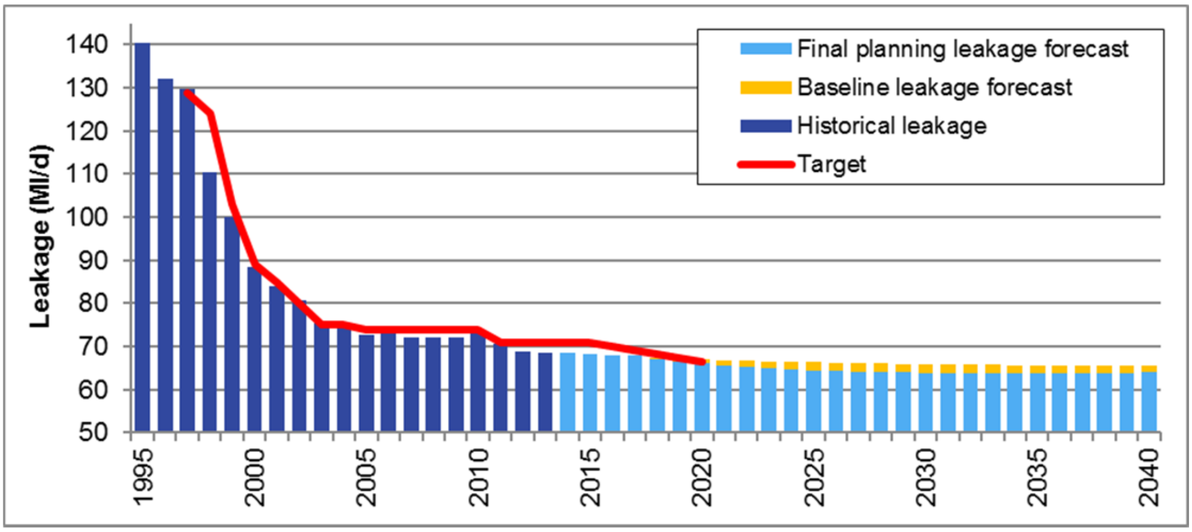


Table 5-19: Baseline and final planning leakage forecasts

Scenario	2019/20	2024/25	2029/30	2034/35	2039/40
Baseline (Ml/d)	67.0	66.4	65.9	65.7	65.6
Reduction below current target (70 Ml/d)	4.3%	5.1%	5.9%	6.1%	6.3%
Final planning (Ml/d)	65.3	64.2	63.8	63.9	64.1
Reduction below current target (70 Ml/d)	6.7%	8.3%	8.9%	8.7%	8.4%
Difference between planning scenarios (Ml/d)	1.7	2.2	2.1	1.8	1.5

There is a minor rise in leakage towards the end of the planning period that sees an increase of 0.28 Ml/d over 7 years. This relates to a growth in assumed customer supply pipe losses associated with new properties connecting to our network. In the earlier years of our plan the effect of property growth is outweighed by the benefits of leakage reduction via a metering programme. Whether this forecast rise in customer losses actually occurs will depend on the house building rates that our region will experience in the 2030s.

Our Strategic Direction Statement (SDS) set a bold and stretching aspiration to reduce leakage by 5% by 2020 and by 25% by 2040. This target has been embedded into our Business Plan that will be approved by Ofwat in December 2014. Against our current (rebased) leakage target (70 Ml/d) this would see leakage fall to 66.5 Ml/d by 2019/20 and to 52.5 Ml/d in the long term.

Table 5-19 shows that our final planning scenario that includes metering on change of occupier meets the aspiration set for the first 5 years of this Plan. The forecast in fact suggests we will exceed the 5% reduction – this relates to our strategy to be up to 2 Ml/d below our leakage target in a normal year to ensure we can still meet the target in years with severe winter weather that can lead to increased leakage breakout. To allow for the fact that a dry year might also be a cold year an allowance is made in our headroom modelling for the increased demand that might result (see Section 6).

Section 8.5 reviews leakage reduction options. Although Wessex Water is committed to the 25% reduction aspiration our final planning scenario does not incorporate reductions of the magnitude required in the later stages of the planning period. This is because our option analysis indicates that currently available options are at present limited either by their cost or by available technology.

Leakage is an important area for innovation and most of the advances are led by technology developers and suppliers, spurred by the economic advantages of alternatives to pipe replacement. We will look to real-time network control and monitoring technologies that predict where leaks are most likely to occur, or pinpoint the location of leaks when they happen. Our Business Plan includes a provision of £1m for leakage research and development in AMP6.

Our 25-year demand forecast accounts for leakage reductions that we have a confirmed plan to be able to deliver – it therefore allows for the reductions resulting during AMP6 and beyond associated with the change of occupier metering proposal but does not incorporate reductions that will be required after 2020 in order to meet our long-term 25% reduction aspiration. Until we have completed research and development in AMP6 the schemes that will be required in AMP7 and beyond are undefined. We fully expect to comply with government policy and continue to make real reductions in leakage in each future AMP period and our research and development investment in AMP6 will ensure we achieve this in an affordable way.

5.8 *Minor elements of demand*

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[70] recommended by the water resource planning guidelines.

Over the last 10 years we have seen DSOU fall from 6.5 Ml/d in 2002/03 to 2.469 Ml/d in 2011/12 (the base year). This has been as a result of operational efficiencies (such as water reuse schemes at sewage treatment works) and improvements in our accounting assessments.

The majority of DSOU (approximately 68%) in 2011/12 was related to washing processes at sewage treatment works. It would therefore 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 and so it is therefore reasonable to assume that this component of DSOU will remain stable through the planning period.

In AMP5 and AMP6 we are investing in integrating our network more fully (our 'grid project') which involves laying an additional 74 km of new mains and 6 new service reservoirs. Whilst these network developments might be seen as reason for DSOU to increase in the long term, the 'grid' is being designed with appropriate flow conditioning as part of the business-as-usual operation of the system to ensure water is not wasted.

Given the above, it is therefore reasonable for demand forecasting purposes that distribution system operational use will remain stable at the base year level (2.5 Ml/d) throughout the planning period.

5.8.2. Unbilled (legally and illegally)

<u>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, sewer flushing and street cleaning, and net consumption read at measured void properties. The UKWIR 1995 Demand Forecasting Methodology report also considers that supply pipe losses to void properties and leakage allowances should be included in water taken legally unbilled, however, we account for these elsewhere; supply pipe losses to void properties are included within the customer leakage volume, and leakage allowances are included within the household water delivered volume.

[70] UKWIR/NRA (1995). Demand forecasting methodology.

Water taken legally unbilled in 2011/12 was 2.752 Ml/d. Water taken legally unbilled varies slightly from year to year depending on the number of void properties and new properties being constructed (in 2011/12 these two components contributed 43% of the total volume).

Illegally unbilled

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 historic estimate. This value is consistent with our last Water Resources Management Plan (2009) and recent June Return submissions.

Total (legally and illegally) water taken unbilled amounted to 3.9 Ml/d in 2011/12. The UKWIR/NRA (1997) report[71] 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).

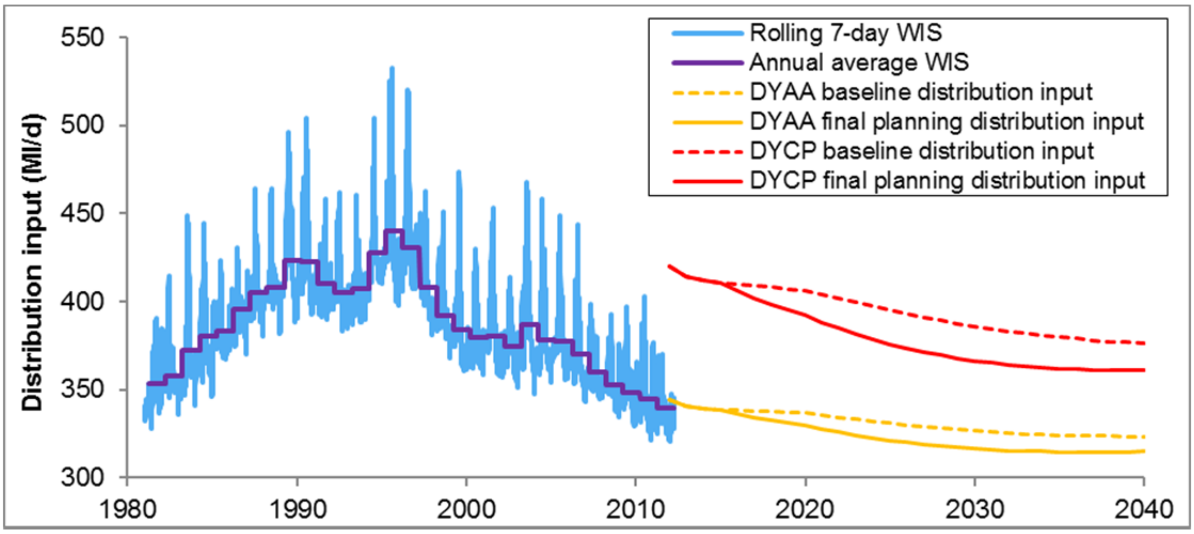
[71] UKWIR/NRA (1997). Forecasting components of water demand.

5.9 Summary of demand forecast

This chapter has reviewed all of the building blocks of the demand forecast. Some elements of demand are driving the forecast upwards (i.e. population growth) and other components of the forecast are driving a reduction in demands through the planning period (i.e. increased metering).

The combined effects and overall demand forecasts are presented in Figure 5-35 and Table 5-20.

Figure 5-35: 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 in Ml/d

Scenario	2011/12	2019/20	2024/25	2029/30	2034/35	2039/40
Baseline						
Average year annual average	331.5	323.8	318.4	314.1	312.0	311.4
Dry year annual average	344.5	336.7	331.0	326.5	324.1	323.3
Dry year critical period	419.7	406.4	395.0	385.7	379.8	376.1
Final planning						
Average year annual average	331.5	317.3	309.6	304.9	303.4	303.6
Dry year annual average	344.5	329.5	321.3	316.3	314.7	314.8
Dry year critical period	419.7	392.1	375.9	366.2	362.1	360.6
Differences						
Average year annual average	0.0	-6.5	-8.8	-9.2	-8.6	-7.8
Dry year annual average	0.0	-7.2	-9.7	-10.2	-9.4	-8.5
Dry year critical period	0.0	-14.3	-19.1	-19.5	-17.7	-15.5

The graph and table shows that the baseline **dry year annual average** demand forecast is projected to fall from 344.5 Ml/d in the base year to 323.3 Ml/d at the end of the planning period which represents a reduction of 21.2 Ml/d or 6.2%. The final planning scenario is forecast to achieve demand reductions that are 8.5 Ml/d greater in the long term and see demand fall to 314.8 Ml/d in 2040, representing an overall reduction of 29.7 Ml/d or 8.6%.

For the **dry year critical period** scenario the baseline forecast projects a reduction from 419.7 Ml/d in the base year to 376.1 Ml/d at the end of the planning period, indicating a reduction of 43.6 Ml/d or 10.4%. Again the final planning scenario is forecast to achieve demand reductions that are nearly 20 Ml/d greater than the baseline at times during the planning period and sees demand fall to 360.6 Ml/d in 2040, representing an overall reduction of 59.1 Ml/d or 14.1%.

5.9.1. How the demand forecasts meets Government objectives

The points below summarise how Government objectives outlined in the Water White Paper and the Guiding Principles of the Water Resources Planning Guideline are met by our final planning demand forecast:

- Overall demand is forecast to fall in absolute terms – our final planning forecast, which includes the effect of a change of occupier metering policy and enhanced water efficiency, projects reductions of nearly 30 Ml/d between the base year and 2040 for the dry year annual average condition and nearly 60 Ml/d over the same period for the critical period (peak week) scenario.
- Average per capita consumption is forecast to fall through the planning period – our final planning forecast indicates that average PCC will fall from 140 l/head/day in the base year to 123 l/head/day by 2040.
- Our leakage forecast indicates a continued downward trend – the final planning forecast which includes change of occupier metering offers bigger reductions through the planning period than the baseline forecast and will force leakage down by nearly 5 Ml/d by 2020 (a reduction of nearly 7%).
- Our final planning forecast includes the effect of proposals to offer an enhanced programme of water efficiency measures. The measures are designed to reach a broad range of customers and will impact on the water consumption of measured and unmeasured domestic customers and businesses.

5.9.2. Sensitivity testing

This chapter has outlined the wide range of information that is required to develop the demand forecast. An allowance for the uncertainty associated with many of the inputs has been developed for this Plan in the Headroom assessment – see Section 6. It is however useful to examine some elements of the demand forecast individually to understand the sensitivity of forecast to the input information.

Two key sensitivities have been examined:

- Population growth rates
- Peak factors.

Population growth rate

Section 5.4.2 explained the development and selection of the baseline population forecast which averaged 0.67% growth per annum.

We have undertaken a sensitivity run of our demand forecasting model with the population growth rate inputs amended to 0.8%. A summary of the impact on overall population and distribution input the dry year annual average for 2019/20 and at the end of the planning period (2039/40) are shown in Table 5-21. Over the full period the difference amounts to an additional 69,000 people which would result in distribution input being 6.7 Ml/d higher than the baseline forecast (2.0%).

Table 5-21: Sensitivity of 0.8% population growth rate on dry year distribution input

	2019/20		2030/40	
	Total population	Distribution input	Total population	Distribution input (Ml/d)
Baseline	1.352m	336.7 M/d	1.533m	323.3 Ml/d
Sensitivity with 0.8% population growth rate	1.365m	338.5 M/d	1.602m	330.0 Ml/d
Difference	0.013m (1.0%)	1.8 Ml/d (0.5%)	0.069m (4.5%)	6.7 Ml/d (2.0%)

The sensitivity of the demand forecast to population growth rates is therefore relatively small. An allowance for higher and lower population growth rates are incorporated into the headroom assessment (Section 6) and it is our conclusion that doing so adequately addresses the sensitivity and therefore risk associated with this element of the demand forecast.

Peak factors

Section 5.2.1 explained the development and selection of the peak factors used to uplift average demands to dry year annual average and dry year critical period demands. A key change from our last Plan is the reduction in the factor used for the dry year critical period forecast for measured households. Analysis undertaken for our last Plan indicated that measured and unmeasured households would exhibit similar peak water demand behaviour (a peak week increase of approximately 54% in the then base year of 2006/07) however evidence provided by our tariff trial has led us to reduce the factor for measured households down to just over 20%.

Our tariff trial study was carried out in years that were not particularly hot and/or dry and although we did update the analysis for the high demand period in summer 2013, there is some risk that the new peak factors have not been fully tested under true peak conditions. We have therefore undertaken a sensitivity run of our demand forecasting model with the dry year critical period peak factor for measured households amended to apply the same uplift values as the unmeasured households. A summary of the impact on distribution input for the dry year critical period in 2019/20 and at the end of the planning period (2039/40) are shown in Table 5-22.

Table 5-22: Sensitivity of using same peak factors for measured and unmeasured households on dry year critical period distribution input

	2019/20			2030/40		
	Measured peak factor	Unmeasured peak factor	Distribution input	Measured peak factor	Unmeasured peak factor	Distribution input (Ml/d)
Baseline	1.224	1.496	405.5 Ml/d	1.225	1.406	376.1 Ml/d
Sensitivity with amended measured peak factor	1.496	1.496	431.3 M/d	1.406	1.406	400.1 Ml/d
Difference	0.272	0.0	24.8 Ml/d	0.181	0.0	24.0 Ml/d

The sensitivity of the demand forecast to the selected peak factor is significant – by changing the measured household critical period peak factor our baseline demand forecast has been supressed by approximately 24 Ml/d throughout the planning period relative to our last Plan (other things being equal).

In recognition of this sensitivity we have included a specific peak factor element in our headroom modelling (Section 6) to account for the uncertainty associated with the potential for higher than forecast demands to occur in the future. This has contributed to the increase in the absolute headroom margin that we have included in our critical period supply demand balance in this Plan (approximately 30 Ml/d) relative to our last Plan (approximately 17 Ml/d).

6. Headroom

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[72]. Mott MacDonald's technical report[73] is available as an Appendix 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 listed below.

- Lower demand forecast = total population growth rate of 0.5% p.a. and measured non-household (NHH) demand reduction of 1.5% p.a.
- Central demand forecast = total pop growth rate of approximately 0.65% p.a and measured NHH demand reduction of approximately 1.4% p.a.
- Upper demand forecast = total population growth rate of 0.8% p.a. and measured NHH demand reduction of 1.0% p.a.

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

[72] A Monte Carlo simulation refers to a mathematical modelling technique that uses repeated random sampling to obtain numerical results i.e. by running simulations many times over in order to calculate a probability distribution just like actually playing and recording your results in a casino: hence the name. In the context of the headroom assessment for this Plan the Monte Carlo simulation combines individual component distributions to produce an overall distribution of headroom uncertainty.
[73] Mott MacDonald (March 2013). Headroom uncertainty analysis.

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[74] . To account for the uncertainty around the baseline forecast we used the 10th percentile (1.33% / 5 Ml/d impact by 2040) and 90th percentile (4.41% / 16.6 Ml/d impact by 2040).

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), sustainability reductions and time limited licences 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 – uncertainty over the possible loss of up to the whole import volume of 11.37 Ml/d from 2011/12 until 2015/16 when the uncertainty reduces as we expect to have a new agreement which limits the annual volume to 4.4 Ml/d and we have assumed up to 10% of this might be at risk.
- Sembcorp Bournemouth Water – Stubhampton – uncertainty over the possible loss of 10% of the import volume from the beginning of planning period
- Veolia Water Projects – uncertainty over the possible loss of up to the whole import volume of 2.74 Ml/d from 2017 (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
Five 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.

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)
- Meter errors (with an uncertainty of +/- 2% of DO)

[74] UKWIR (2013). Impact of climate change on water demand. CL/04.

- Abstraction licence compliance (with an uncertainty between 0 and 3% of DO)
- Reservoir yield uncertainty (with volumes at risk being identified from analysis)

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 4.11) derived 11 possible impact values 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.

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.

Figure 6-1: Baseline dry year annual average headroom uncertainty

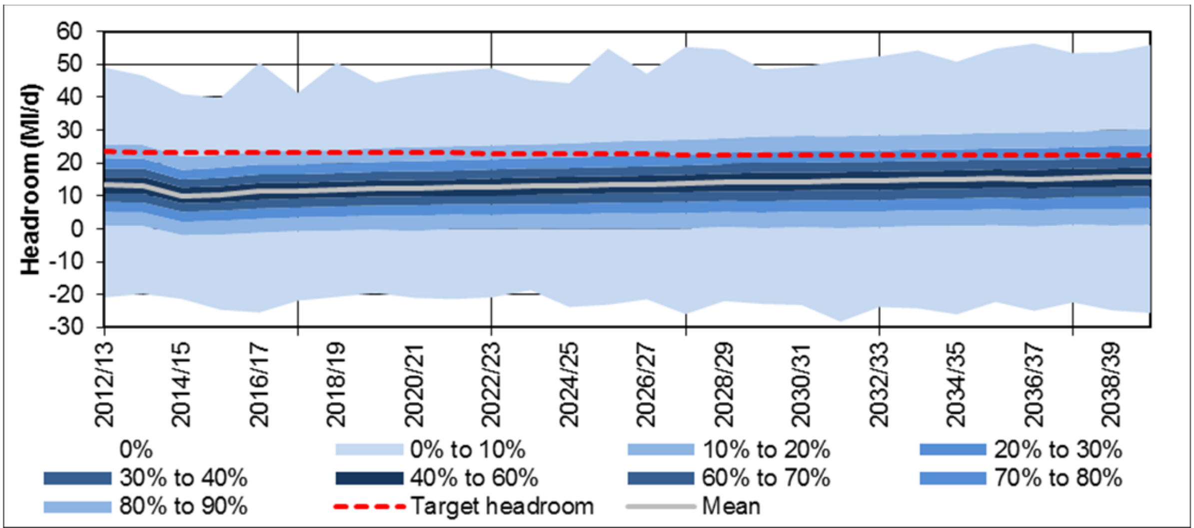


Table 6-1: Dry year annual average target headroom and risk percentile

	2011/12	2019/20	2024/25	2029/30	2034/35	2039/40
Percentile uncertainty	85%	88%	83%	78%	75%	72%
Baseline target headroom (Ml/d)	23.7	23.2	22.8	22.5	22.3	22.3
Final planning target headroom (Ml/d)	23.7	22.7	22.1	21.8	21.7	21.7

The target risk profile was determined by selecting the 85th percentile in the base year and then calculating the associated headroom value (23.7 Ml/d) as a percentage of the baseline dry year annual average distribution input for the year (344 Ml/d), i.e. 6.9%. By fixing target headroom at 6.9% 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 5% of distribution input throughout the planning period.

In 2014/15, a reduction in the overall headroom is observed as the uncertainty around the Bristol Water bulk transfer (import) is significantly reduced. This results in target headroom (expressed as a fixed percentage of distribution input) corresponding to less uncertainty (i.e. reduction in risk) that is shown by the increase in the target headroom percentile for the dry year annual average scenario (the same effect is also observed for the dry year critical period scenario, Section 6.3).

Figure 6.2 and Table 6.2 present the results of the sensitivity analysis which show 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. The uncertainty surrounding the demand forecast and the impact of climate change on water supplies grow through time, which is logical. Because we chose to fix the target headroom allowance at a fixed percentage of distribution input a higher risk percentile is selected in 2014/15 which alters the contribution of various issues to the overall target headroom figure and this shows primarily as an increase in the S6 issues contribution as these are responsible for the higher (extreme) values in the headroom calculation.

Figure 6-2: Dry year annual average target headroom allowance breakdown by component

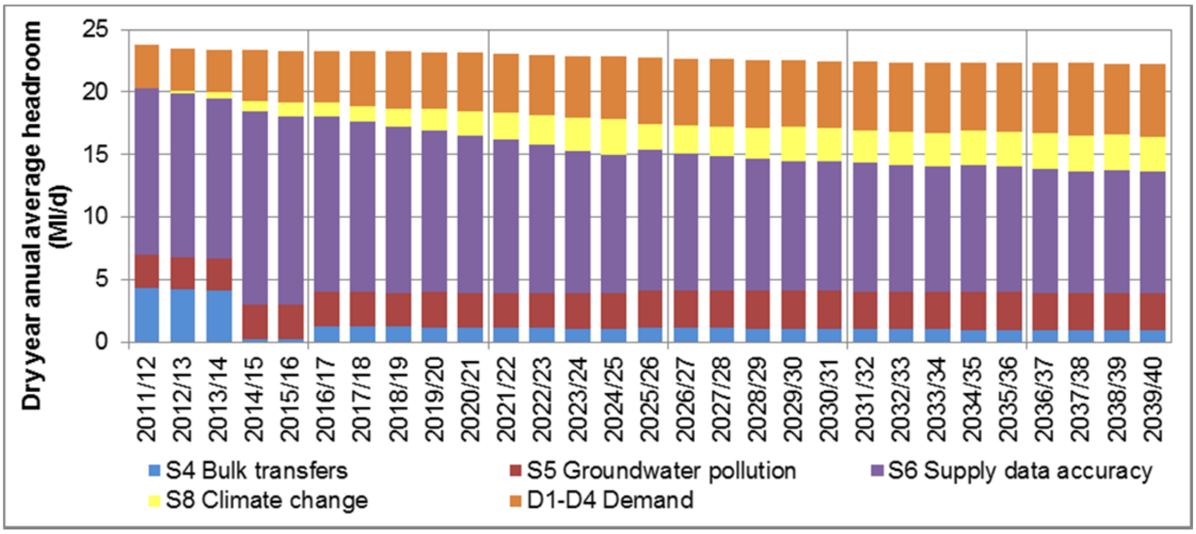


Table 6-2: Dry year annual average target headroom allowance breakdown by component

	2011/12	2019/20	2024/25	2029/30	2034/35	2039/40
D1-D4 Demand	3.4 Ml/d 14%	4.6 Ml/d 20%	5.0 Ml/d 22%	5.3 Ml/d 24%	5.5 Ml/d 24%	5.8 Ml/d 26%
S4 Bulk transfers	4.3 Ml/d 18%	1.2 Ml/d 5%	1.1 Ml/d 5%	1.0 Ml/d 5%	1.0 Ml/d 4%	0.9 Ml/d 4%
S5 Groundwater pollution	2.7 Ml/d 11%	2.8 Ml/d 12%	2.9 Ml/d 13%	3.0 Ml/d 13%	3.0 Ml/d 14%	3.0 Ml/d 13%
S6 Supply data accuracy	13.4 Ml/d 56%	13.0 Ml/d 56%	11.1 Ml/d 48%	10.4 Ml/d 46%	10.1 Ml/d 45%	9.8 Ml/d 44%
S8 Climate change	0.0 Ml/d 0%	1.7 Ml/d 7%	2.8 Ml/d 12%	2.8 Ml/d 12%	2.8 Ml/d 12%	2.8 Ml/d 12%

6.3 Headroom results – dry year critical period (peak)

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

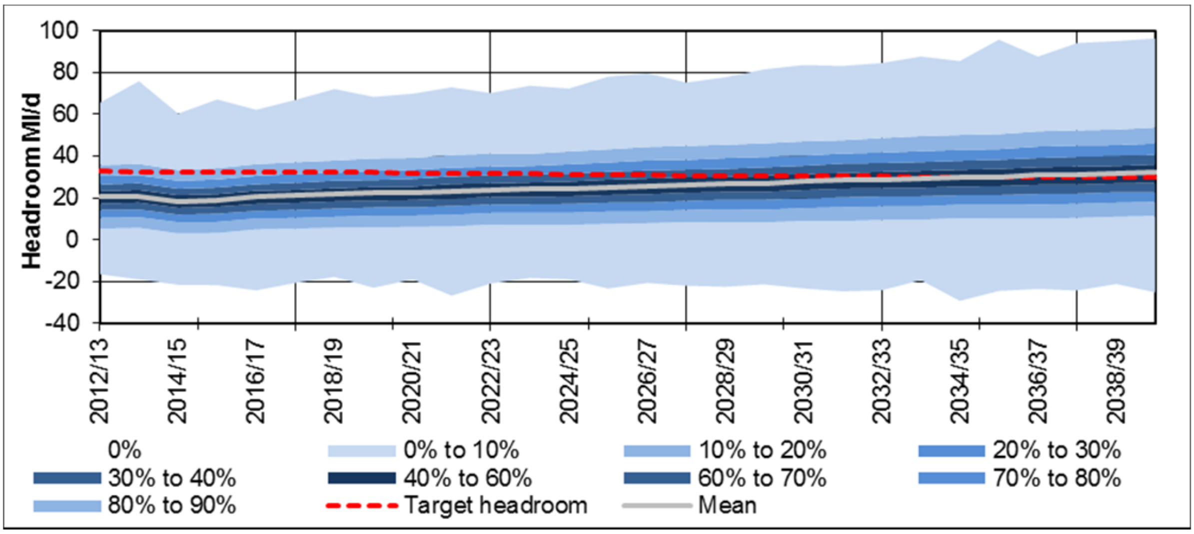


Table 6-3: Dry year critical period target headroom and risk percentile

	2011/12	2019/20	2024/25	2029/30	2034/35	2039/40
Percentile uncertainty	85%	79%	69%	60%	52%	46%
Baseline target headroom (Ml/d)	32.6	31.6	30.7	30.0	29.5	29.3
Final planning target headroom (Ml/d)	32.6	30.5	29.2	28.5	28.2	28.1

The target risk profile was determined using the same approach as the annual average condition – the 85th percentile was selected for the base year and the associated headroom value (32.6 Ml/d) was calculated as a percentage of the baseline dry year critical period distribution input for the year (419.3 Ml/d), i.e. 7.8%. By fixing target headroom at 7.8% 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.

Figure 6-4 and Table 6-4 show the relative contribution of each of the sub-components to the overall target headroom profile.

Under this critical period scenario the uncertainty associated with demand components is proportionally larger (*c.* 40% throughout the planning period) than under the annual average scenario (*c.*22%). This is related to the current uncertainty associated with the peak factors for measured households related to the infrequent occurrence of dry year demands and therefore the limitations of the data available.

The uncertainty associated with the impact of climate change on water supplies is small, which an allowance of less than 1 Ml/d throughout the planning period.

Figure 6-4: Dry year critical period target headroom allowance breakdown by component

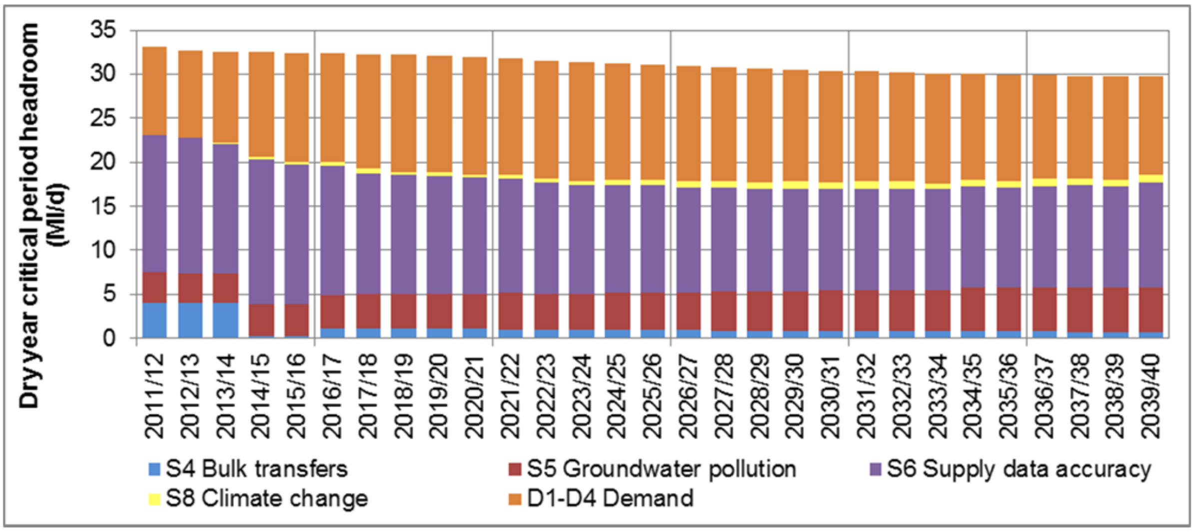


Table 6-4: Dry year critical period target headroom allowance breakdown by component

	2011/12	2019/20	2024/25	2029/30	2034/35	2039/40
D1-D4 Demand	10.1 Ml/d 30%	13.3 Ml/d 41%	13.2 Ml/d 42%	12.6 Ml/d 41%	12.0 Ml/d 45%	11.2 Ml/d 38%
S4 Bulk transfers	4.1 Ml/d 12%	1.1 Ml/d 3%	1.0 Ml/d 3%	0.9 Ml/d 3%	0.8 Ml/d 3%	0.7 Ml/d 2%
S5 Groundwater pollution	3.4 Ml/d 10%	4.0 Ml/d 12%	4.2 Ml/d 13%	4.5 Ml/d 15%	5.0 Ml/d 17%	5.0 Ml/d 17%
S6 Supply data accuracy	15.7 Ml/d 47%	13.4 Ml/d 42%	12.3 Ml/d 39%	11.7 Ml/d 38%	11.5 Ml/d 38%	12.0 Ml/d 40%
S8 Climate change	0.0 Ml/d 0%	0.4 Ml/d 1%	0.6 Ml/d 2%	0.9 Ml/d 3%	0.7 Ml/d 2%	0.8 Ml/d 3%

As we are in supply demand balance surplus we have not considered options to specifically reduce the headroom allowance in the future however, should a dry year occur prior to the development of our next Plan we would expect to increase our understanding of critical period demands and as more of the customer base become metered the uncertainty of the difference between measured and unmeasured peak factors will also inherently reduce.

6.4 Possible changes in headroom assumptions in future plans

Over time we would expect to clarify issues that currently appear uncertain. This is why it is appropriate to have a reducing percentile risk over time (85% reducing to 72% for dry year annual average and 85% reducing to 46% for dry year critical period). In particular the risks that we would expect to reduce are:

- Demand – a particular uncertainty is the critical period peak factor for metered customers. This should become more certain in the event of a dry summer.
- Bulk supplies – a clearer understanding will be obtained on the reliability of bulk supplies under dry weather conditions.
- Groundwater pollution – the risk can be better quantified over time supported by the samples we take and our on-going catchment management work.
- Supply side data accuracy – for this Water Resources Management Plan we have improved the accuracy of our supply side data particularly for our groundwater sources (Section 4.2). This work will continue.
- Climate change – the impact of climate change is small using the method specified in the Guideline. However we are keen to explore the impact of climate change on the likely duration of droughts, as this is likely to have more effect (positive or negative) on deployable output than the “dryness” of the drought.

7. Baseline balance between supply and demand

The overall balance of the supply system is assessed by comparing the forecast of water available for use with the forecast of demand (distribution input) plus target headroom. 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.

The reduction in water available for use in 2017/18 relates to the reduction in abstraction licences to improve river flows (Section 4.5).

For the dry year annual average scenario once the sustainability reductions have been made the surplus then grows to 29 Ml/d in 2019/20 and to 41 Ml/d in 2039/4040. For the critical period the surplus grows to 27 Ml/d in 2019/20 and to 60 Ml/d in 2039/40.

Figure 7-1: Baseline supply demand balance for the dry year annual average scenario

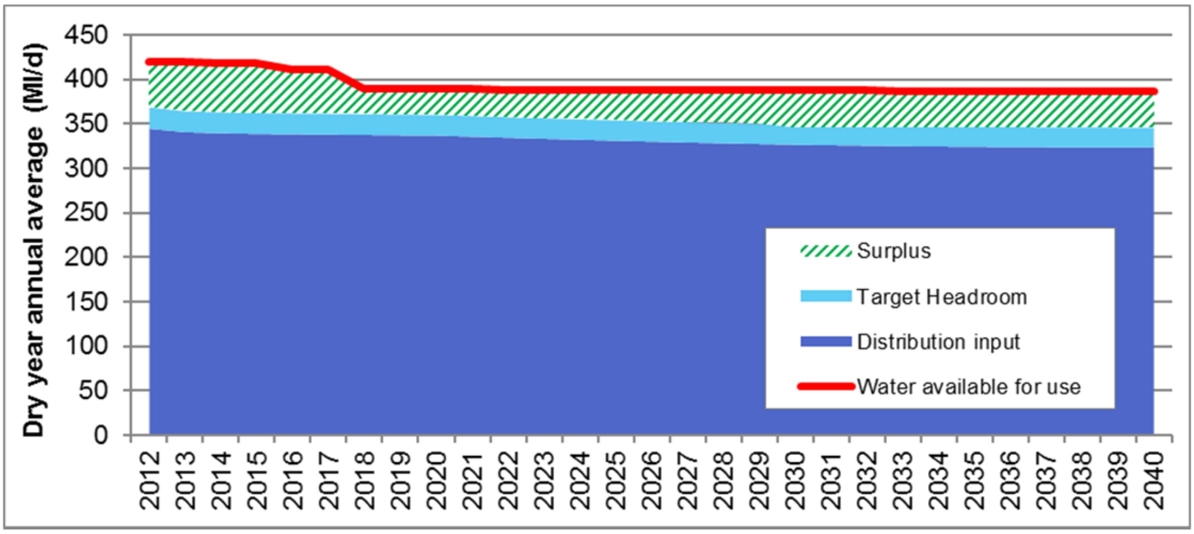


Table 7-1: Key information relating to the supply demand balance for the dry year annual average scenario

Dry Year Annual Average	2014/15	2019/20	2039/40
Distribution input	338	337	323
Deployable output	426	402	401
Water available for use*	419	389	387
Target headroom	23	23	22
Supply demand balance	**+57**	**+29**	**+41**

*Water available for use = Deployable output – outage + imports – exports.

Figure 7-2: Baseline supply demand balance for the dry year critical period scenario

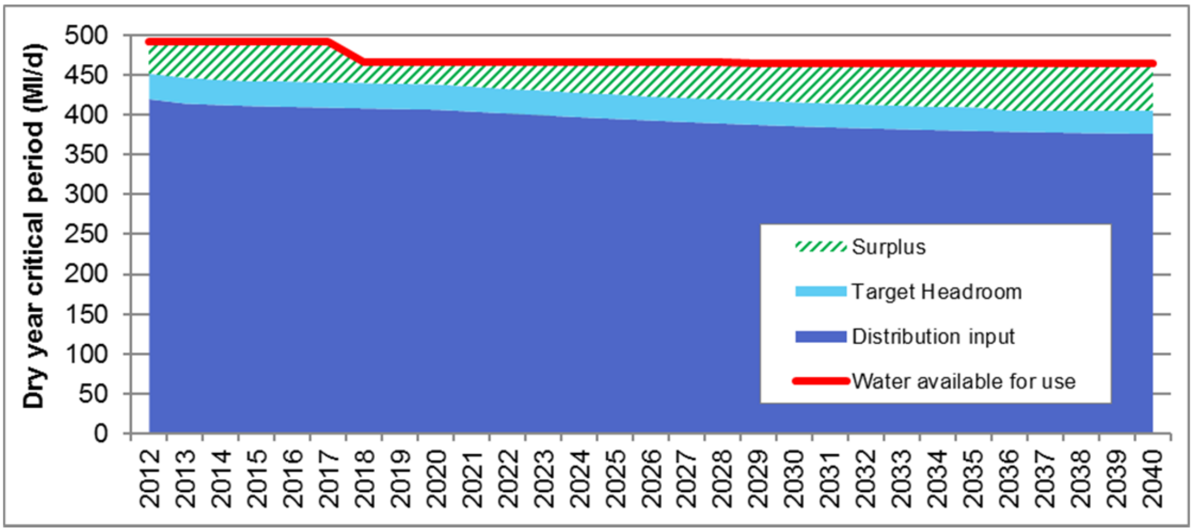


Table 7-2: Key information relating to the supply demand balance for the dry year critical period scenario

Peak Week Critical Period	2014/15	2019/20	2039/40
Distribution input	420	406	376
Deployable output	514	488	487
Water available for use	492	466	465
Target headroom	32	32	29
Supply demand balance	**+49**	**+27**	**+60**

*Water available for use = Deployable output – outage + imports – exports.

8. Options and future investments

8.1 Investment drivers and selection of options to review

In the absence of a supply demand balance deficit during the planning period (see Section 7) there are two potential approaches that we can take with regard to determining our future strategy for water resources management:

- Continue with current policies only
- 'Do the right thing' – meaning that despite the supply demand balance surplus we wish to implement measures that; help us become more efficient, are better for the environment, help maintain the positive supply demand balance and achieve Government aspirations.

We have therefore investigated what **'doing the right thing'** might specifically mean for Wessex Water by taking into account Government aspirations, company objectives, customer expectations and willingness to pay for new measures and the wider environmental context. Key issues for each of these are summarised below but in summary they each point us strongly towards going further in reducing demand.

8.1.1. Government aspirations

In December 2011 the Government published a Water White Paper, '*Water for Life*', which describes their vision for future water management. The guiding principles of the Water Resources Planning Guidelines (November 2012) produced by the Environment Agency, Defra and Ofwat summarised the key Government aspirations and those which are particularly relevant to option analysis are summarised below:

Reducing the demand for water – water companies are expected to show how they will promote the efficient use of water to customers and where a company is in an area designated as water stressed or where per capita consumption (PCC) is above the national average (147 litres per head per day) Government expects the demand trend to be 'significantly downwards'. Average PCC in the Wessex Water region is 142 l/h/d and so we are below the national average, however the current Environment Agency consultation on water stress indicates we are in an area of serious water stress (see Section 4.3.2) and so we recognise this challenge to reduce per capita consumption.

The Government has concluded that a blanket approach to metering is not appropriate for the UK as the costs and benefits vary from region to region, however where a company is in an area designated as in serious water stress it must consider compulsory metering in the feasible options analysis. Installing a meter by itself does not reduce water use; Government also expects that an effective metering programme would include provisions to support customers in reducing the amount of water they use through enhanced water efficiency measures and that customer views would be taken into account in assessing the impacts of the metering.

The Water White Paper states that it is important to raise customer awareness of the links between their water use, their bill and their local environment.

Water companies are also expected to ensure that leakage does not rise during the planning period and should consider options to manage and innovate leakage control measures to balance supply and demand.

Water trading and cross boundary solutions – the Water White Paper also makes reference to improving the interconnection between the water supply systems of different companies. While recognising that water is heavy and so pumping it long distances can have high energy requirements, the Government is looking to water companies and Ofwat to facilitate short distance strategic interconnection projects to incrementally build up a more integrated water network in the UK. This they believe will increase flexibility and resilience and could offset the need to develop new resources or other infrastructure.

8.1.2. Customer expectations and willingness to pay

In the development of our Strategic Direction Statement (SDS) we engaged extensively with customers about what they want to see from us in the medium and longer term. We talked to more than 2,000 households and businesses, prospective customers (under 25s) and teenagers, as well as members of our four liaison panels. These include more than 50 local stakeholders interested in customer service, our environmental work and planning and development issues. We also conducted in-depth interviews with business customers and national stakeholders.

We built in a deliberative element allowing us to compare a spontaneous or natural reaction to our longer-term plans with one that is more informed. This was supported by two rounds of quantitative research by telephone. This customer engagement work and the strategy itself were then assessed and reviewed by our customer scrutiny group which includes regulators and representatives of our liaison panels.

The top priorities identified by our research are illustrated in Figures 8-1 (from our SDS research) and 8.2 (from our 'image tracker' survey in 2012).

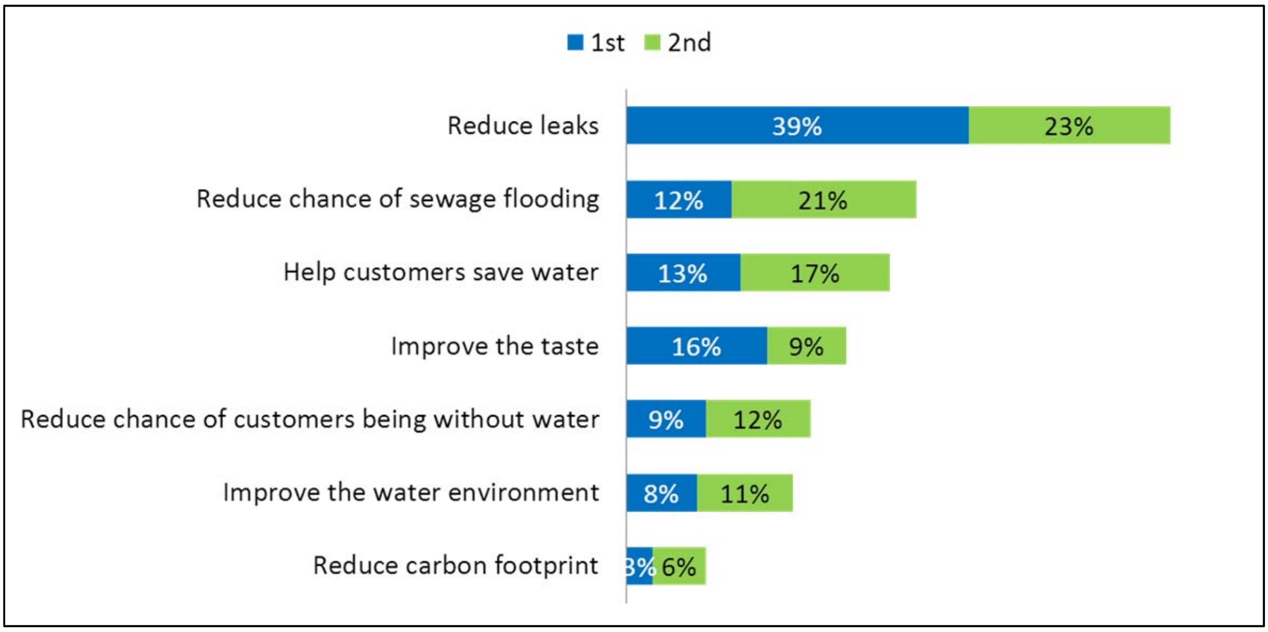
Figure 8-1: Priorities for customers

The top priority for the majority of customers is affordable bills, driven mainly by the impact of the recession on both household and business budgets. The great majority of customers want the amount they spend on water as a proportion of their household budget to stay the same.

Tackling leakage and helping customers to save water and save money also rank highly. The taste and hardness of tap water is important but only a minority see a need for improvement. Similarly, keeping the risk of sewage flooding to a minimum is seen as very important even though few customers are directly affected. Customers also regard clean rivers and beaches as important but do not see a significant problem as things stand.

Business customers are looking for a closer relationship with their water company and a wider range of added value or tailor made services to suit their needs.

Figure 8-2: Image tracking survey (2012) response to the question: "Which of the following do you think are the first and second most important things for your water company to do in the future?"



This research helped us to re-evaluate our long term direction and develop nine key outcomes for our SDS and Business Plan that are specified in Section 8.1.4.

In addition we have investigated customer preferences in relation to their 'willingness to pay' for improvements in water and sewerage services. We commissioned NERA Economic Consulting and Ipsos MORI to design implement and analyse a series of stated preference surveys. The findings have been used to generate 'customer benefit values' for use in the cost benefit analysis of alternative options.

The survey was developed in line with industry best practice, and in particular following the recommendations made by NERA and Accent set out in UKWIR (2011)[75]. The draft survey was sent to the Customer Scrutiny Group as well as appropriate staff in Wessex Water. Their comments were used to edit the draft survey. Testing was then undertaken with customers in which the respondents went through the survey and were then asked further probing questions about the survey itself. Further changes were made before the final survey was piloted.

The final survey involved a 20 minute face to face interview with 631 customers. These interviews focussed mostly on issues of relevance to the Water Resources Management Plan. A further 1052 interviews involved a range of water supply issues, including some that are relevant to this plan. This quantitative work was supported by a qualitative study among four focus groups, covering the topics of leakage, water efficiency and metering.

[75] UKWIR (2011). Carrying out willingness to pay surveys (NERA Economic Consulting and Accent). 11/RG/07/22

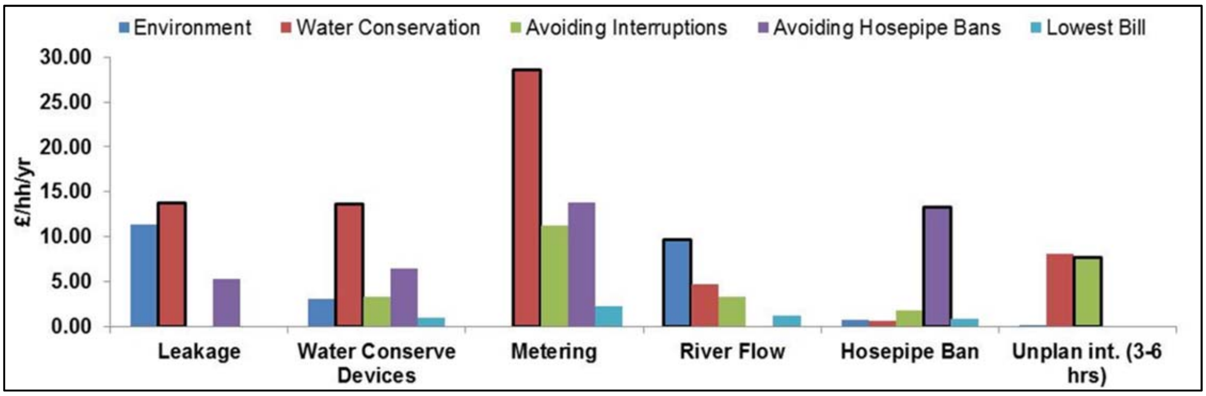
In the quantitative work customers were asked to decide between a series of service attributes, including the potential impact on their water bill. Customers were also asked about what was their main motivation when making their choices – such as environmental concerns, water conservation, avoiding a decline in service or lower bills.

Table 8-1 and Figure 8-3 show what motivations customers gave as their primary concern and how this affected their valuations (willingness to pay). This information confirms the conclusions from our other research that that the top priority for most of our customers is to maintain affordable bills but that for a significant proportion issues around water conservation and the environment are a key priority. Reasons of environmental concern and water conservation were strongly linked in the valuations to leakage, the distribution of water efficiency devices and metering in particular.

Table 8-1: Responses customer gave when asked what they were mostly concerned about when making choices

	Environment	Water conservation	Avoiding interruptions	Avoiding hosepipe bans	Lowest bill
Number of respondents	86	146	74	12	292

Figure 8-3: Comparison of customers' stated motivations and valuations



Findings from the willingness to pay research are reported within the options analysis sections of this chapter and NERA Economic Consulting and Ipsos MORI also produced a technical report[76] to support this Plan.

8.1.3. Environmental issues

We recognise that we have a responsibility to protect and enhance the environment when we are managing our water resources. The environment in the region is exceptionally varied, in terms of landscape and wildlife habitats.

Notable landscapes include the Somerset Levels adjoining the Severn Estuary, the south Cotswolds, the chalk downs of Salisbury Plain, the Hampshire River Avon, the Quantock and Mendip Hills, the Dorset heaths, the Isle of Purbeck and Chesil Beach. Most of these lie

[76] NERA and Ipsos Mori (March 2013). Customer preferences for services and Price for PR14 and WRMP14 – prepared for Wessex Water.

within areas classified as Areas of Outstanding National Beauty. The quality of wildlife habitats is reflected in the fact that the southern part of our region has the highest density of sites protected under the European Union Habitats and Species Directive.

Across the region there are nearly 500 SSSIs, 39 SACs, 11 SPA, 23 National Nature Reserves and nearly 7000 county wildlife sites. The area around Wareham is the most biologically diverse in the country and there are 8 Areas of Outstanding Natural Beauty which cover over 55% of the region.

In section 4.5 we outlined the measures we have taken over the years to ensure that our abstractions do not have a significant impact on this precious environment. This has included reducing licensed volumes and providing stream support.

In the future there may be requirements for further changes, either in licence quantities or by using innovative approaches such as the Abstraction Incentive Mechanism (AIM, see Section 4.5.5). During the AMP6 period we will be investigating the environmental impact of a number of our abstractions and the conclusion of these studies may be that changes in abstraction are required.

Whilst our assessment of climate change indicates little impact on our available water resources (Section 4.11) the same may not be true for river flows. One of the purposes of Defra’s Abstraction Licence Reform process (Section 4.5.1) is specifically to see how abstraction licencing should be reformed to manage water resources under a changing climate.

Even where there is no specific, proven, scientific link between abstraction rate and environmental impact, the less water we take from the environment the better. This is true both in terms of the impact on the environment and also in terms of the costs and environmental impact of treating and distributing the clean water, and then collecting and treating the resulting sewage flows.

Where appropriate, and permitted by the Water Resources Planning Guidelines, we have allowed for these uncertainties in our assessment of headroom. However these influences would be best recognised by pursuing strategies that reduce the demand for water, and therefore the need to abstract it from the environment in the first place.

8.1.4. Company objectives

In 2012, following the customer research outlined in Section 8.1.2 we published our 25-year strategic direction statement, *Water – the way ahead 2015-2040.* It outlines our aims and nine major outcomes we intend to address. In each case we have already made progress but the views of customers, regulators and others show there is more to be achieved. The nine outcomes are (see also Figure 1-2 in Section 1):

1. **Delivering for customers** – high levels of satisfaction by consistently meeting or exceeding customers’ expectations; being viewed as a trusted, reliable and preferred service provider.
2. **Saving water and money** – affordable bills for our customers; and wiser and more efficient use of water and sewerage services
3. **Drinking water quality** – safe, wholesome and pleasant drinking water, which complies with mandatory standards and supports the well-being of our customers and communities
4. **Leakage** – continue to drive leakage down and fix leaks reported by customers within 24 hours

5. **Bathing water** – contributing to bathing water quality being in good or excellent condition
6. **Rivers, lakes and estuaries** – watercourses in good ecological and chemical condition, with abstraction, effluent and land runoff fit to be sustainably accommodated by the environment
7. **Flooding** – the risk of sewage flooding kept to a minimum, benefitting the well-being of our customers, communities and environment
8. **Resilience** – assets and working practices that continue to deliver high quality reliable services, even in the face of unusual events
9. **Carbon footprint** – achieving carbon neutrality in our combined activities and generating our own renewable energy

Of most relevance to the option analysis for this Plan are our desires to help customers save water and money, continued leakage reduction, maintenance of abstraction at a sustainable level, and continued movement towards a more resilient supply system. All of these drivers point towards continued demand reduction.

8.1.5. Selection of options for review

From our review of the influencing factors we determined that options that warrant consideration under what has been termed 'do the right thing' should be those which will reduce demand, that is:

- Options to enhance metering
- Options to enhance our water efficiency
- Options to reduce leakage

Importantly given the views of customers around the affordability of their bill, discretionary options such as these will be reviewed in the context of our ambition to maintain flat bills.

In addition to these we also decided to review a range of supply-side options that our last Water Resources Management Plan identified as feasible but were not implemented as part of the final planning solution – we believe it is appropriate for a water company to regularly review the costs and benefits of a range of options even in the absence of a supply demand balance need.

Table 8-2 presents the list of options we have analysed for this Plan.

Table 8-2: Options reviewed

Code	Option name	Category
'Do the right thing' demand-side options		
M2.1	Metering – change of occupier (standard meters)	Options to change volume delivered to unmeasured households
M2.2	Metering – change of occupier (AMR*)	
M2.3	Metering – change of occupier (smart meters)	
M3	Metering – compulsory (standard meters)	
WE1	Water efficiency – large scale domestic retrofit scheme	Options to change volume delivered to measured households
WE3	Water efficiency – device installation in social housing	
WE4	Water efficiency – community engagement programme	
WE2	Water efficiency – community fund	Options to change volume delivered to unmeasured households
L1.1	Leakage – asset renewal 2 Ml/d reduction	Options to reduce distribution losses
L1.2	Leakage – asset renewal 7 Ml/d (10%) reduction	
L1.3	Leakage – asset renewal 17 Ml/d (25%) reduction	
L1.4	Leakage – asset renewal 35 Ml/d (50%) reduction	
L2	Leakage – pressure management	
L3.1	Leakage – active leakage control 2 Ml/d reduction	
L3.2	Leakage – active leakage control 7 Ml/d reduction	
Other supply-side options		
R1.1	Desalination (30 Ml/d)	Options to increase raw water abstractions
R1.2	Desalination (10 Ml/d)	
R2	New reservoir (south of Yeovil)	
R3	River Avon abstraction near Saltford	
R4	River Avon abstraction to Chew Valley Reservoir	
R5.1	Avonmouth effluent reuse	
R5.2	Avonmouth boreholes	
R6	Longham Lakes	

AMR = Automatic meter reading

Given our supply demand balance surplus position we have not appraised a change in our level of service as an option.

8.2 Analysis of options

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) as this is in line with the approach taken for our last Water Resources Management Plan.

Customer preferences have been assessed using the quantitative and qualitative findings from our customer research including willingness to pay research (Section 8.1.2).

Cost estimates have used the 2012/13 price base and have been prepared based on:

- outline designs to determine required assets and their sizes
- up to date cost curves used to work out the cost of each asset
- collation into standard company spreadsheets that are used across the entire capital programme
- challenge and review both internally (Technical Review Meetings) and externally.

All costs and benefits have been considered over an 80 year horizon.

8.3 Metering options

At present just over 50% of the households we supply pay for their water services by metered volume. We have provided customers the option of switching from an unmeasured supply to a metered supply for free since 1996 and the proportion of our customer base that is metered has been steadily growing as a result.

Section 5.5.4 outlined the impact on the baseline demand forecast of a continuation of our current optional metering policy and Section 5.5.5 described the impact on the demand forecast of our final planning scenario which includes a proposal to implement a change of occupier metering policy from 2015/16 coupled with an enhanced water efficiency programme.

This section reviews two alternative metering proposals relative to the base case optional metering only scenario – (i) change of occupier and (ii) compulsory. The comparison of options explains why we have selected to include a policy to include change of occupier metering in our final planning scenario for this Water Resources Management Plan.

Further detailed analysis and discussion is presented in a separate technical appendix[77] to this Plan.

Our proposal to introduce a change of occupier metering policy is intended to be implemented in parallel to an enhanced water efficiency programme comprising several individual schemes that are outlined in Section 8.4 of this chapter.

8.3.1. Metering option descriptions

Table 8-3 states the key features of the alternative metering options that we have considered relative to the current optional metering policy.

Table 8-3: Metering option specifications

	Optional metering	Change of occupier metering	Compulsory metering
Option code	N/A – current policy	M2.1 – standard M2.2 – AMR M2.3 – smart meter	M3 – standard
Meter installation policy[78]	Meter installed free upon customer request	Meter installed for free upon notification of new occupier	All properties to be systematically metered during AMP6
Forecast of meters installed	43.6k Optional meters installed in AMP6.	65.2k Change of occupier meters installed in AMP6. 39.7k Optional meters installed in AMP6.	183.2k Compulsory meters installed in AMP6 27.6k Optional meters installed in AMP6

AMP6 = Asset Management Period 6, 2015/16 to 2019/20; AMR = automatic meter reading

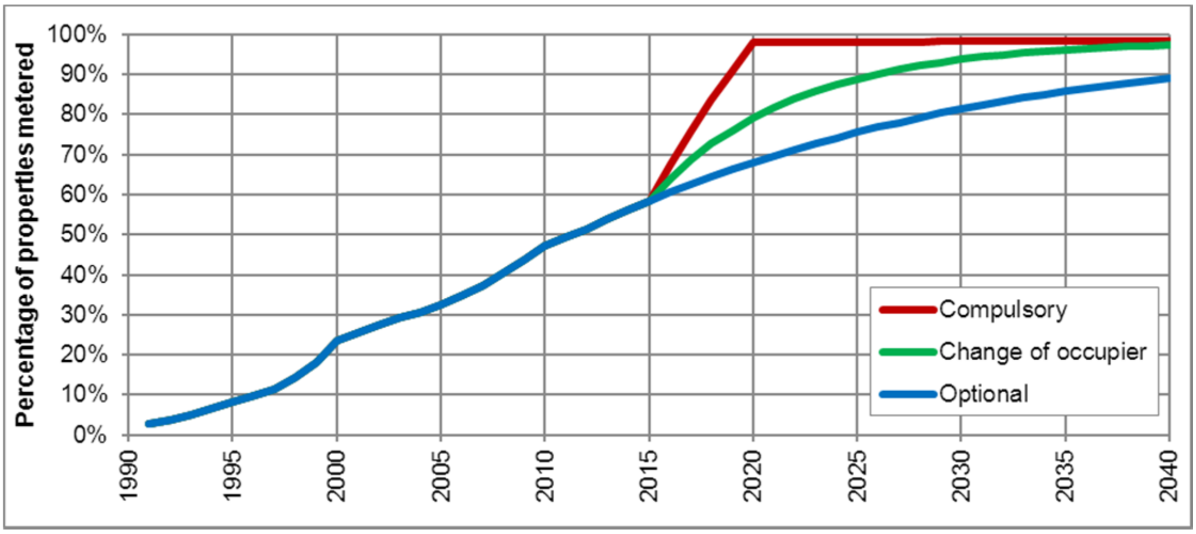
[77] Wessex Water (March 2013). PR14 Metering policy options.

[78] Meter installation under all scenarios is assumed to occur providing the cost of installation is less than £1000; where the cost of installation is expected to exceed £1000 the customer would be offered an assessed charge.

Figure 8-4 shows the effect that the alternative metering policies would have upon the rate of increase in the proportion of our domestic customers that are metered. At the end of the current AMP period in 2014/15 we expect that nearly 60% of customers will be metered leaving nearly 220,000 unmetered households.

The compulsory scenario would naturally lead to the fastest increase in meter penetration involving the installation of over 210,000 meters by 2020, taking meter penetration to 98%. Under the change of occupier scenario meter penetration would grow to nearly 80% by 2020 and reach over 90% by 2025. A continuation of the current optional metering policy would see metering increase to more steadily reaching only 70% by 2020.

Figure 8-4: Meter penetration under different metering policies



All metering scenarios have been assessed assuming standard (i.e. not smart) meters are installed. We have additionally appraised the costs for installing AMR (automatic meter reading) and smart meters for the change of occupier metering policy.

8.3.2. Metering impacts on demand

When a household switches from an unmeasured charge to being metered an incentive is created for the household to reduce their water usage. The savings that are made depend upon the scenario under which a meter is installed. We have assumed a reduction in demand of 15% when a household moves into a metered house rather than an unmetered one (i.e. change of occupier metering). This was a key finding of our recent tariff trial[79]. This contrasts with a reduction in demand of only 6% for optional metering (where the customer's primary intention is usually to save money, but not necessarily water) and a reduction of 12.5% for households that become compulsory metered.

Our tariff trial study found that the small additional demand management benefits associated with seasonal tariff structures were outweighed by the associated reduction in customer satisfaction and so we have not included alternative tariff structures as part of our metering options analysis for this Plan.

[79] Wessex Water (September 2012). Towards sustainable water charging – conclusions from Wessex Water's trial of alternative charging structures and smart metering.

The highest saving is associated with change of occupier metering – this is likely to be due to what behavioural theories refer to as “moments of change”. Moments of change are occasions where the circumstances in an individual’s life change considerably within a relatively short time frame. The theory suggests that many of our behaviours are habitual, i.e. they are repeated very often with little or no conscious intent, and that previously existing habits may be more easily broken, and new habits more easily formed, at “moments of change”. This is because the individual is forced to become newly conscious of the behaviour before it becomes a habit.

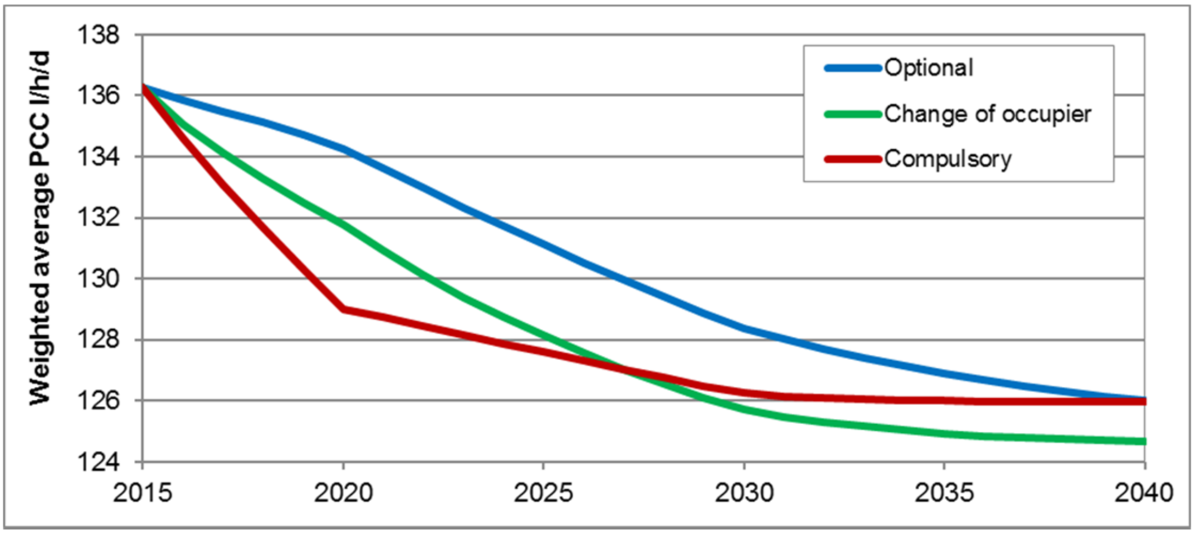
Moving home has been defined in the literature as one of the four key “life event” moments of change and there is evidence on this subject that interventions targeted at this time have led to more pro-environmental travel behaviour for example.

Members of a household will be forming new water usage habits using new water using devices in their new home. Similarly a household is more likely to take water efficiency into consideration when purchasing new white goods and other water using appliances for their new home if they are aware that it will impact on their water bill.

Impact on per capita consumption

The reductions in household demand for each metering scenario can be examined in terms of their effect on overall weighted average per capita consumption (i.e. accounting for the split of measured and unmeasured households). Figure 8-5 shows that while the fastest reduction in average per capita consumption results from the compulsory metering policy, the greatest and most sustained reduction in the long term is associated with metering on change of occupier policy. This is because people who move to a metered supply on change of occupancy use less water than if they are metered compulsorily.

Figure 8-5: Weighted average per capita consumption forecast for alternative metering policies (excluding impacts of non-baseline water efficiency)



At the end of the planning period the lowest average per capita consumption of 124.7 litres/day is forecast to be achieved by a change of occupier metering policy which is 1.3 litres lower than compulsory metering (126.0 litres/day) and optional metering (126.0 l/day).

Detailed household flow data collected and analysed as part of the tariff trial lends further support to the changes seen at an aggregated level. Differences in the patterns of water consumption between unmetered and metered customers suggest that far greater care is taken with water use by the latter. Unmetered customers are twice as likely to have periods of low level continuous water use suggesting problems like dripping taps and leaking toilet cisterns are far more prevalent. They also have far higher incidences of high-rate continuous consumption indicative of deliberate use for garden watering and/or paddling pool use. During the summer of 2010 three times more unmetered customers exhibited these characteristics than metered customers. These observed changes in discretionary use make up one quarter of the overall changes in demand seen as a result of metering.

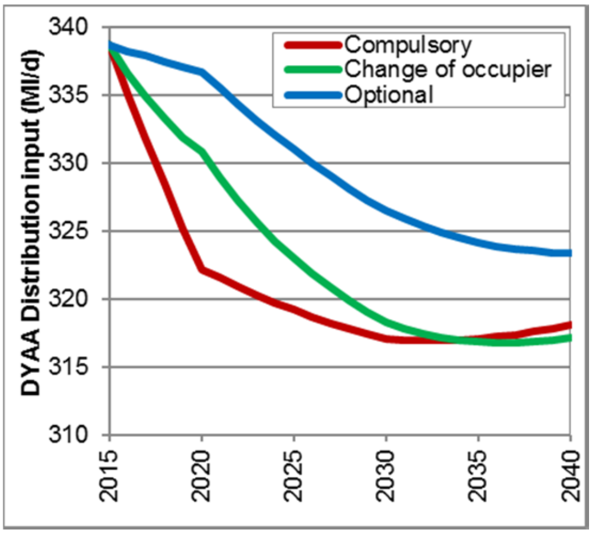
Impact on distribution input

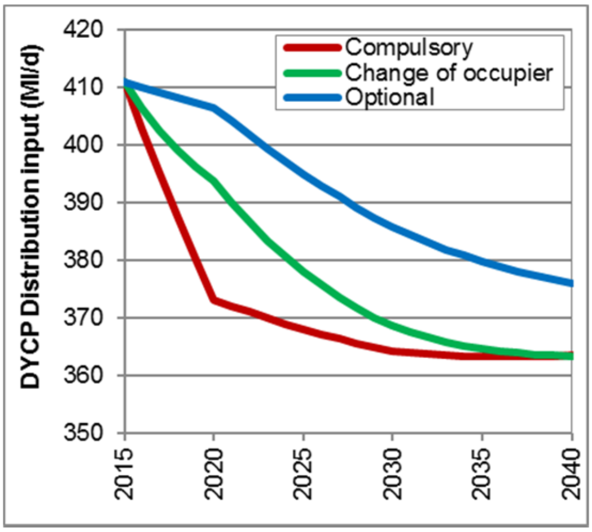
We have modelled the effect of the reductions in demand at a household and per capita level to examine the overall impact on water demand (distribution input) that would arise from each metering policy. Figure 8-6 shows that the quickest reductions in demand are associated with compulsory metering as this is the strategy that would install meters at the fastest rate.

A policy of metering on change of occupancy is expected to result in distribution input being 12.6 Ml/d lower for peak demand and 6.2 Ml/d lower for dry year average demand by 2040 than would be the case if we continued with optional metering alone.

Assuming a value of water resources of £5/Ml/d of capacity this resource is worth between £31m (dry year annual average) or £63m (dry year critical period).

Figure 8-6: Dry year annual average (DYAA) and dry year critical period (DYCP) forecasts of distribution input for alternative metering policies (excluding impacts of non-baseline water efficiency)





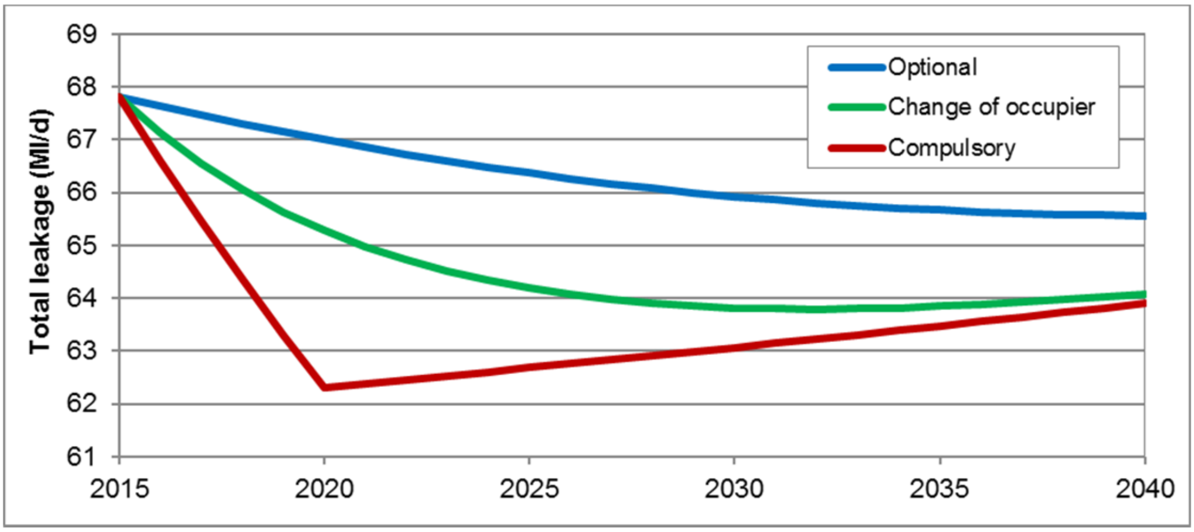
Impact on leakage

On average we consider that installing a meter externally reduces leakage from customers' supply pipes by around 30 litres per property per day. This reduction occurs because leaks are detected at the time of installation, when the meter is read and from anomalous bills.

Figure 8-7 illustrates that, assuming no changes to distribution losses, a policy of metering on change of occupier would result in leakage being reduced by 1.5 Ml/d below the optional metering scenario by 2040. The compulsory metering scenario would lead to more rapid reductions in leakage in the short term (4.7 Ml/d less than the optional scenario in 2020). Our customer research and tracker surveys regularly show that reducing leakage is a top priority for customers.

With compulsory metering leakage rises after 2020 due to leaks developing in the supply pipes of new properties.

Figure 8-7: Total leakage forecast for alternative metering policies



8.3.3. Metering costs, benefits and customer preferences

Our cost benefit analysis followed the methodology and spreadsheet model developed by the 2012 UKWIR study on smart metering[80]. The UKWIR study was led by Frontier Economics and we held a session with Frontier Economics in December 2012 to clarify some points and to confirm the correct application of the model. Further details of our analysis are presented in our Metering Policy Options report[81] which is a technical appendix to this Plan. The costs of the alternative approaches to metering in AMP6 are summarised in Table 8-4. These costs are additional to the cost of the baseline approach of optional metering only (which itself is £11m Capex and £1m per year Opex during AMP6).

Table 8-4: Comparison of costs for alternative metering options

Option	AMP6 Capex (£m)	AMP6 Opex (£m)	Impact on bills	AIC (p/m^3)	AISC exc. WTP (p/m^3)	AISC inc. WTP (p/m^3)
Change of occupier – standard	11.6	0.9	+2%	26	-19	-75
Change of occupier – AMR	18.2	-0.2		35	-5	-35
Change of occupier – smart	29.4	7.2		240	208	190
Compulsory	31.1	2.4	+4%	31	-15	-15

The willingness to pay survey indicated that our customers are prepared to pay for metering becoming more widespread. The survey estimated that each customer is prepared to pay £0.26 each year for our meter penetration to increase by 1%. This is at least twice as much

[80] UKWIR (2012). Smart Metering in the Water Sector Phase 3 – Making the Case.
[81] Wessex Water (March 2013). PR14 Metering policy options.

as the cost of installing a meter. No willingness to pay has been applied to compulsory metering because customers have told us that they do not support it.

On all measures (AIC, AISC exc. WTP and AISC inc. WTP) change of occupier metering is preferable to compulsory metering.

In addition to the financial costs of the options we have also reviewed the qualitative issues associated with metering and customer preferences – these are summarised below.

Qualitative impacts of demand reduction

Increasing meter penetration enhances the link for more of our customers between the amount of water they use and their water bill. The resulting reduction in demand that occurs is beneficial, even without a need for the resource to balance supply and demand.

Reduced demand leads to reduced abstraction. Demands and therefore abstraction has been declining in the Wessex Water 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 rivers and ecosystems in our area. The Wessex Water region is currently designated as an area of 'not serious' water stress, but in its recent consultation on a new methodology for assessing water stress the Environment Agency temporarily proposed to change the status of this region to 'serious water stress' (Section 4.5.6). It is perhaps particularly appropriate to drive demand down in areas of serious water stress.

Reduced demand also gives us 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 may be small (at least over the 25 year planning period) 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 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.

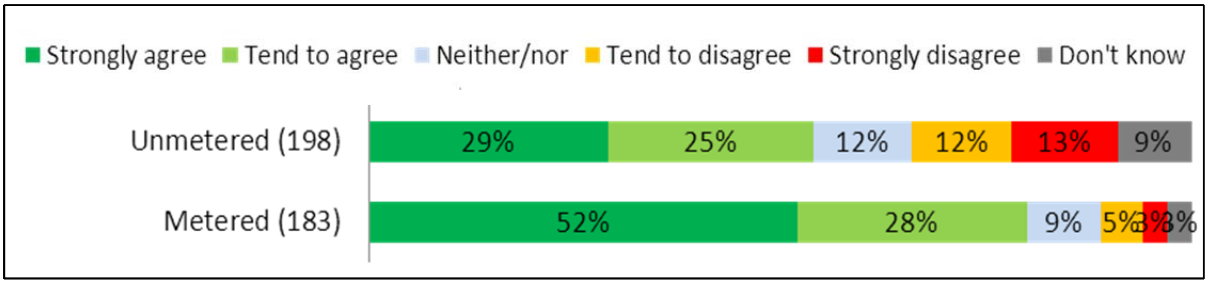
Impacts on customers and their preferences

We have been investigating customer preferences related to metering for many years. Our previous draft Water Resources Management Plan and Business Plan proposed to introduce metering on change of occupier from 2010, we had support from some stakeholders and customers but the proposal was not funded by our regulator Ofwat.

From 2008 to 2011 we undertook a metering tariff trail (see 'case study' box in this Section) and a key part of this project involved qualitative research with customers to understand their views in relation to metering. Furthermore, in the development of our Strategic Direction Statement and to guide this Plan and our Business Plan we have undertaken further significant work to understand customer preferences. Our key findings are summarised here:

Customers believe that metering is the fairest way to pay for water services so that everyone pays for what they use and that it would help reduce water usage. When asked if we should fit a meter when someone moves house 80% of metered households either 'strongly agreed' or 'tended to agree' and only 8% disagreed with the proposal. Households that are currently unmetered were less supportive; over half (54%) agreed with the proposal (Figure 8-8).

Figure 8-8: Customer response to question 'should Wessex Water fit meters automatically when someone moves house?'



Whilst the majority of our customers support proposals to increase metering the views of the significant minority that are not in favour also need to be considered. Customers that are not supportive of metering tend to express concern that they will become financially disadvantaged and perceive their own bills might rise. They are also inclined to oppose the element of enforcement surrounding enhanced metering programmes. Compulsory metering is therefore less favoured than change of occupier metering as the imposition of a meter on a property that you have just moved into is less than for a household that has been living in the same property for some time. Other objections to metering raised by customers are that they assume it is a money generating scheme, that despite the 'free' wording that they will have to pay for their meter to be installed and some question whether there is any need to save water (e.g. say "it's a wet country", are climate change sceptics, or feel that leakage should be reduced first). Some customers feel that increased metering is now the 'inevitable' and that its part of the Government's agenda and not just part of water company plans.

8.3.4. Metering conclusion

The analysis of metering options presented leads us to propose to introduce a policy of metering on change of occupier from 2015.

We believe that taking steps to enhance meter penetration is the right approach because metering:

- reduces demand
- reduces leakage
- is a fair way to pay
- is consistent with the Government's, customer's, environmentalists' and Wessex Water's desire to drive demand down.

We believe that metering on change of occupier is the best approach to increase metering because:

- it has biggest impact on demand in the long term
- it is supported by customers
- it moves towards universal metering
- it is affordable in the context of stable bills.

CASE STUDY: Meter tariff trial

In 2008 Wessex Water set out to test how metering on change of occupancy and more sophisticated price signals could contribute to our vision for sustainable charging. In terms of scale and scope the trial has been the largest of its kind since the national metering trials of the early 1990s. This work was the winner of the Research and Evaluation Award (sponsored by Ofwat) at the UK Water Efficiency Awards 2012 organised by Waterwise and the Environment Agency.

The results of the trial were reported in September 2012 and the key conclusions were:

- Metering properties when the occupier changes has reduced water demand significantly more that we had expected and without adverse customer reaction
- More sophisticated tariff structures could lead to a further step change in demand and a lower burden of water charges falling on the financially vulnerable. However the benefits achieved from these new tariff structures were at the cost of reduced customer satisfaction.

8.4 Water efficiency options

Water companies have a statutory duty to promote water efficiency to customers and since 2010 Ofwat has set each company an annual water efficiency target. Our current water efficiency strategy[82] to achieve our annual target of 0.55 Ml/d of savings provides domestic and business customers with information, advice and free devices.

Customer research carried out for our meter tariff trail, in the development of our strategic direction statement and our 'willingness to pay' research for this Plan has highlighted that customers value water efficiency services and they are keen for us to provide more.

We assessed our current water efficiency offerings and considered how we could meet Government aspirations to reduce demand and enhance customers' awareness of their water use and also meet customer expectations for enhanced services that will help them manage their bills.

Our water efficiency strategy for AMP6 involves the addition of four new water efficiency options to our existing baseline programme, these are:

- Large scale domestic retrofit scheme
- Social housing retrofit scheme
- Water efficiency community fund
- Enhanced community engagement.

Although they are described here as four individual options, they are proposed as one combined programme, which would be delivered alongside our proposed change of occupier 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[83] to this Plan.

8.4.1. Water efficiency option descriptions

The four new options we are proposing mark a transition in our services from mainly providing advice towards increasingly offering more practical assistance. Three options focus on device installation in homes and businesses and the fourth option seeks to enhance community engagement and understanding of water efficiency issues.

Large scale domestic retrofit (option code WE1)
This 'kit fit' option involves the promotion of a water efficient device installation service at no cost to the customer. A range of devices would be made available for customers to choose to have installed including dual flush retrofit devices, low flow showerheads, low flow tap inserts and CombiSmarts[84]. We have estimated that a 'kit fit' visit by one of our specially trained technicians would achieve average savings of 40 litres per property per day.

[82] Wessex Water (March 2013) Water efficiency strategy 2013 – Review of current activities and strategy for the future.
[83] Wessex Water (March 2013) Water Resources Management Plan – Water efficiency option descriptions.
[84] The CombiSmart device is a simple thermostatic valve that accelerates the heating process by holding back water while the combi-boiler heats it to the right temperature. In doing this, it is able to reduce water and energy use by householders.

The service would be made available to all customers but promotions would particularly target households that were metered on change of occupier and meter optants to offer support and assistance at a time when the customer is particularly motivated to reduce their water use.

We propose to deliver this retrofit service to 4,000 households a year throughout the planning period. With average savings of 40 litres per property per day we have estimated that this option will deliver dry year annual average savings of approximately 0.14 Ml/d each year of AMP6 so that cumulative savings by 2019/20 amount to 0.8 Ml/d and by 2039/40 amount to 2.0 Ml/d.

<u>Social housing retrofit (option code WE3)</u>

We have been developing partnerships with housing associations for a number of years and have identified that while these organisations are keen to introduce water efficiency measures in the properties that they manage, a barrier to them achieving this, even when we have offered then devices for free, is co-ordinating and delivering the programme of device installation.

This option therefore will offer housing associations free devices and retrofit services in which installations will be carried out with a plumbing contractor and paid for by Wessex Water. A range of devices would be made available to be installed including dual flush retrofit devices, low flow showerheads, low flow tap inserts and CombiSmarts.

The service will be offered to all housing associations in our area throughout the AMP6 period (2015-2020) and we would particularly propose partnering with associations that have a high proportion of older housing stock where the potential savings might be greatest. We have estimated that each retrofit visit to a social housing property would achieve average savings of 35 litres per property per day.

We propose to deliver this retrofit service to 1,200 social housing properties each year of AMP6 and have estimated that this option will deliver dry year annual average savings of 0.04 Ml/d each year so that cumulative savings by 2019/20 amount to 0.2 Ml/d.

<u>Water efficiency community fund (option code WE2)</u>

Over the last two years we have carried out over 100 water use audits in schools that have identified the potential for water savings to be made if devices such as urinal controls, cistern dams and infrared taps were installed. Our experience has shown us that although schools are keen to have the audits and welcome the information provided, there is often a lack of funding from within the schools to pay for the improvements identified.

This option proposes to overcome this barrier by establishing a fund to pay for water efficiency devices and their installation in schools and the premises of other not-for-profit organisations such as councils, charities and local services.

The community fund would be promoted to relevant organisations and those that apply would first receive a water audit to identify potential measures. Devices would be provided and retrofitted only where the measures meet predefined criteria on costs per litre saved to ensure we only fund the most beneficial measures.

We propose to work with approximately 100 organisations each year of AMP6 and have estimated that this option will deliver dry year annual average savings of 0.06 Ml/d each year so that cumulative savings by 2019/20 amount to 0.3 Ml/d.

Enhanced community engagement (WE4)
This option proposes to develop an engagement programme to meet the Government's objective to enhance customer awareness of the links between their water use and their environment. We currently provide a good educational service to school children and this option would see us develop educational links with a broader sector of the community and seek to identify opportunities for partnership working to install water efficient devices to achieve measurable savings (which themselves could be delivered by the community fund scheme described above).

The programme will involve providing dedicated staff to deliver bespoke water efficiency and wider water resource information and advice to community groups and organisations in our area. We would particularly promote this service to groups with common environmental objectives e.g. Transition Towns, Eco-Schools and the Centre for Sustainable Energy.

The delivery of water efficiency information will be achieved through attendance at community meetings and workshops and also through the provision of 'trade stands' at events. Free devices will be provided to customers through this service with the added value of face-to-face explanation and discussion.

The programme will also seek to connect us with organisations and communities with particular concerns about water abstraction and water efficiency such as the Mere Rivers Group that we began working with in 2011 (see Section 4.5.4). The ability to deliver such engagement programmes will become increasingly important with the introduction of the Abstraction Incentive Mechanism (see Section 4.5.4).

We propose that the enhanced community engagement programme will involve approximately 2000 customers a year throughout the planning period and have estimated that this option will deliver dry year annual average savings of 0.02 Ml/d each year so that cumulative savings by 2019/20 amount to 0.07 Ml/d and by 2039/40 amount to 0.22 Ml/d. The assumed water savings are linked to the provision of free devices handed out at events; no savings associated with customer water use behaviour changes resulting from the service have been included in the option assessment and so savings can be regarded as conservative.

8.4.2. Water efficiency impacts on demand

The overall water savings throughout that planning period achieved by the four water efficiency schemes are presented in Figure 8-9 and summarised in Table 8-5.

The domestic retrofit and community engagement schemes are both planned to continue throughout the full 25-year planning period and so the savings continue to increase over the planning period. The community fund and social housing retrofit schemes are planned to be delivered as 5 year schemes for AMP6; the savings for these options therefore peak in year 6 of the period (2020/21) and then decay over the remainder of the planning period at a rate determined by the 'half-life' of the programme.

In combination, the proposed measures are projected to provide water dry year annual average savings of 1.28 Ml/d by the end of AMP6 (2019/20) and 2.25 Ml/d by 2039/40.

Figure 8-9: Water efficiency savings for the proposed schemes through the planning period (dry year annual average scenario)

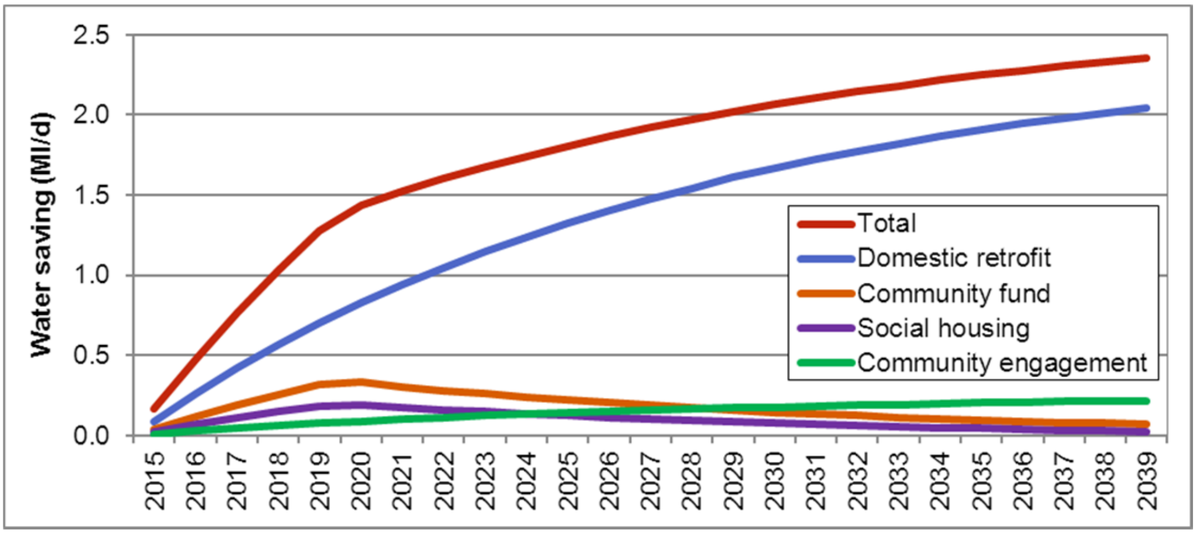


Table 8-5: Combined savings from water efficiency measures (Ml/d)

	2019/20	2024/25	2029/30	2034/35	2039/40
Dry year annual average	1.28	1.74	2.02	2.22	2.25
Dry year critical period	1.63	2.19	2.49	2.70	2.84

8.4.3. Water efficiency costs, benefits and customer preferences

A summary of the costs associated with the proposed water efficiency programme are presented in Table 8-6, for further details see the technical appendix on the water efficiency options[85] that supports this Plan.

Table 8-6: Summary of cost information for the water efficiency options

Option	AMP6 Capex (£m)	AMP6 Opex (£m)	AIC (p/m^3)	AISC exc. WTP (p/m^3)	AISC inc. WTP (p/m^3)
Large scale domestic retrofit scheme	1.3	0.0	41	6	-269
Social housing retrofit	0.4	0.0	57	37	-270
Water efficiency community fund	0.4	0.0	29	17	-271
Enhanced community engagement	0.2	0.0	73	13	-281
Total	**2.3**	**0.0**	-	-	-

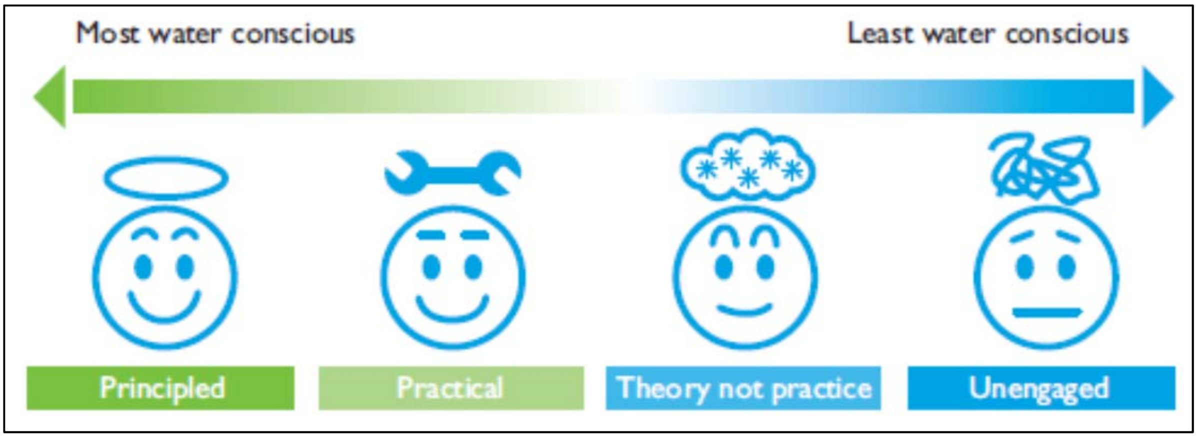
[85] Wessex Water (March 2013) Water Resources Management Plan – Water efficiency option descriptions.

The willingness to pay research conducted to support this Plan[86] indicated that customers are prepared to pay £0.40 each per year for every 1% of our customer base to whom we provide water efficiency advice and devices. Cumulatively, this equates to a value about 6 times greater than the cost of providing these services.

In addition to the cost and willingness to pay information presented above it is important to consider more qualitative customer opinions in relation to water efficiency. Figures 8-1 and 8-2 earlier on in this Section demonstrated that customers tell us that they are keen on us providing water efficiency services but it is also useful to consider what their motivations are so we can understand how to meet their needs most appropriately. Research conducted for our Tariff Trial[87] indicated that our customers can typically be divided into four groups reflecting their relative attitudes to water use and water conservation as shown in Figure 8-10.

Those that are 'principled' and 'practical' are already water conscious and are driven either by moral or financial considerations. Additional water efficiency services for these customers will tend to be well received and reinforce their water conscious beliefs and behaviours, although the services may result in proportionally smaller water savings as customers would be starting from a lower baseline water use.

Figure 8-10: Customer groups reflecting water use attitudes



Customers that are 'unengaged' can move to the 'practical' group when provided with water efficiency information and advice. They are typically motivated to become more water wise by financial considerations and can make the greatest water savings.

The 'theory not practice' group of customers might be categorised as the time-poor and cash-rich middle classes where the annual water bill simply does not figure on their list of priorities.

It is important that our future water efficiency services are tailored to meet the different needs of all of our customers and we believe that our proposed programme of measures does just this. In particular, the domestic and social housing retrofit schemes will help those that are currently unengaged become more practical in their approach to water saving and the community engagement programme will appeal to the more principled and practical groups of customers.

[86] NERA and Ipsos Mori (March 2013). Customer preferences for services and Price for PR14 and WRMP14 – prepared for Wessex Water.
[87] Wessex Water (September 2012). Towards sustainable water charging – conclusions from Wessex Water's trial of alternative charging structures and smart metering.

The wider benefits of demand reduction that were described in Section 8.3.3 in relation to metering are also true in relation to water efficiency measures:

- Reduced demand leads to reduced abstraction. The less we abstract the more that is left in the environment to support the rivers and ecosystems in our area.
- Reduced demand also gives us more resilience to climate change. Reducing demand now and helping our customers understand the link between their water use and their environment enhances our adaptive capacity to deal with potential reductions in supplies or increases in demands in the future.
- Reduced demand reduces carbon emissions. Abstracting, treating and pumping water to serve our customers has associated 'carbon costs'. The reduced use of hot water in customers' homes also leads to lower carbon emissions as less energy is required to heat water.

8.5 Leakage reduction options

Since 1995 we have halved leakage from our network reducing it from 140 Ml/d to 69 Ml/d in 2011/12. We have consistently met the target set by our regulator, which currently stands at 71 Ml/d, even in years with severe winters.

Leakage reduction is a key priority for our customers and so we have reviewed a range of options of varying magnitudes of leakage reduction.

8.5.1. Leakage option descriptions and impacts on demand

Table 8-7 lists the seven leakage reduction options we have reviewed – further details of these are presented in our Options Report[88] that supports this Plan.

Table 8-7: Leakage reduction options

Code	Option type	Yield	Comment
L1.1	Asset renewal	2 Ml/d	Reduction during AMP6
L1.2	Asset renewal	7 Ml/d	10% reduction during AMP6
L1.3	Asset renewal	17 Ml/d	25% reduction over 25 years
L1.4	Asset renewal	35 Ml/d	50% reduction over 25 years
L2	Pressure management	0.2 Ml/d	Average zonal night pressure analysis demonstrated the potential savings are very small.
L3.1	Active leakage control	2 Ml/d	Reduction during AMP6
L3.2	Active leakage control	7 Ml/d	Reduction during AMP6
M2.1	Change of occupier metering	1.7 Ml/d by 2020 1.5 Ml/d by 2040	See Section 8.3
M3	Compulsory metering	4.7 Ml/d by 2020 1.7 Ml/d by 2040	See Section 8.3

8.5.2. Leakage costs, benefits and customer preferences

The costs of the alternative approaches to leakage reduction in AMP6 are summarised in Table 8-8.

88 Wessex Water (March 2013). Water Resources Management Plan – option descriptions.

Table 8-8: Summary of cost information for leakage options

Option	AMP6 Capex (£m)	AMP6 Opex (£m)	AIC (p/m^3)	AISC exc. WTP (p/m^3)	AISC inc. WTP (p/m^3)
L1.1 asset renewal 2 Ml/d reduction during AMP6	10.1	0.0	44	45	15
L1.2 asset renewal 7 Ml/d (10%) reduction during AMP6	70.2	0.0	105	107	78
L1.3 asset renewal 17 Ml/d (25%) reduction over 25 yrs	87.7	0.0	292	297	267
L1.4 asset renewal 35 Ml/d (50%) reduction over 25 yrs	488.0	0.0	840	868	838
L2 pressure management	0.1	0.0	6	6	-23
L3.1 active leakage control 2 Ml/d	0.3	0.4	16	16	-13
L3.2 active leakage control 7 Ml/d	1.1	1.6	21	22	-8
M2.1 change of occupier metering	11.6	0.9	26	-19	-75
M3 compulsory metering	31.1	2.4	31	-15	-15

Our willingness to pay research indicated that customers on average are prepared to pay £0.66 each, per year for a 1% (3 Ml/d) reduction in leakage.

Managing and reducing leakage is a key customer priority. Our Strategic Direction Statement (SDS) that was developed though consultation with customers and other stakeholders set a bold and stretching aspiration to reduce leakage by 5% by 2020 and by 25% by 2040. Against our current leakage target this would see leakage fall by 18 Ml/d to 52.5 Ml/d in the long term.

Although Wessex Water is committed to the 25% reduction aspiration our final planning scenario does not incorporate reductions of the magnitude required in the later stages of the planning period. This is because our option analysis indicates that currently available options are at present limited either by their cost or by available technology. To achieve the 25% reduction over the next 25 years might cost up to £500m. This would not be compatible with our intention of achieving stable bills for our customers. Nevertheless our SDS reinforces the possibilities for innovation associated with leakage reduction and we expect that our Business Plan will include expenditure for research and technologies that will help us develop a strategy to achieve our long term aspiration.

In the meantime metering options give the leakage reduction with the lowest AISC.

8.6 Other supply demand balance options

8.6.1. Resource option descriptions

Table 8-8 describes the supply-side options that we reviewed for our option analysis.

Table 8-9: Resource option descriptions

Code	Option	Yield	Comment
R1.1	Desalination (large)	30 Ml/d	A large desalination development on the South coast with the water transferred across the Wessex Water supply system.
R1.2	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	River Avon abstraction to Chew Valley Reservoir	30 Ml/d	Abstraction from the River Avon in the Bath area to supplement the resources of Chew Valley Reservoir during dry periods. An advanced treatment works would be required to treat the water discharged to the reservoir as well as additional abstractions from the reservoir.
R5.1	Avonmouth effluent reuse	11 Ml/d	Use of treated effluent for non-potable supplies using treated effluent from Avonmouth STW.
R5.2	Avonmouth boreholes	8 Ml/d	Development of boreholes in alluvial deposits at Avonmouth site for non-potable use. Treatment would be required to reduce chloride level.
R6	Longham Lakes	20 Ml/d	Developed of confined chalk boreholes around Sembcorp Bournemouth's Longham lakes. Abstracted water would be treated to reduce fluoride level before discharge to lakes.

8.6.2. Resource option costs

Table 8-10 below presents a summary of the analysis of the resource options ranked in ascending order of their Average Incremental Social Cost (AISC), excluding the willingness to pay values.

Table 8-10: Resource options ranked by AISC with commentary

Rank	Code	Option	Yield	AISC (exc. WTP) (p/m^3)	Comment
1	R6	Longham Lakes	20 Ml/d	13	This is a potentially very sustainable groundwater resource development. The assessment only includes delivering the water to Sembcorp Bournemouth's Longham Lakes. Further cost may be involved in the treatment of water and its onward distribution.
2	R5.2	Avonmouth boreholes	8 Ml/d	65	This is also potentially a sustainable groundwater development although less is known of the geology in this area compared to Longham Lakes. The assessment only includes costs in delivering water to a tank on Wessex Water's land at Avonmouth. As a resource option it would best be suited to meeting additional non-potable demand in the Avonmouth area.
3	R5.1	Avonmouth effluent reuse	11 Ml/d	70	This is a good option for meeting further non potable water demand in the Avonmouth area, with the possibility of displacement of water into Wessex Water's supply system.
4	R3	River Avon abstraction near Saltford	30 Ml/d	86	This is the lowest cost stand-alone water resources option that includes distribution of the additional water to customers (albeit in an assumed area). It is therefore the option we take as our assumed "next resource".
5	R4	River Avon abstraction to Chew Valley Reservoir	30 Ml/d	118	A high cost option
6	R1.1	Desalination (large)	30 Ml/d	128	A high cost option
7	R2	New reservoir (south of Yeovil)	22 Ml/d	150	A high cost option
8	R1.2	Desalination (small)	10 Ml/d	154	A high cost option

None of these options have been included in our preferred options list, they were analysed for comparison only.

8.7 Summary of supply and demand option costs

Figures 8-11, 8-13 and 8-14 present the cost-yield graphs for all of the supply and demand options analysed for this Plan.

They show that change of occupier metering and water efficiency are the preferred options, particularly if environmental and social impacts are taken into account (Figure 8-12), and even more so allowing for customers' willingness to pay (Figure 8-13).

Figure 8-11: Average incremental cost and yield

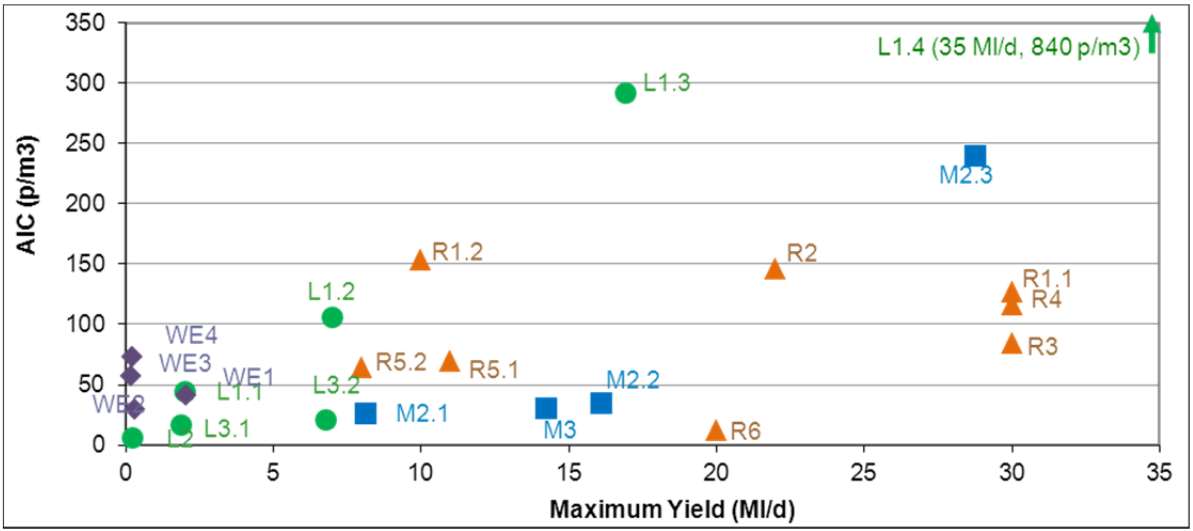


Figure 8-12: Average incremental social cost (excluding willingness to pay) and yield

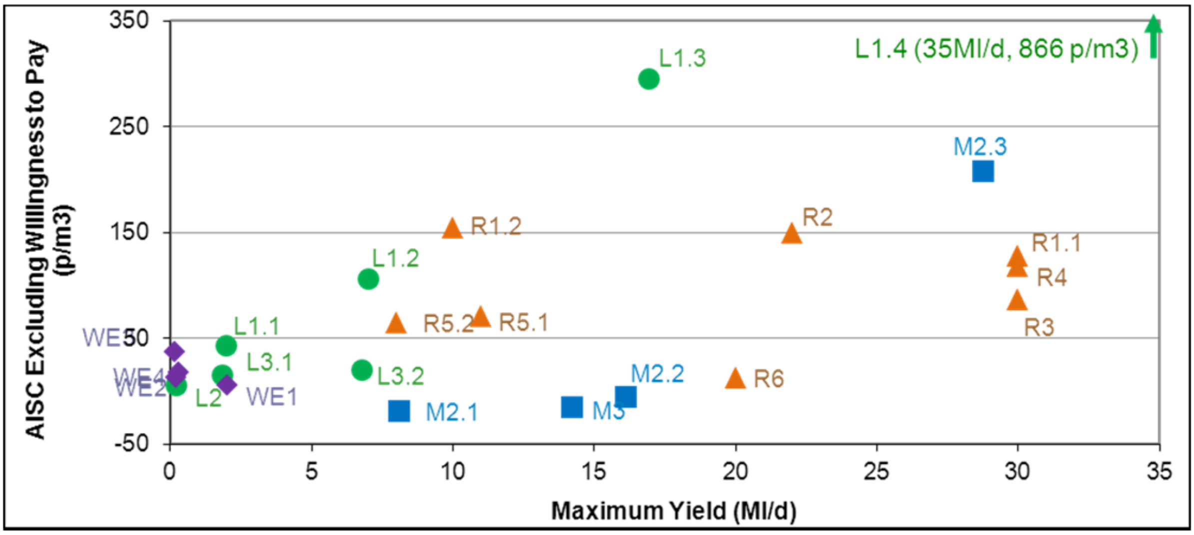
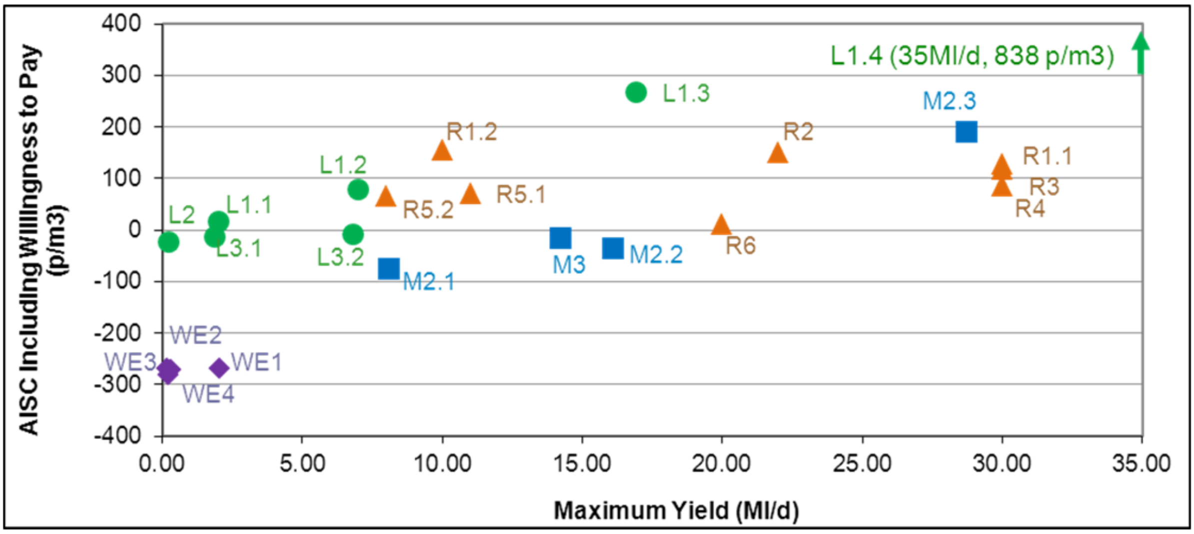


Figure 8-13: Average incremental social cost (including willingness to pay and yield



9. Final balance between supply and demand

9.1 Preferred options included in final planning scenario

Section 8 of this Plan reviewed a range of demand management and resource development options. Those that were selected to be included in our proposed final planning scenario are:

- The introduction of a metering on change of occupier policy (which is also associated with a reduction in leakage)
- An enhanced water efficiency programme comprising:
    - Large scale domestic retrofit scheme
    - Social housing retrofit scheme
    - Water efficiency community fund
    - Enhanced community engagement.

Sections 5 and 8 examined the specific impacts of these options on demand and this section will now show the overall impact of these measures on our supply demand balance through the planning period.

The plan will be monitored through the key activities such as the number of houses metered and the enhanced water efficiency activity. In addition outputs such as per capita consumption, leakage and overall distribution input will be monitored. We are currently developing targets for these outputs as part of the Periodic Review process. We will report each year on these activities and targets.

9.2 Effect of preferred options on supply demand balance

Figures 9.1 and 9.2 show the final planning supply demand balance situation for the dry year annual average and critical period scenarios respectively, key information is also summarised in Tables 9.1 and 9.2.

The Figures and Tables show that we forecast to remain in supply demand surplus throughout the planning period for both scenarios. We will therefore be able to achieve our planned level of service throughout the planning period.

Like the baseline scenario the reduction in water available for use in 2017/18 relates to the reduction in abstraction licences to improve river flows (Section 4.5).

For the dry year annual average scenario once the sustainability reductions have been made the surplus grows to 36 Ml/d in 2019/20 and to 50 Ml/d in 2039/4040. For the critical period the surplus grows to 36 Ml/d in 2019/20 and to 69 Ml/d in 2039/40.

Figure 9-1: Final supply demand balance for the dry year annual average scenario

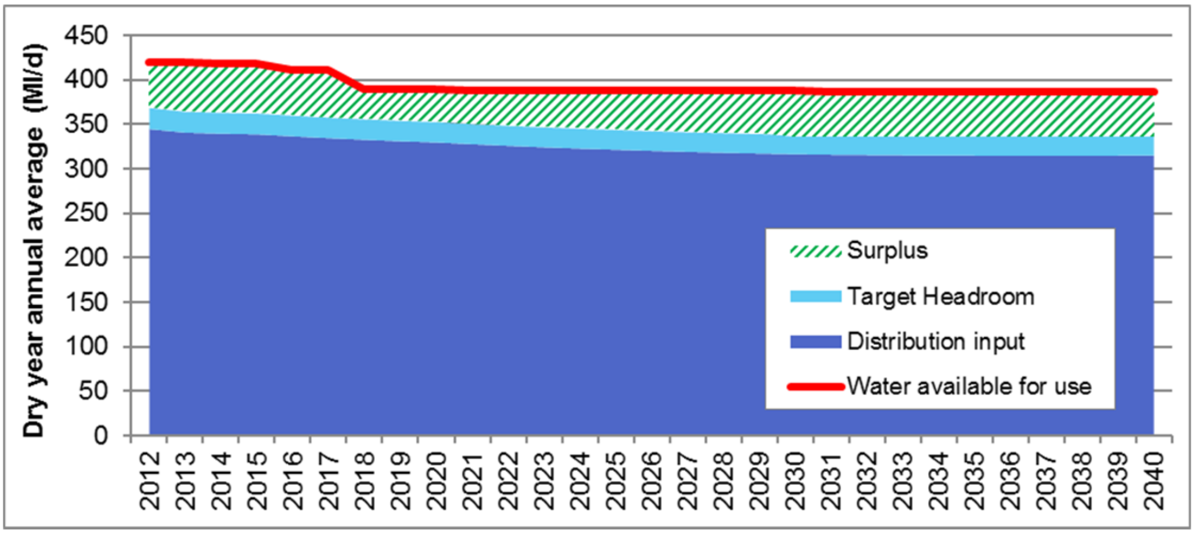


Table 9-1: Key information relating to the final supply demand balance for the dry year annual average scenario

Dry Year Annual Average	2014/15	2019/20	2039/40
Distribution input	339	330	315
Deployable output	426	403	401
Water available for use*	419	389	387
Target headroom	23	23	22
Supply demand balance	**+57**	**+36**	**+50**

*Water available for use = Deployable output – outage + imports – exports.

Figure 9-2: Final supply demand balance for the dry year critical period scenario

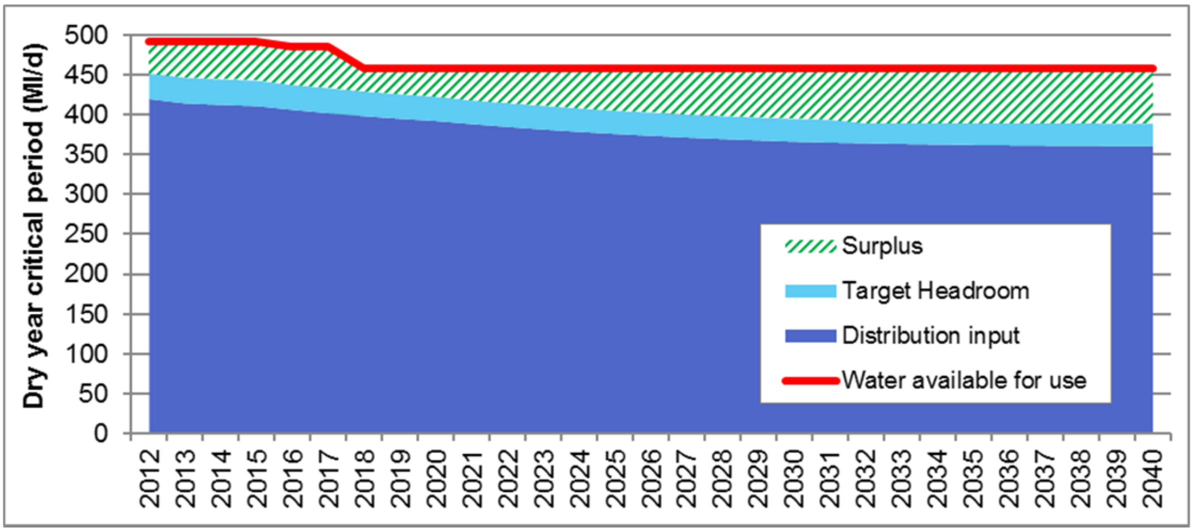


Table 9-2: Key information relating to the supply demand balance for the dry year critical period scenario

Peak Week Critical Period	2014/15	2019/20	2039/40
Distribution input	420	392	361
Deployable output	514	488	487
Water available for use	492	458	458
Target headroom	32	30	27
Supply demand balance	**+49**	**+36**	**+69**

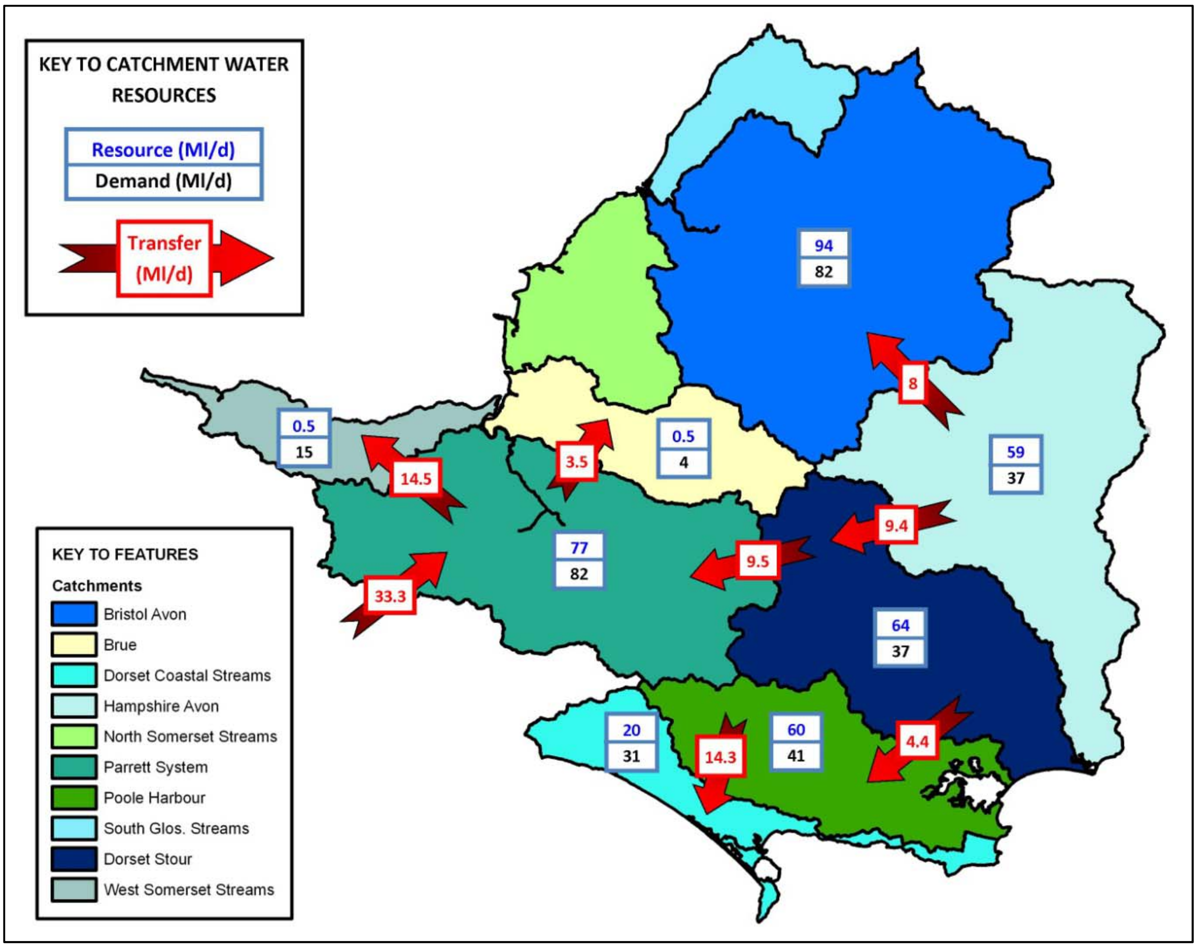
*Water available for use = Deployable output – outage + imports – exports.

9.2.1. Representation at a catchment level

As outlined in Section 3.3, while water resource zones are the key unit used for balancing supply and demand for water resources planning, catchments are the key assessment area for assessing our impacts on the water environment. We have therefore chosen to analyse the final planning supply demand balance results (for 2019/20, at the end of the next AMP period) at a catchment level.

Figure 9-3 shows the balance between resources (deployable output) and demand in each of the eight catchments that our water supply area covers. Net transfers of water between catchment areas are also shown.

Figure 9-3: Resources, demands and transfers between catchments in 2020



9.2.2. Strategic Environmental Assessment

We contracted consultants Cascade to review our draft Water Resources Management Plan and determine the need to undertake a Strategic Environmental Assessment (SEA) on our final planning scenario.

They prepared a draft SEA screening statement which was sent to the statutory consultees (Environment Agency, Natural England and English Heritage) for comment in February 2013. Since the Plan does not involve any resource developments or significant construction activities instead focussing on enhanced demand management measures the screening identified that a full SEA on our Plan was not required.

We received comments back from Natural England stating they concurred with our conclusion that there is no need to prepare an SEA on the basis of our forecast surplus through the planning period and that there is no intention to develop any new water sources. Their comments did however also suggest that we should be mindful of the fact that while our Plan may not warrant an SEA this does not mean it will have no impact on the environment and we should continue to consider sensitive water dependant environments in the development of this Plan and our Business Plan.

The Environment Agency and English Heritage also submitted comments on the draft screening statement and similarly agreed with our conclusion that it is not necessary to prepare a formal SEA.

The comments from consultees were incorporated into the final SEA Screening Statement[89] which is available as a technical appendix to this Plan.

9.2.3. Habitats Regulations Assessment

We contracted consultants Cascade to review our draft Water Resources Management Plan and undertake the Stage 1 Screening for the Habitats Regulations Assessment (HRA)

The purpose of the 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.

The 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.

The conclusion of the screening is therefore that there is no need to progress to Stage 2 of the HRA process, Appropriate Assessment.

The HRA Screening Report[90] is available as a technical appendix to support this Plan.

In terms of our current abstraction licences the Environment Agency have reviewed all of them to ensure compliance with the requirements of the Habitats Directive in their Review of

[89] Cascade (March 2013). Draft Water Resources Management Plan 2013 SEA screening statement.
[90] Cascade (March 2013). Draft Water Resources Management Plan 2013 Habitats Regulations Assessment Stage 1 – Screening.

Consents process. This process identified a number of abstraction licences that were potentially not consistent with the requirements of the Habitats Directive. These were investigated in detail in AMP4 and, where necessary, appropriate changes to abstraction licence conditions have been agreed. These changes will be implemented as part of our Grid scheme due for completion in 2018. Where the Environment Agency has remaining concerns over any of our abstractions they have asked us to undertake investigations in AMP6. These are included in our Business Plan.

9.2.4. Environmental effects of bulk supply imports

In response to stakeholder representations on the draft Water Resources Management Plan, and to ensure that the potential environmental effects of our operations are considered and minimised as much as possible, we worked with consultants Cascade to undertake an assessment of environmental effects of our current bulk supply imports.

<u>Methodology</u>

The assessment reviewed the current agreed volumes of bulk supply imports in relation to the donor water company abstractions that provide water for the bulk supplies. Consideration was given to the 'impact' (i.e. environmental benefit) of ceasing the transfer and the subsequent proportional reduction in abstraction at the donor company's source. A staged assessment was undertaken, involving:

- An initial strategic hydrological / hydrogeological assessment.
- A Water Framework Directive status assessment.
- A screening exercise was undertaken to establish the potentially affected habitats and resources within the identified zone of influence.
- An overall effects assessment was completed using a similar approach to that employed in the Strategic Environmental Assessment for the submission of the draft Plan.
- A GIS interpretation of the import sources and with an understanding of hydrological connectivity, each import source was considered as to whether it could lead to in-combination effects (i) with Wessex Water's own abstractions (ii) with abstractions proposed in neighbouring company draft Water Resources Management Plans.

<u>Assessed effects</u>

Most of our bulk supply imports are considered insignificant or small in size relative to the overall total abstraction by the donor water company at each source.

A summary of the assessment of effects is provided in the Table 9-3.

<u>In-combination effects of import sources with Wessex Water abstractions</u>

None of the bulk supply imports are likely to cause potential in-combination effects with our own abstractions. This is either due to geographic location and lack of hydrological connectivity or the insignificant size of the import relative to the on-going total abstraction by the donor water company from any particular source.

<u>In-combination effects of import sources with donor company draft Water Resources Management Plans and Drought Plans</u>

The Bath/Marshfield, Leckford, Tidworth, Ludgershall and Stubhampton transfers were reviewed for potential in-combination effects due to the fact that they represent not insignificant proportions of their respective sources.

There are no adverse in-combination effects anticipated with respect to the Bristol Water draft Water Resources Management Plan and the Bath/Marshfield transfer based on the assumption that new schemes (e.g. those that involve abstraction from the River Severn) would be controlled through licensing by the Environment Agency and informed by investigations for the Restoring Sustainable Abstraction programme.

The Veolia Water Projects draft Water Resources Management Plan identifies that planned development may increasing reliance on abstraction from the groundwater sources that supplies the Leckford and Tidworth transfers, with potential effects on the Nine Mile River (recently designated as a Site of Special Scientific Interest). Cessation or reduction of the Leckford transfer could reduce future use of their sources and any associated effects on the Nine Mile River and the River Bourne. However, if the transfer was stopped and we had to develop an alternative supply to the communities currently provided with water from these transfer we would either have to build a nitrate treatment plant at our own existing (but currently out of service) source at Leckford with its associated environmental impacts (waste discharge) or make infrastructure investments to connect the demand area to our wider network. This would place greater demand on our Durrington and Newton Toney sources which were investigated in AMP4 and as a result Newton Toney's licence will be modified in 2018 to reduce abstraction for public water supply by 1.5 Ml/d and make provision for stream support to protect flows in the River Bourne.

The Ludgershall and Stubhampton bulk supply imports from Southern Water and Sembcorp Bournemouth water are both located in areas with no deficit forecast over the 25 year water resources planning period. Hence no resource options are required by the donor company which could result in any in-combination effects.

The donor company Drought Plans do not include drought permit/order options that could present the potential for in-combination effects. The bulk supply transfers to us are identified in all donor company drought plans. With respect to the proportionally larger transfers (described above), both the donor companies and Wessex Water identify that in the event of a drought there would be regular communication to discuss relative resource positions and the potential need for flexibility with regard to transfer volumes.

Habitats Regulations Assessment and SSSI screening

No European Sites or SSSIs would be significantly affected by the reduction or cessation of our bulk supply imports, taking into account both individual and in-combination potential effects.

Table 9-3: Summary of assessed effects of the bulk supply imports

Company	Bulk supply name	Annual average (Ml/d)	Peak (Ml/d)	Summary of effects
Bristol Water	Bath	11.37	11.37	The source of the Bath import is the Gloucester and Sharpness Canal at Purton. The canal is supplied by the River Severn at Gloucester. Abstraction from the River Severn into the Gloucester and Sharpness Canal was investigated through the Review of Consents (RoC). It was found that influenced and natural flows are above what is considered to be indicative of 'good ecological status', and that all permissions investigated, which included the canal abstractions, alone and in combination are not likely to have a significant effects. Considering this and the fact that levels in the Gloucester and Sharpness Canal are managed, the potential for any effects as a result of terminating the transfer are considered negligible except those that relate to the availability of additional resource to other abstractors or in relation to increased resilience to the effects of climate change.
Bristol Water	Marshfield	0.04	0.05	The Marshfield transfer represents less than 0.1% of the maximum that can currently be abstracted from the source. It uses the same source as the Bath import (Gloucester and Sharpness Canal at Purton). Therefore, considering the size of the transfer and the findings of the Severn Estuary RoC, the impact of the Marshfield transfer to is considered negligible.
Bristol Water	Ashcott	0.29	0.36	The Ashcott transfer represents less than 0.2% of the maximum that can currently be abstracted from the source. The statutory condition associated with the source, which includes a prescribed flow to the downstream Cheddar Yeo has operated in the same fashion since 1935. The impact of the transfer is therefore considered negligible.
Thames Water	Malmesbury	0.01	0.06	The Malmesbury transfer represents less than 0.2% of the maximum that can currently be abstracted from the source. The aquifer from which the abstraction is made is confined and test pumping suggests there are limited effects on drawdown. Environment Agency Water Framework Directive investigations have concluded that no further action (in relation to the total abstraction made by Thames Water) is required for the waterbody. The impact of the transfer is considered negligible.
South West Water	Lyme Regis	0.04	0.05	Up to three sources can contribute to the Lyme Regis transfer. In all cases the proportion of the transfer relative to the maximum that can currently be abstracted from each source is considered negligible. The impact of the transfer is considered negligible.

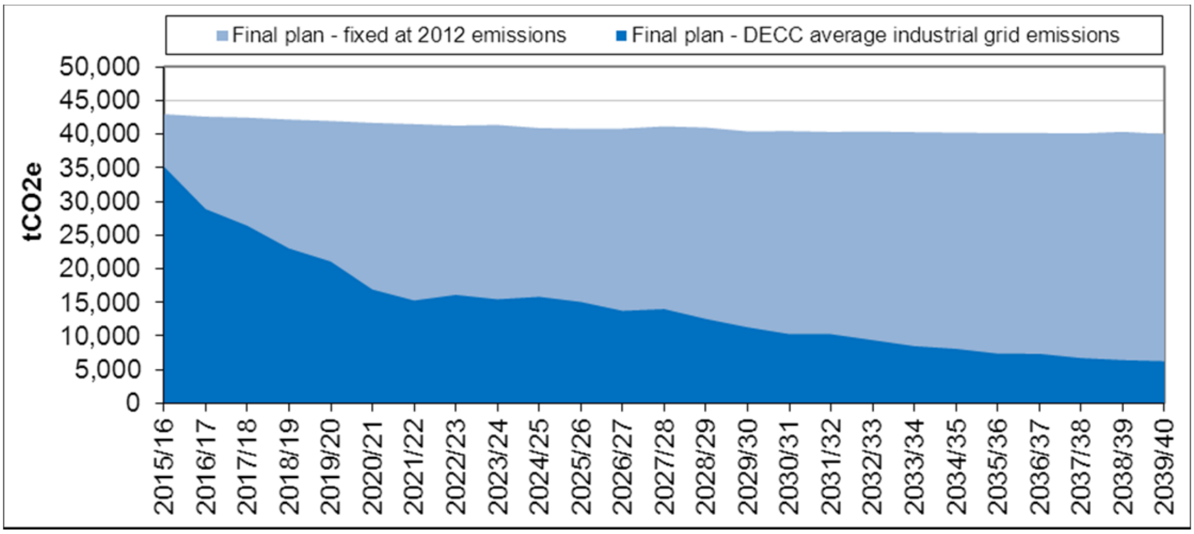
Company	Bulk supply name	Annual average (Ml/d)	Peak (Ml/d)	Summary of effects
Veolia Water Projects	Leckford	2.74	3.00	The source of the Leckford transfer is the unconfined Chalk aquifer at Tidworth. Studies show that the River Bourne (a winterbourne) is only marginally affected by Veolia Water. These marginal effects (the ephemeral River Bourne dry season length and reach) are offset by high local return of the abstracted water to the same Chalk aquifer. It is acknowledged that most of the abstracted water transferred to Wessex Water is returned to the environment outside of the Bourne catchment. It was identified that groundwater abstraction causes local variations in groundwater levels immediately around boreholes. However, variations are not considered significant, and are unlikely to be seen further away. Due to the limited impact on surface waters, the characteristics of the affected reach of the River Bourne and the current Water Framework Directive (WFD) status of related water bodies the potential for effects on WFD status are considered negligible. The River Avon Review of Consents (RoC) process has been completed. Veolia Water Projects' Tidworth abstractions were included in the in combination assessment with Wessex Water sources, including that at Leckford Bridge, for which the Leckford transfer is a direct replacement. The Leckford Bridge impact at full licence on the River Bourne was found to be acceptable by the RoC. If a cessation in the transfer to Wessex was matched by an equal reduction in abstraction by Veolia Water Projects at Tidworth there would be some local benefit to the timing and magnitude of seasonal flows in the River Bourne, particularly as the water transferred to Wessex is mostly exported from the Bourne catchment. Although, the extent of these benefits (in terms of the hydroecology of ephemeral streams) are somewhat compromised by the characteristics of the River Bourne.
Veolia Water Projects	Tidworth	0.18	0.22	The Tidworth transfer is drawn from the same unconfined chalk aquifer groundwater source as the Leckford transfer. However, the Tidworth transfer comprises a significantly smaller portion of the Veolia Water Projects abstraction. Therefore, considering the outcome of the assessment for the Leckford import, the impact of the Tidworth transfer is considered negligible.
Southern Water	Biddesden	0.04	0.04	Southern Water operates two sources that can both individually provide the maximum required contribution to make the Biddesden transfer. If each source were to supply all of the Biddesden transfer the relative proportion of the total abstractions represents less than 0.5% and 1.3% respectively. The impact of the transfer is therefore considered negligible.

Company	Bulk supply name	Annual average (Ml/d)	Peak (Ml/d)	Summary of effects
Southern Water	Ludgershall	0.29	0.36	The Ludgershall transfer equates to 1.8% and 9.9% of the total abstraction licence held by Southern Water for the two potential groundwater sources. The latter was assessed for potential effects (e.g. on surface water flows in the River Bourne Rivulet), although this was limited due to lack of available information. Flows in the Bourne Rivulet are augmented further down the catchment by a watercress farm near St. Mary Bourne approximately 7.5km downstream of the abstraction. Inevitably if a cessation in the transfer to Wessex was matched by an equal reduction in abstraction there would be some benefit to the timing and duration when the winterbourne headwaters of the Bourne Rivulet. Cessation of the transfer is not considered likely to affect overall Water Framework Directive (WFD) objectives in the River Test Chalk (groundwater body) or the Bourne Rivulet as WFD elements are already at Good or High status.
Sembcorp Bournemouth Water	**Stubhampton**	**1.27**	**1.27**	The Stubhampton transfer represents approximately 10% of the total abstraction made at the Stanbridge Boreholes located adjacent to the River Allen. Any change to the existing transfer is not considered likely to result in any significant effects on water levels or flows in the River Allen. Considering a sustainability reduction of 12.5Ml/d implemented in 2003, the abstraction at Stanbridge is now considered sustainable, therefore any further reductions are assumed to present negligible additional benefits and negligible effects regarding WFD status of the Upper Dorset Stour (groundwater body) or the Allen (Lower) waterbody.

9.2.5. Greenhouse gas emissions (carbon)

The Water Resources Management Plan Direction 2012 requires us to assess likely greenhouse gas emissions from current and future activities. Figure 9-4 shows our forecast of carbon emissions (tonnes of CO2 equivalent) for our final planning scenario. The more steeply falling curve includes DECC's projection for the reducing carbon intensity of grid electricity supplied to the industrial sector over the planning period. The more gently falling curve has the carbon intensity of grid electricity held at the 2012 level. This demonstrates that our final plan, including metering and water efficiency options, results in a downward trend in carbon emissions associated with our activities, without also allowing for the effect of the 'greening' of the national grid.

Figure 9-4: Carbon emissions projection for the planning period (final planning scenario)



9.3 Scenario testing

The final supply demand balance surplus position presented at the start of this Section is a robust central estimate of the most likely future scenario. We followed best practice guidelines to develop each element of the supply and demand forecasts and tested the sensitivity of key elements of the demand forecast in particular (Section 5.9.2) to help inform the headroom allowance modelling (Section 6).

In addition we have examined the impact on our supply demand position of the following scenarios:

- New bulk supply exports
- Leakage reduction of 25%
- Expansion of Hinkley Point power station
- Reference level of service supply demand balance
- Impact of worst case nitrate scenario

We have not included a specific scenario to examine the impact of sustainability reductions. The confirmed licence reductions of 23.5 Ml/d resulting from the AMP4 investigations have been incorporated into the baseline water available for use assessment and given the small size (1.5 Ml/d) of the likely reduction arising from the AMP5 investigations this was also incorporated into the baseline water available for use assessment.

These scenarios demonstrate that the plan is robust to the most likely significant changes in the assumptions with which the plan has been developed.

9.3.1. New bulk supply exports

In October 2012, in accordance with the planning guidelines we published an interim supply demand balance position which informed neighbouring companies that we were expecting to forecast a supply demand balance surplus in this Plan. Our pre-consultation discussions with other water companies identified that of our neighbours Bristol Water and Thames Water were the only companies expecting to have deficits to address.

At the time of publishing this final Plan no agreements have been made with either company for the provision of a new bulk supply export from us to them.

For the purposes of scenario testing the impact on our supply demand balance position of new exports to Bristol Water, Thames Water and Cholderton are considered.

<u>Bristol Water</u>

During the pre-consultation period we made an indicative offer to Bristol Water for a package of changes to bulk supply arrangements between our companies. This package would provide them with additional resources of 17.2 Ml/d for the dry year annual average condition and 10 Ml/d for the dry year critical period condition. This would involve a new transfer of 10 Ml/d from the Bridgwater area of our supply region to the south of their supply region and an annual reduction in the existing transfer of 11.3 Ml/d to 4.1 Ml/d from Bristol Water to our Bath supply area (net impact of 7.2 Ml/d).

Between the publication of our draft Plan and the revised draft Plan discussions continued with Bristol Water and we are now expecting to reduce the existing bulk supply import for Bristol Water to our Bath area. We have incorporated into our baseline supply forecast a reduction in both the annual average and peak period agreed volumes from 11.37 Ml/d to 4.4 Ml/d – for further details see Section 4.7.

As a sensitivity we have therefore examined the effect that a new 10 Ml/d bulk supply to Bristol Water would have on our supply demand balance. Table 9-4 shows the impact assuming it came into effect in AMP6. It shows that the new transfer could be accommodated within our current surplus and so would not result in a lower security of supply to our own customers.

Table 9-4: Impact of new export to Bristol Water on our supply demand balance (Ml/d)

		2014/15	2019/20	2039/40
Final supply demand balance	**DYAA**	+57	+36	+50
	DYCP	+49	+36	+69
Impact of scenario on water available for use	**DYAA**	0	-10	-10
	DYCP	0	-10	-10
Supply demand balance with scenario	**DYAA**	+57	+26	+40
	DYCP	+49	+26	+59

Thames Water

During pre-consultation we discussed a possible new export of 5 Ml/d (peak and average) from the north of our supply region to Thames Water.

Table 9-5 shows the impact that a new bulk supply to Thames Water would have on our supply demand balance, assuming it came into effect in AMP6. It shows that the new transfer could be accommodated within our current surplus and so would not result in a lower security of supply to our own customers. Whilst this transfer would therefore be feasible for us to supply, Thames Water's option modelling did not select it as a preferred option at this stage.

Table 9-5: Impact of new export to Bristol Water on our supply demand balance (Ml/d)

		2014/15	2019/20	2039/40
Final supply demand balance	**DYAA**	+57	+36	+50
	DYCP	+49	+36	+69
Impact of scenario on water available for use	**DYAA**	0	-5	-5
	DYCP	0	-5	-5
Supply demand balance with scenario	**DYAA**	+52	+31	+45
	DYCP	+44	+31	+64

Cholderton Water

We have had detailed discussion with Cholderton Water and Ofwat regarding a possible new bulk supply to them of 0.8 Ml/d to mitigate rising nitrate concentrations at their sources. However, it was not possible to agree satisfactory commercial terms.

9.3.2. Leakage reduction of 25%

This scenario examines the impact of achieving the aspiration set out in our Strategic Direction Statement to reduce leakage by 25% (to 52.5 Ml/d) by 2040. No impact is shown until 2019/20 as our final planning forecast already accounts for the first stage in achieving the 25% reduction which is a 5% reduction by 2019/20. The final planning forecast indicates that leakage in 2039/40 will be 64.5 Ml/d meaning that it would need to be reduced by a further 11.5 Ml/d to reach the 25% aspiration.

Table 9-5 shows that this leakage reduction scenario would increase our surplus in 2039/40 to 61.6 Ml/d on average and 80.6 Ml/d on peak.

Table 9-6: Impact of 25% leakage reduction on our supply demand balance (Ml/d)

		2014/15	2019/20	2039/40
Final supply demand balance	**DYAA**	+57	+36	+50
	DYCP	+49	+36	+69
Impact of scenario on distribution input	**DYAA**	0	0	-11.6
	DYCP	0	0	-11.6
Supply demand balance with scenario	**DYAA**	+57	+36	+61.6
	DYCP	+49	+36	+80.6

9.3.3. Expansion of Hinkley Point power station

We currently supply Hinkley Point power station in Somerset with water. In October 2010 the British government announced that Hinkley Point was one of the eight sites it considered suitable for future nuclear power stations. In October 2011 the power station's owner EDF submitted a planning application in to build a new reactor (C); planning permission was granted in March 2013 and in October 2013 the Government gave the go ahead for the new reactor to be built.

A new reactor will require an additional supply of water of approximately two-thirds the current supply they receive. Given the size of our final planning surplus we would be able to accommodate this additional demand however the volume has not been incorporated into our final planning scenario as there is still some uncertainty surrounding construction and operation start dates.

9.3.4. Reference level of service supply demand balance

Section 4.10 demonstrated that under the reference level of service our deployable output would be 419 Ml/d for the dry year annual average scenario which is 15 Ml/d higher than under the company's planned level of service (404 Ml/d).

Table 9-6 demonstrates the effect the reference level of service would have on our supply demand balance position. It illustrates that it would increase our surplus as explained in Section 4.10.

Table 9-7: Impact of the reference level of service on the dry year annual average supply demand balance (Ml/d)

	2014/15	2019/20	2039/40
Final supply demand balance	+57	+36	+50
Impact of scenario on water available for use	+15	+15	+15
Supply demand balance with scenario	+72	+51	+65

9.3.5. Impact of worst case nitrate scenario

The risk to overall water supplies related to increasing concentrations of nitrates is modelled in the headroom allowance to account for the likely probability distribution of impact/risk for each source. The discussion of supply forecast sensitivities (Section 4.13) and water quality issues (Section 4.6) highlighted that the total loss of deployable output that could occur should all sources at risk of nitrate pollution fail at the same time would be over 85 Ml/d. This effect of this worst case scenario on our supply demand balance is shown in Table 9-7. This indicates that if every nitrate vulnerable source failed at the same time our supply demand balance would be significantly impacted so that we would be in deficit. The likely response to this would be to install treatment to remove the nitrate.

Table 9-8: Impact of a worst case nitrate pollution scenario on the dry year annual average supply demand balance (Ml/d)

	2014/15	2019/20	2039/40
Final supply demand balance	+57	+36	+50
Impact of scenario on water available for use	-85	-85	-85
Supply demand balance with scenario	-28	-49	-35

9.4 Future use of surplus

In the short term, and built into this Water Resources Management Plan and our Business Plan, the surplus of resources has allowed us to mothball or decommission a number of sources (see Section 4.8.2) which will reduce operating and maintenance costs. It will also enable us to reduce abstraction licences by 25 Ml/d where these have been shown to be environmentally damaging (Section 4.5.1), and to introduce AIM for the Mere source where local residents have concerns about the level of abstraction (Section 4.5.4). The surplus, when combined with our integrated grid project and our catchment management work, allows us to take a more risk based, sustainable, lower cost approach to high levels of nitrate and pesticides in the raw water at some sources.

Over the next few years and ultimately in the lead up to our next Water Resources Management Plan and Business Plan we will be reviewing with regulators and customer groups how best to use any surplus of resources over expected demands. The degree of surplus we have will depend on a number of factors including support for our metering programme from Ofwat through the 2014 Price Review, water quality and outage trends over the next few years, the outcome of the proposed environmental investigations, stream support requirements, whether AIM is rolled out on a wider basis and whether we enter into any new bulk supply agreements, for instance with Bristol Water.

The review will involve obtaining customers views over reliability of supply, affordability, environmental issues (both site specific and generally), and potential operational and capital maintenance savings.

10. Summary and conclusions

This Water Resources Management Plan has set out how we expect to maintain secure water supplies for our customers over the next 25 years while protecting the environment.

To develop the Plan we have developed forecasts of:

- the supply of water available to us taking account of source yields, the impact of climate change and outage
- the demand for water from our customers taking account of population and property growth rates, household water consumption patterns, commercial demands and leakage projections
- we have also assessed an appropriate headroom allowance to account for the uncertainties in our supply and demand forecasts.

Building on our forecasts we have developed a strategy for water resources management in our region that meets the key objectives set in response to what our customers have been telling us, Government aspirations and environmental requirements.

The key objectives of this Plan are to:

- reduce the demand for water
- reduce leakage
- reduce abstraction where this is required to improve river flows
- ensure that we can provide a reliable supply to our customers and identify whether there is scope to transfer water to neighbouring companies

We will meet these objectives by:

- Introducing a change of occupier metering policy and an enhanced water efficiency programme that will in combination reduce overall demand in a dry year by over 7 Ml/d by 2020 and 9 Ml/d by 2040, see leakage fall by 5% by 2020 and help drive average per capita consumption down to nearly 130 litres per person by 2040.
- Continuing to work with the Environment Agency and other stakeholders to investigate where there are concerns that current abstraction licence conditions do not adequately protect the environment. In 2018 when our integrated grid project is complete we will be reducing licences by 23.5 Ml/d.

Our supply demand balance forecast indicates a surplus throughout the planning period and we have liaised with neighbouring companies with deficits to consider the optimal way to use these resources possibly through new transfers.

11. Appendices

11.1 WRP Table commentaries
11.2 Pre-consultation with Environment Agency and Ofwat
11.3 Resource zone integrity assessment
11.4 Deployable output modelling adjustments
11.5 Treatment works operational use schematics
11.6 Miser schematics
11.7 Environmental status of abstractions
11.8 Water Resources Management Plan Direction
11.9 Water resources planning guideline checklist provided by Environment Agency
11.10 Glossary
11.11 Supporting documents and references

11.1 Table commentaries

Version 1.4 (December 2012) of the tables are submitted as part of this Plan. We have followed the technical instructions for the water resources planning guideline supply demand tables (December 2012).

We had already begun completing the tables when subsequent versions (1.5 and 1.6) were issued by the Environment Agency (in February and March 2013). We were too far into the process to switch to completing a different version and so have tried to keep track of the numerous error corrections and patch ups that the Environment Agency have issued in the lead up to the submission deadline. We have added comments to the worksheets and in this section to describe the corrections we have made to the tables where possible.

We have completed two sets of tables – one for the dry year annual average condition and one for the dry year critical period. Table 11-1 lists the worksheets contained in each set of tables and an outline description of their content.

Table 11-1: Water resources management plan supply-demand tables

Worksheet	Content	Dry Year Annual Average	Dry Year Critical Period
Resource zone summary	Supply-demand balance and components	✓	✓
Data QA summary	Data QA and amendments notifications	✓	✓
WRP1a BL Licences	Baseline water resources	✓	✓
WRP1 BL Supply	Baseline water supplies	✓	✓
WRP2 BL Demand	Baseline demand	✓	✓
WRP2a BL Customers	Baseline customer base	✓	✓
WRP2b Weighted baseline demand	Weighted average year demand - Ofwat requirement	✓	n/a
WRP3a Feasible detailed costs	Fixed and Variable costs, Net Present Value, AIC and AISC of all feasible options - confidential	✓	✓
WRP3b Least costs (Weighted)	Least Cost version preferred options - confidential	✓	✓
WRP3c Preferred (Weighted)	Fixed and Variable costs, Net Present Value, AIC and AISC of preferred options - confidential	✓	✓
WRP3 Feasible options	High level costs of all feasible options (Dry Year) - publicly available	✓	✓
WRP4 Preferred options	High level costs of preferred options (Dry Year) - publicly available	✓	✓
WRP5 FP Supply	Final planning water supplies (impact of scenario options)	✓	✓
WRP6 FP Demand	Final planning demand (impact of scenario options)	✓	✓
WRP6a FP Customers	Final planning customer base (impact of scenario options)	✓	✓
WRP6b Weighted FP demand	Final planning weighted demand	✓	n/a

We have also completed version 1.3 (issued on 22 March 2013) of the 'Dashboard' table for the dry year annual average and dry year critical period scenarios.

11.1.1. WRP1a BL Licences

Individual sources – deployable output

The deployable output modelling undertaken for our conjunctive use system using our Miser model incorporated the sustainability licence changes confirmed for the AMP4 studies (Brixton Deverill, Codford, Clarendon and Newton Toney) and the likely licence change expected to result from the AMP5 study at Fonthill Bishop. For the purposes of completing these Tables the loss of deployable output for resulting from the sustainability reductions has been added back in to these sources and is subtracted again WRP1 BL line 8.2BL.

Annual impact of climate change on source (% change)

The values entered in this column for the individual licences are the % change (positive or negative) in theoretical yield for the hydrologically constrained groundwater sources from the base year to 2035 (2030s). These values were calculated following the WRPG guidelines and as described in Section 4.11 of this Plan.

Period of record and critical event

Our deployable output modelling is based upon the critical drought event of 1975/76 selected from the period of measured data we have to support analyses since 1975. A 24 month simulation of sources during this period was undertaken to derive deployable outputs and is described in Section 4.9. We also have modelled records of reservoir inflows and groundwater levels that we extended back to the 1890s and we use these to test the sensitivity of our source yields to earlier and alternative droughts over this period – see Section 4.1.

11.1.2. WRP1 BL Supply

Raw water abstracted

Calculated as: Distribution Input – Imports + Exports + Treatment Works Operational Use.

11.1.3. WRP2a Baseline customers

Total resource zone properties

Row ref 48BL: Formula corrected to account for measured voids.

Measured household - occupancy rate (average) (excluding voids)

Row ref 54BL: Formula corrected to ensure measured voids were excluded.

Total household metering penetration (excluding voids)

Row ref 56BL: Formula corrected to ensure voids were excluded.

Total household metering penetration (including voids)

Row ref 57BL: Formula corrected to ensure measured voids were included.

11.1.4. WRP3

AIC and AISC including Willingness to Pay have been calculated in two ways in the tables. One defining the resource created based on utilisation and one based on capacity. In both cases assumed utilisation has been used in calculating the operating cost of the option.

Wessex Water prefers the capacity approach as the problem that a water resources plan is usually trying to solve is a lack of capacity – either on an annual average or a critical period basis.

3, 3a, 3b and 3c

<u>NPV of WAFU</u>
Formula changed to correct units error.

<u>NPV of WAFU</u>
Formula range changed from 104 years to 80 years.

<u>NPV of Opex savings</u>
Formula changed to correct +/- errors.

<u>Social & Env NPV</u>
Formula range changed from 60 to 80 years.

3c

The macro contained some errors in the rows that were deleted and retained. These errors were manually corrected.

Cost components named "the utilisation demand met" were changed to "Utilisation met" so that the summary table calculates correctly.

11.1.5. WRP4

Descriptions of lines 61.1 to 61.4 changed to match those in tables WRP3a.

Many of the names ranges used in WRP4 and WRP5 did not seem to be picking up the correct cell references – the majority of the names ranges were therefore deleted and the formulae were amended so that the correct information could be entered and reported.

<u>Change in volume delivered to unmeasured non-households</u>
The water efficiency schemes that impact on the water delivered to unmeasured households have a small knock-on impact on the water delivered to unmeasured non-households. This is because our demand forecasting model applies a per capita component of water use to unmeasured non-households that is derived from the unmeasured households – therefore any change to unmeasured household PCC will also impact on unmeasured non-household PCC.

11.1.6. WRP5

The names ranges used in WRP4 and WRP5 did not seem to be picking up the correct cell references – the majority of the names ranges were therefore deleted and the formulae were amended so that the correct information could be entered and reported.

11.1.7. WRP6

The same formula corrections were made to this table that had been applied to WRP2.

<u>Total resource zone properties</u>
Row ref 48FP: Formula corrected to account for measured voids.

<u>Measured household - occupancy rate (average) (excluding voids)</u>
Row ref 54FP: Formula corrected to ensure measured voids were excluded.

<u>Total household metering penetration (excluding voids)</u>
Row ref 56FP: Formula corrected to ensure voids were excluded.

<u>Total household metering penetration (including voids)</u>
Row ref 57FP: Formula corrected to ensure measured voids were included.

11.1.8. Dashboard (dry year annual average and dry year critical period)

<u>Total household properties (including voids)</u>
The formula was incorrect in that it did not account for unmeasured voids this was corrected.

<u>% of homes with a meter</u>
The formula was incorrect in that it was dividing measured households (excluding voids) by all households (including voids). This has been corrected so that it calculates meter penetration excluding voids and the values are consistent with WRP2.

<u>Total water gains/savings</u>
These cells appeared blank and so a formula was added so that it summed the four scheme types in the rows below.

11.2 Pre-consultation with Environment Agency and Ofwat

We have regular contact with the Environment Agency on a variety of water resources issues. Pre-consultation of the draft Water Resources Management Plan is specified in the Guiding Principles to be scheduled to occur between July 2012 and January 2013.

We held pre-consultation meetings with regional Environment Agency staff on: 17 July, 30 August, 11 October, 8 November 2012, 16 January, 6 February and 7 March 2013. We held a pre-consultation meeting with Ofwat on 28 January 2013.

A summary of the discussions had with regulators on the topics specified in the Water Resources Planning Guidelines (WRPG) to have particular pre-consultation requirements are detailed in the table below.

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Resource zone integrity (p. 19, 20)	Water companies should discuss the WRZ assessment method with their local EA team.	**WSX July 2012:** WSX and the local EA team began discussing resource zone integrity issues in November 2011. A draft stage 1 assessment pro-forma was completed by WSX and comments from the EA allowed it to be refined and further information added for enhanced clarification. **EA July 2012:** It is reasonable for WSXs WRMP to be developed as a single resource zone. Letter sent to WSX confirming this in July 2012: (our ref: DM 1463966). **OUTCOME: Issues discussed, approach agreed, no further pre-consultation required. Appendix 11.3 of this Plan provides the final resource zone integrity assessment.**
Weighted average demand (p. 23)	Water companies may wish to discuss the development of their weighted average demand forecast with Ofwat during pre-consultation.	**WSX July 2012:** We intend to arrange a WSX-Ofwat meeting during pre-consultation period to discuss climate change and weighted average demand (WAD), WSX will inform EA of the outcome of discussions with Ofwat. **WSX Jan 2013:** Meeting held with Ofwat on 28 January 2013 – we described modelling work undertaken to analyse the impacts of weather on demand and proposal to treat Weighted Average Demand (WAD) as normal/average demand. There was general agreement from Ofwat that our proposed approach to the development of the WAD forecast was acceptable. Notes from the meeting: DM 1518818; we shared this note on the proposed approach to WAD forecast with the EA and updated them on the discussion with Ofwat. **OUTCOME: Issues discussed, approach agreed, no further pre-consultation required.**

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Utilisation (critical period) forecast (p. 24)	Where relevant, the company must provide in table WRP2b Weighted BL Demand a forecast of utilisation to illustrate how much it is likely to use, on average over the 25 year planning period, any solution to a critical period deficit. Water companies may wish to discuss the development of their utilisation forecast with Ofwat during pre-consultation.	**WSX July 2012:** Issue discussed with EA during July pre-con meeting - not thought to be an issue for WSX as not expecting to be including any resource schemes in preferred option list as not expecting to forecast a supply demand deficit. No further action proposed. **OUTCOME: Issues discussed, no further pre-consultation required.**
Levels of service (p. 33)	The EA will comment of levels of service during pre-consultation.	**WSX July 2012:** Levels of service in the context of their impact on bills and the environment is one of the topics we will be investigating in our WTP surveys and customer research as we prepare our next plan. **WSX Jan 2013:** We described a proposed approach to reviewing LoS in the context of deployable output and discussed whether this would meet the requirements of the WRPG. **EA Feb 2013:** We do not see how Wessex Water is going to show in a planning scenario the actual Level of Service. Actual LoS is a mix of events when measures would have been required and those events when with hindsight measures would not have been required. We would like to discuss this issue further (perhaps at our next meeting). **WSX March 2013:** Discussions with the EA in January and February guided us to review our approach to our analysis of LoS and deployable output. At our meeting with the EA in March 2013 we presented a more detailed analysis that assessed the impact of the no restrictions and reference levels of service by examining the impact of key historical droughts – this information now comprises section 4.10 of this Plan. At the meeting the EA expressed the view that they were more confident that our work met the requirements of the guidelines. **OUTCOME: Issues discussed, no further pre-consultation required.**

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Deployable output (DO) (p. 37)	Water companies should consult with the EA during the pre-consultation phase in order to assess to what extent its calculations for DO in its previous (2009) WRMP are still valid and can be carried forward into the new plan.	**WSX July 2012:** We are in the process of reviewing our DO calculations. Ultimately, DO will be calculated using our Miser model as at PR09. We intend to continue to use the y=mx+c groundwater relationships within Miser but are reviewing these and seeking to provide greater supporting evidence. Hydrogeologists from Hyder are supporting us with this work and we intend to make available some example assessments to the EA during the pre-consultation period. **WSX Nov 2012:** Overview of on-going work on source yields and DO review presented to EA during pre-con meeting in November and draft pages from the developing 'source yield handbook' provided. **WSX Jan 2013:** We provided a draft of the text we intend to include in the draft WRMP regarding our approach to the DO assessment using Miser and this was reviewed with the EA at a meeting on 16 Jan. The EA commented that the approach used was clearly explained. **OUTCOME: Issues discussed, approach agreed, no further pre-consultation required.**

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Climate change (p. 49)	Water companies should discuss the appropriate level of CC analysis for assessing the effects on DO with the EA and Ofwat during the pre-consultation stage. Discussions should be informed by the vulnerability assessment and include the resulting CC analysis proposed to be agreed with regulators.	**WSX July 2012:** A draft of the vulnerability assessment suggests our single resource zone (region) is of low vulnerability to climate change. At PR09 we had four water resource zones and of these only the west zone indicates a medium risk; north, south and east all indicate low risk. The decision tree in the WRPG (p. 52) states that low and low-medium risk zones can be assessed using approaches 1.1, 1.2, 1.3 or 1.4. A review of these methods in the context of the available models and data we have available to use leads us to propose using: • A3 to perturb groundwater sequences using rainfall and PET for the 2030s from the 11 climate models. • A4 to perturb river flow sequences (inc. reservoir inflows) using monthly flow factors for the 2030s from the 11 climate models The approach outlined above was discussed with the EA during the July pre-con meeting and the vulnerability documentation was also provided shortly after the meeting. The EA verbally confirmed their agreement with the proposed approach. **WSX Jan 2013:** We sent the EA a copy of the text we intend to include in the WRMP outlining the vulnerability assessment, impact on groundwater and river flows and impact on DO. This work was discussed at a meeting on 16 Jan and the EA verbally confirmed that they were satisfied with the work and its explanation. We sent Ofwat a copy of the text we intend to include in the WRMP outlining the vulnerability assessment, impact on groundwater and river flows and impact on DO. This work was briefly discussed at a meeting on 28 Jan and Ofwat subsequently emailed (1 Feb) stating: *"We've checked over the material you provided. This complies with the guidance and we had no concerns with the approach you had taken or the conclusions you had reached on the impact of CC."*. **OUTCOME: Issues discussed, approach agreed, no further pre-consultation required.**

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Treatment works operational use (p. 65)	Water companies are expected to describe treatment works losses within each water resource zone and show how these have been calculated. Where appropriate, they should provide diagrams and other supporting evidence that can be used in pre-consultation discussions with Ofwat and the Environment Agency.	**WSX July 2012:** TWOU is a minor component of the plan - in 2011/12 it amounted to 1.2% of abstraction. WSX will prepare a short note outlining the calculation methods, average values for each WTWs and if these might change through the planning period. We intend to make this information available during pre-con and it will also be included in our draft plan. **WSX Feb 2013:** We presented a draft version of what now comprises 4.4 of this Plan which outlines our approach to TWOU. The bulk of TWOU relates to surface water treatment sites but an allowance is made in the DO modelling for this so only 0.88 Ml/d is reported in the tables to account for other small sites and water quality monitors. At the meeting the EA verbally expressed the view that they were satisfied with our explanation of this element of the supply forecast. **OUTCOME: Issues discussed, approach agreed, no further pre-consultation required.**
Outage (p. 64)	If a water company does not use the UKWIR 'Outage allowances for water resources planning' (1995) method to develop its outage allowance then it must be able to provide evidence that the alternative has been discussed with the Environment Agency and statutory consultees during pre-consultation.	**WSX July 2012:** Our outage assessment is underway (using Mott MacDonald) we are following the recommended UKWIR methodology. **WSX Nov 2012:** Preliminary results from the outage modelling analysis were presented and discussed at the pre-con meeting. Work is on-going and is expected to be complete by the end of the year.

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Unconstrained option list (p. 105 & 127)	The unconstrained list should be developed from a generic list of options. The water company should discuss this list, at an early pre-consultation stage, with the regulators and consult with other neighbouring water companies and interested third parties to ensure a complete list has been identified. Regulators will expect to see evidence of engagement with regulators and stakeholders to develop the list.	**WSX July 2012:** We are not expecting to forecast supply-demand balance deficits during the planning period meaning there is no problem to be solved and as per p. 99 of the guidance we are not required to take any further actions. Nonetheless, we believe it is prudent for us to evaluate a range of options and are particularly keen to investigate options under the 'do the right thing' heading. **WSX Nov 2012:** At the pre-con meeting with the EA in Nov we discussed initial qualitative findings from the on-going customer research particularly with regard to options involving leakage reduction, increased metering and increased water efficiency. The qualitative research is being used to inform the quantitative research and willingness to pay study which will be used to inform our decisions with regard to progressing 'do the right thing options' (i.e. this is evidence of engagement with regulators and stakeholders).
Resource sharing (Apx 7, p.170)	Companies are expected to develop and operate a contact plan with its neighbouring companies during the pre-consultation phase. By the end of September 2012 it is expected that companies will publish a view of 'need' and 'availability'.	**WSX July 2012:** We confirmed that we will develop a 'contact plan' for liaison with neighbouring companies (letters / meetings) to make them aware of the expected 'spare water' in September as per the WRPG requirement. **WSX Oct 2012:** We contacted neighbouring companies by email on 1 Oct and made them aware of our initial SDB forecast and expected surpluses. We published the information on our website and made the EA and Ofwat aware that this contact had taken place with other companies. **WSX Nov 2012:** We discussed our 'contact plan' with the EA at the pre-con meeting and confirmed that discussions were on-going with several neighbouring companies with regard to future new bulk supply options; the EA recommended that we confirm by email an overview of the details of our contact plan – this was done on 9 Nov (our ref: DM 1502902) **OUTCOME: Pre-consultation requirement to liaise with neighbouring companies met, discussions on-going but no further regulatory pre-consultation required.**

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
SEA (p. 123)	A company should confirm whether it considers that its water resources management plan will be subject to the SEA Directive during the pre-consultation phase with regulators and stakeholders.	**WSX July 2012:** The requirement for and pros and cons of completing an SEA was discussed. We believe it is not necessary to undertake an SEA for the elements of the 'grid' that will be completed in AMP6 as most of the grid will be substantially complete in AMP5. It is thought however that completing an SEA for the plan may be prudent as it would help to support the case for metering by capturing and monetising the wider benefits. **WSX Jan 2013:** We confirmed our decision to prepare a draft SEA screening statement on our draft WRMP. We expect to provide this to statutory consultees in February. **WSX Feb 2013:** We issued a draft SEA screening statement confirming that as our Plan will not lead to negative environmental impacts as it is focussed on demand management (metering and water efficiency) it is not necessary to complete a full SEA. We circulated this draft screening statement to the statutory stakeholders (EA, NE and English Heritage) and asked for comment. **EA March 2013:** We accept your conclusions that it is not necessary for you to prepare an SEA. **OUTCOME: Issues discussed, approach agreed, no further pre-consultation required.**
Options proposed by third parties (Apx 8, p.173)	During the pre-consultation stage, companies should investigate possible options and solutions (customer-side, production-side, distribution-side or resource management measures) by third parties (e.g. Appointed water companies or other organisations).	**WSX July 2012:** Not applicable as no deficits are expected. No further work required.

Issue and WRPG reference	Pre-consultation requirements	Notes from discussions
Sustainability reductions (p. 42)	Not formally specified in the WRPG as an item for pre-consultation.	**WSX July 2012:** The EA wrote to us on 6 July (our ref: DM 1464492) with indicative sustainability changes. Annex A included a list of the confirmed licences that will be reduced when the grid is complete in 2018 (as agreed at PR09); Annex B included a list of the licences we are currently investigating in AMP5; and Annex C included a list of the WFD sites currently being screened. **EA Feb 2013:** We provided Phase 2 of the Natural Environment Programme (NEP) in February 2013 and these schemes should be incorporated into the WRMP and Business Plan. Phase 3 will be released in August 2013. **WSX March 2013:** We confirm that we have included the impact of the schemes that are confirmed or likely in our assessment of deployable output for our draft WRMP supply forecast.

At the end of the pre-consultation period in March 2013, our regional Environment Agency Principal Environment Planning Officer wrote to us to formally summarise our pre-consultation discussions – the letter is included below for information.

[redacted]
Wessex Water
Claverton Road
Bath
BA2 7WW

Date: 19 March 2013

Dear [redacted]

Response to Water Resource Management Plan pre-consultation from Wessex Water

1 Introduction

Thank you for consulting with us during development of your draft water resource management plan. This letter is our formal pre-consultation response and summarises our discussions and advice over the last year. We look forward to continued discussions during preparation of your final plan.

In the sections below we set out the issues that are specific to Wessex Water, together with wider issues that we are asking all water companies to consider.

Government expects water companies to follow the water company water resources planning guideline when preparing their draft WRMP. This is available from http://www.environment-agency.gov.uk/business/sectors/39687.aspx. This revised guideline has been jointly produced by the Environment Agency, the Welsh Government, Defra and Ofwat and includes several documents:

- The guiding principles - providing an overview of UK Government and Welsh Government policy and advice to water companies in preparing a plan.
- The technical guideline – providing guidance and details on the technical methods of the water resources planning process. An update to this guideline was published at the end of October 2012.
- The supply-demand and water company level tables – blank tables to be used for capturing and presenting water resources planning data

2 Specific areas to consider as part of your draft plan submission

Resource Zone integrity
Based on your completion on the Stage 1 detailed WRZ assessment and discussions, our view is that a single WRZ based on completion of the integrated grid in 2017/18, broadly meets the definition set out in our guidelines. We also agree in principle to the development of your 2014 WRMP based on this single resource zone. In taking forward this approach, you may also need to consider any funding uncertainties and the views of Government and other interested parties.

We recommend continued discussions on resource zone integrity and outputs from your water supply system model. Of particular interest will be any issues relating to isolated sub zones. This will help to ensure that your company approach remains appropriate.

Water stress classification
The outcome of the consultation on a revised methodology to designate areas of water stress is not yet complete. The current published water stress classification should be used for your draft plan (Wessex Water: Low).

Sharing resources
As a company with a supply demand surplus, you shared a summary of the resource available to neighbouring water companies and regulators. Your draft plan should provide details of any potential bulk supply exports, or, if you have rejected any request for surplus water by a neighbouring company, you should explain why.

Demand Forecast, supply forecast and overall supply demand balance
During the pre-consultation phase you presented early drafts of your supply demand forecasts. This work was well presented and useful to our discussions. Your general approach to sharing this information has been recognised by us as good practice.

Climate change vulnerability
Your climate change vulnerability assessment showed a low to low/medium vulnerability classification for resource zones in your company area. You also provided a justification to use approach 1.3 for groundwater flow/level sequences and approach 1.4 for river flow sequences. We had further discussion on the use of your own flow factors for this work. At this stage, we conclude that your approach is appropriate for both your draft and final plan.

National Environment Programme
We provided you with the schemes that make up phase two of the National Environment Programme (NEP) in February 2013. These should be incorporated into your WRMP and Business Plan.

An alternative solution is being investigated for the Malmesbury Avon – this was also included in Phase 2 of the NEP. This will flag up the potential need for funding with Ofwat. As we take this work forward we will also need to consider how potential solutions fit with the broader requirements of your WRMP.

We will release the Phase Three of the NEP in August 2013. In the meantime, we will continue to work closely with you to clarify, review and, where necessary, revise the programme.

Leakage and demand management
You currently forecast a reduction in overall leakage due to a decrease in Underground Supply Pipe Leakage as a result of your proposed change of occupancy metering programme. In particular, this shows a significant leakage reduction in the early part of your plan. This helps to meet Government objectives for a continued downward trend for leakage.

Distribution losses are forecast to remain constant through the planning period. We recognise that this may represent a slight reduction in real terms leakage due to new connections. Government also expects water companies to continue to innovate, and develop expertise in preventing, identifying and repairing leakage more effectively during the WRMP plan period. You should ensure that you have fully considered opportunities to reduce distribution losses over the planning period.

Strategic Environmental Assessment (SEA)
We have reviewed your SEA screening report in accordance with the criteria in schedule 1 of the SEA regulations. We accept your conclusions that it is not necessary for you to prepare an SEA.

Your draft WRMP is largely a continuation of existing options and activities. You may need to consider the environmental report prepared for your 2009 WRMP in the implementation of your latest WRMP.

Other issues
We also discussed a number of other issues such as Levels of Service and Treatment works losses. Details of these discussions are not captured in this letter but have helped us to agree how these are best presented within your draft plan.

3 Next steps

Please contact me if you would like to discuss the information in this letter or our review of your draft plan.

Yours sincerely

[redacted]

Principal Environment Planning Officer (Water Resources)

11.3 Resource zone integrity assessment

For security reasons this appendix is not available in the version of this Plan published on our website.

11.4 Deployable output modelling adjustments

For security reasons this appendix is not available in the version of this Plan published on our website.

11.5 Treatment works operational use schematics

For security reasons this appendix is not available in the version of this Plan published on our website.

11.6 Miser schematics

For security reasons this appendix is not available in the version of this Plan published on our website.

11.7 Environmental status of abstractions

The table below summarises our current understanding of the environmental impact of Wessex Water's sources grouped according to their catchment.

- Green indicates that there is not believed to be an environmental issue and in many cases this has been demonstrated by detailed environmental studies.
- Amber means that there may be an environmental issue. All of these sites are being investigated in AMP6.
- Red indicates that there is known to be a problem with the current licence and schemes have been agreed to reduced abstraction and licences at these sites during AMP6.

The Environment Agency has been consulted in preparing this table, and their comments taken into account. When the EFI banding for each site is available these will be added to the table. This is likely to show considerable inconsistencies with the assessment presented here. This is because the EFI bands do not reflect the outcome of detailed local studies.

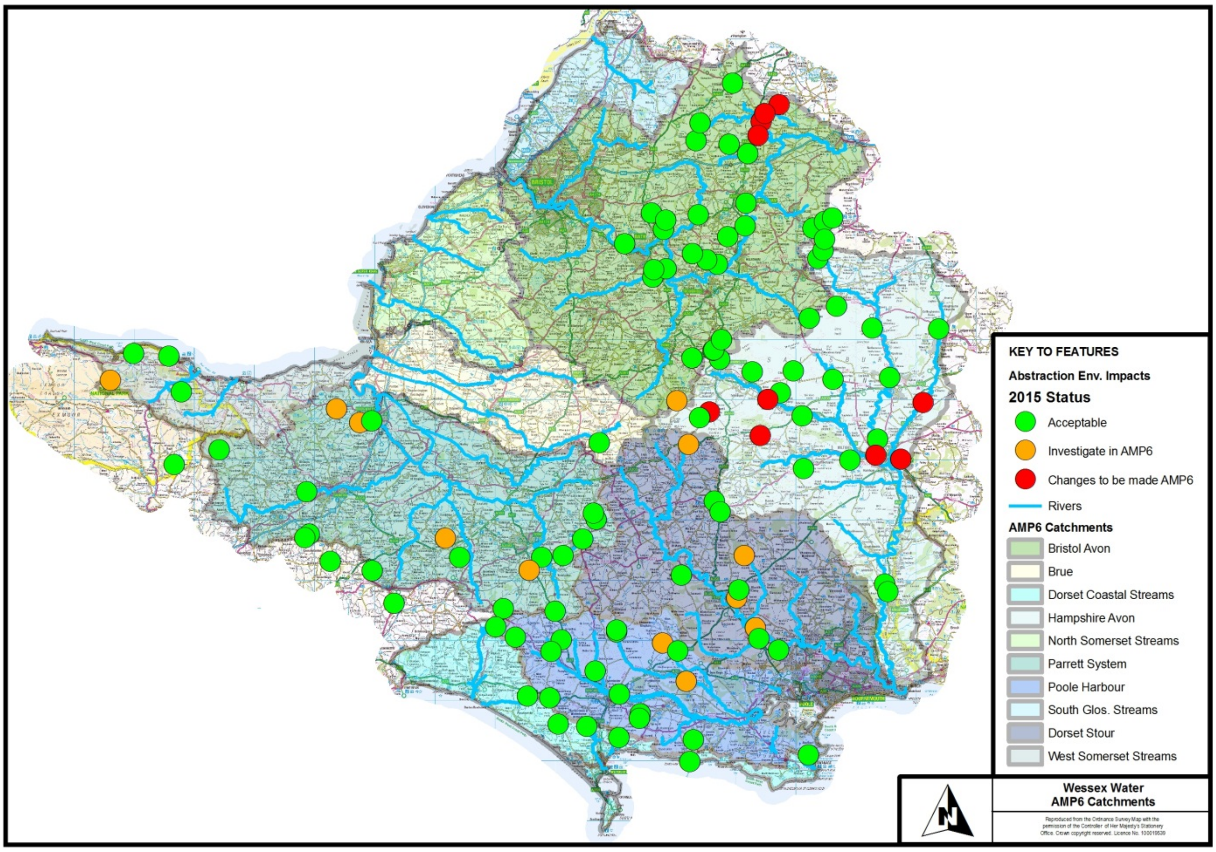
Site Name	Licence Number	Annual licence Ml/yr	Daily licence Ml/d	Status as of 2015	Status change end AMP6	Catchment	Comment
Arn Hill	13/43/23/G/107	548	2.3	1		Bristol Avon	No issues ever raised
Batheaston Springs	17/53/01/S/304	1150	7.0	1		Bristol Avon	AMP3 investigation, no licence changes required
Calstone Springs	17/53/08/S/017	730	2.7	1		Bristol Avon	AMP3 investigation, no licence changes required
Charlton	17/53/01/G/410	4900	13.6	3	1	Bristol Avon	Final solution for Malmesbury to be implemented in AMP6 at latest
Cherhill	17/53/08/G/047	438	1.4	1		Bristol Avon	AMP3 investigation, no licence changes required
Cowbridge	17/53/01/G/410	2738	7.5	3	1	Bristol Avon	Final solution for Malmesbury to be implemented in AMP6 at latest
Divers Bridge	17/53/11/S/090	1576	15.0	1		Bristol Avon	No issues ever raised
Dunkerton Springs	17/53/11/S/011	1660	6.8	2	?	Bristol Avon	Proposed AMP6 investigation
Easterton	17/53/09/G/099	415	1.1	1		Bristol Avon	No issues ever raised
Goodshill	17/53/01/G/201	219	2.5	1		Bristol Avon	No issues ever raised
Holt	17/53/01/G/405A	4015	17.0	1		Bristol Avon	AMP3 investigation, minor changes made to stream support operation
Hullavington SS	17/53/01/G/410	900	2.5	1		Bristol Avon	Provides stream support
Ivyfields	17/53/01/G/207	5110	18.7	1		Bristol Avon	Impact on Pudding Brook reviewed as part of developing NEP for AMP6, no issue
Lacock	17/53/01/G/415	2555	9.1	1		Bristol Avon	No issues ever raised
Little Chalfield SS	17/53/01/G/405B	402	1.1	1		Bristol Avon	Provides stream support
Lower Stanton SQ SS	17/53/01/G/410	900	2.5	1		Bristol Avon	Provides stream support
Luckington SS	17/53/01/G/410	900	2.5	1		Bristol Avon	Provides stream support
Midford Springs	17/53/13/S/090	1150	5.0	1		Bristol Avon	No issues ever raised

Site Name	Licence Number	Annual licence Ml/yr	Daily licence Ml/d	Status as of 2015	Status change end AMP6	Catchment	Comment
Milbourne	17/53/01/G/203	2080	5.7	3	1	Bristol Avon	Final solution for Malmesbury to be implemented in AMP6 at latest
Monkswood Springs	17/53/01/S/303	1460	15.0	1		Bristol Avon	AMP3 investigation, no licence changes required
Monkton Combe	17/53/01/S/398	3650	7.0	1		Bristol Avon	No issues ever raised
Newton Meadows	17/53/01/S/308	10797		1		Bristol Avon	No issues ever raised, source not yet developed
Oakford Spring	17/53/01/S/305	913	3.9	1		Bristol Avon	No issues ever raised
Rodbourne	17/53/01/G/410	5200	13.0	3	1	Bristol Avon	Final solution for Malmesbury to be implemented in AMP6 at latest
South Wraxall SS	17/53/01/G/405C	730	2.0	1		Bristol Avon	Provides stream support
Stanbridge SS	17/53/01/G/410	900	2.5	1		Bristol Avon	Provides stream support
Tetbury SS	17/53/01/G/410	900	2.5	1		Bristol Avon	Provides stream support
Tucking Mill	17/53/13/S/091	913	6.0	1		Bristol Avon	No issues raised
Upton Scudamore Springs	17/53/10/S/011B	730	0.0	1		Bristol Avon	AMP5 investigation, daily licence to be reduced
Upton Scudamore Boreholes	17/53/10/G/011A	2190	11.4	1		Bristol Avon	AMP5 investigation, HOF to be raised
Wellhead	17/53/10/G/009	548	1.8	1		Bristol Avon	AMP5 investigation, no licence change required
Widdenham Springs	17/53/04/S/025	438	2.7	1		Bristol Avon	Source abandoned
Pitcombe Spring	16/52/09/G/075	182	0.5	1		Brue	No issues ever raised
Friar Waddon	13/44/60/G/004	3000	14.1	1		Dorset Coastal	AMP5 investigation, no licence changes required
Langdon	13/44/81/G/001	409	1.3	1		Dorset Coastal	Source abandoned
Litton Cheney	13/44/70/G/112	1250	3.4	1		Dorset Coastal	There are local concerns over level in a pond. Not proposed for investigation but time limited variation unlikely to be renewed.
Portesham	13/44/04/G/002	279	0.8	1		Dorset Coastal	No issues ever raised
Sutton Poyntz	13/44/03/S/015	4015	12.4	1		Dorset Coastal	Impact on River Jordan reviewed as part of developing NEP for AMP6, no issue
West Lulworth Spring	13/44/03/G/008	273	0.9	1		Dorset Coastal	No issues ever raised
Bishops Cannings	13/43/21/G/204	620	1.2	1		Hants Avon	AMP5 investigation, minor licence change agreed.
Blashford Intake	13/43/28/S/128	3000	0.0	1		Hants Avon	AMP4 investigation, no licence changes required. Source mothballed
Blashford Lakes	13/43/28/S/129	1500	50.0	1		Hants Avon	AMP4 investigation, no licence changes required. Source mothballed.
Bourton	13/43/21/G/154	767	2.1	1		Hants Avon	AMP5 investigation, minor licence change agreed.
Brixton Deverill	13/43/23/G/238	3300	9.0	3	1	Hants Avon	AMP4 investigation, licence to be reduced in 2018

Site Name	Licence Number	Annual licence Ml/yr	Daily licence Ml/d	Status as of 2015	Status change end AMP6	Catchment	Comment
Bulbridge	13/43/22/G/075	279	0.8	1		Hants Avon	Assessed as no problem in HD ROC
Chirton	13/43/21/G/213	548	2.3	1		Hants Avon	No issues ever raised
Chitterne	13/43/23/G/212	2072	13.0	1		Hants Avon	Licence reduced in 2011 following investigation
Chitterne SS	13/43/23/G/212	1468		1		Hants Avon	Provides stream support
Clarendon	13/43/26/G/104	4000	14.0	3	1	Hants Avon	AMP4 investigation, licence to be reduced in 2018
Codford	13/43/23/G/213	7300	6.0	3	1	Hants Avon	AMP4 investigation, licence to be reduced in 2018
Compton	13/43/21/G/137	996	3.9	1		Hants Avon	Some local concerns about impact by EA closed their investigation in March 2013
Deans Farm	13/43/21/G/208	4300	12.0	1		Hants Avon	AMP4 investigation, no licence changes required
Devizes Road	13/43/22/G/079	330	6.5	3		Hants Avon	Daily licence to be reduced to 3 Ml/d following AMP4 investigation
Durrington	13/43/21/G/152	1800	6.6	1		Hants Avon	AMP4 investigation, no licence changes required
Fonthill Bishop	13/43/22/G/120	2550	7.0	3	1	Hants Avon	AMP5 investigation, licence change to be implemented by 2018
Fovant	13/43/22/G/081	548	2.1	1		Hants Avon	AMP4 investigation, no licence changes required
Heytesbury	13/43/23/G/238	3300	10.0	1		Hants Avon	AMP5 investigation, no licence changes required
Kingston Deverill SS	13/43/23/G/238	1500	10.0	1		Hants Avon	Provides stream support
Leckford Bridge	13/43/24/G/101	1000	4.5	1		Hants Avon	Source mothballed, no licence change required following HD ROC
Newton Toney	13/43/24/G/019	2396	6.5	3	1	Hants Avon	AMP4 investigation, licence to be changed in 2018
Shrewton	13/43/23/G/101	832	2.3	1		Hants Avon	AMP4 investigation, no licence changes required
Wylye	13/43/23/G/102	292	1.6	1		Hants Avon	AMP4 investigation, no licence changes required
Ashford and Hawkridge	16/52/07/S/069	5000	15.9	2	?	Parrett	AMP3 investigation led to change in Currypool CF. AMP6 investigation.
Blackdown Sources	16/52/05/S/228	1250		1		Parrett	No issues ever raised
Bradley Head	16/52/02/G/133	420	1.5	1		Parrett	AMP4 investigation, no licence changes required
Castleton	16/52/02/G/128	700	3.9	1		Parrett	No issues ever raised
Clatworthy	16/52/05/S/230	10000	36.8	1		Parrett	AMP5 investigation into impact of HMWB, no licence changes required
Clifton Maybank	16/52/02/S/267	1000	0.0	1		Parrett	No issues ever raised
Compton Durville	16/52/03/G/079	1730	5.9	2	?	Parrett	Proposed AMP6 investigation
Corscombe Springs	16/52/02/G/279	150	0.5	1		Parrett	AMP4 investigation, no licence changes required
Durleigh	16/52/07/S/070	8000	30.0	2	?	Parrett	Proposed AMP6 adaptive management trial on compensation flows
Hele Bridge	16/52/05/S/470	850	0.0	1		Parrett	No issues ever raised

Site Name	Licence Number	Annual licence Ml/yr	Daily licence Ml/d	Status as of 2015	Status change end AMP6	Catchment	Comment
Lake	16/52/02/G/135	3000	11.0	1		Parrett	AMP4 investigation. No licence changes required
Milborne Wick	16/52/02/G/127	360	1.1	1		Parrett	AMP4 investigation, no licence changes required
Pole Rue	16/52/01/G/063	1659	4.5	1		Parrett	No issues ever raised
Sutton Bingham	16/52/02/S/130	5546	22.0	2	?	Parrett	Proposed AMP6 adaptive management trial on compensation flows
Taunton and Bridgwater Canal	16/52/07/S/123	4300	18.0	1		Parrett	No issues raised – proposed AMP6 potential drought permit data collection
Waterloo Farm	16/52/03/G/171	457	1.5	1		Parrett	Impact on Lam Brook? reviewed as part of developing NEP for AMP6, no issue
Woolcombe Springs	16/52/02/G/280	730	5.0	1		Parrett	Source abandoned
Alton Mill SS	13/44/041/G/005	405		1		Poole Harbour	Provides stream support
Alton Pancras	13/44/041/G/005	1364	4.5	1		Poole Harbour	Annual licence reduced in 2010 and stream support provided
Belhuish	13/44/59/G/106	2920	15.0	1		Poole Harbour	AMP4 investigation, no licence changes required
Briantspuddle	13/44/43/G/103	6637	9.2	2	?	Poole Harbour	AMP2 investigation, licence reduced by 9 Ml/d, AMP6 investigation
Cattistock	13/44/51/G/001	475	2.7	1		Poole Harbour	No issues ever raised
Dewlish	13/44/42/G/101	2364	9.1	2	?	Poole Harbour	Previous investigations indicate no issue on headwater, AMP6 investigations for lower river
Eagle Lodge	13/44/55/G/105	2550	8.2	1		Poole Harbour	No issues ever raised
Empool	13/44/58/G/105	4550	19.1	1		Poole Harbour	AMP4 investigation, no licence changes required
Forston	13/44/55/G/021	1095	4.6	1		Poole Harbour	No issues ever raised
Hooke	13/44/52/S/001	1064	2.9	1		Poole Harbour	AMP3 investigation, no licence changes required
Maiden Newton	13/44/51/G/027	232	0.6	1		Poole Harbour	No issues ever raised
Milborne St. Andrew	13/44/44/G/100	2046	10.5	1		Poole Harbour	AMP5 investigation, no licence changes required
Ulwell	13/44/03/G/001	341	3.3	1		Poole Harbour	No issues ever raised
Watergates Fish Farm	13/44/58/G/010	2560	10.9	1		Poole Harbour	Provides stream support
Winterbourne Abbas	13/44/56/G/103	1250	2.8	1		Poole Harbour	AMP3 investigation, no licence changes required
Barton Hill	13/43/22/G/098	323	1.1	1		Stour	No issues ever raised
Black Lane	13/43/34/G/259	2920	10.5	2	?	Stour	AMP6 investigation.
Boyne Hollow	13/43/22/G/098	499	1.6	1		Stour	No issues ever raised
Corfe Mullen	13/43/34/G/149	8319	33.0	1		Stour	AMP4 investigation, no licence changes required
Mere	13/43/00/G/001	3319	9.1	2	1	Stour	AMP4 investigation and proposed AMP6 AIM trial

Site Name	Licence Number	Annual licence Ml/yr	Daily licence Ml/d	Status as of 2015	Status change end AMP6	Catchment	Comment
Okeford Fitzpaine Spring	13/43/34/S/148	386	1.4	1		Stour	No issues ever raised
Shapwick	13/43/34/G/216	2920	9.1	2	?	Stour	Proposed AMP6 investigation
Stubhampton	13/43/00/G/001	796	2.2	2	?	Stour	Proposed AMP6 investigation
Sturminster Marshall	13/43/34/G/229	5820	20.0	1		Stour	AMP4 investigation no licence changes required
Yarde Lane SS	13/43/34/G/259	138	1.5	1		Stour	Provides stream support
Bossington	16/51/02/G/008	146	1.4	1		West Somerset	AMP3 investigation, no licence change required, source to be abandoned.
Broadwood Spring	16/51/05/G/044	219	1.1	1		West Somerset	No issues ever raised
Moorbrake	16/51/05/G/037	50	0.9	1		West Somerset	Source abandoned
Nutscale	16/51/3/13	1250	3.6	2	?	West Somerset	Proposed AMP6 HMWB investigation
Forches Corner	14/45/02/1899	455	5.0	1		Axe*	No issues ever raised
Otterhead	14/45/01/0002	909	11.4	1		Axe*	No issues ever raised
Tatworth	14/45/00/0521	500	1.4	1		Axe*	AMP4 investigation no licence changes required
Wimbleball	14/45/02/2021	11615	45.5	1		Exe*	No issues raised, licence varied in 2011
Shepherds Shore	28/39/22/289	1023	4.0	1		Kennett*	No issues ever raised
Yatesbury	28/29/22/290	318	0.9	1		Kennett*	No issues ever raised



11.8 Water Resources Management Plan Direction

The table below was reproduced from the Guiding Principles of the Water Resources Management Plan. It contains the specific requirements of the Water Resources Management Plan Direction and specifies how we have complied with each element of the Direction.

Direction paragraph	Direction text	Guidance	Assessment
2	"A water undertaker shall prepare a water resources management plan, for a period of 25 years commencing on 1st April 2015."	Water resources management plans must cover a 25 year time horizon. However, this in itself does not constrain water companies to a 25 year forward look and if it is important to its plans, a water company can provide information past this planning horizon.	Has the company provided a plan that covers a time period from 1 April 2015 to 31 March 2040? Yes
3(a)	—how frequently it expects it may need to impose prohibitions or restrictions on its customers in relation to the use of water under each of the following - (i) section 76 (ii) section 74(2)(b) of the Water Resources Act 1991; and (iii) section 75 of the Water Resources Act 1991"	A water company must set out its planned level of service that it will achieve throughout the planning period for its final planning scenario. The company will need to explain any changes or variation with this planned level of service. The company should indicate, as good practice, if customers will actually be receiving a different level of service as options are implemented.	Has the company clearly set out its planned level of service and provided evidence that its final planning scenario will meet that level of service. See Section 9.2.
3(b)	"the appraisal methodologies which it used in choosing the measures it intends to take or continue for the purpose set out in section 37A(2), and its reasons for choosing those measures"	Section 6 of the water resources planning guideline technical document sets out the approach to be followed by a water company when appraising a new option or solution to remove a deficit. Where this method is used a water company need only state that it is using the approach set out in the Guideline. A water company may use an alternative approach, but it must set out the appraisal method and the reasons for choosing that method. If the water company is part way through delivery and using an alternative approach, it must explain its existing measures and reasons. A narrative rather than a full appraisal will suffice.	The water company has confirmed it has followed the guideline showing transparency through its decision process See Section 8.1 which describes the option appraisal process – methods used are consistent with approached outlined in Section 6 of the guidelines.

3c	"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) "	A water company will need to produce an assessment of the likely emissions of greenhouse gases from its current and future activities. This should be produced in the water resources management plan for its final planning scenario. The company can decide at what point it starts its assessment but it should be the same for all components.	The company has produced clear set of information about the total emissions of greenhouse gases for its final planning scenario for each year. This should include current and future operations. See Section 9.2.4.
3d	"how the supply and demand forecasts contained in the water resources management plan have taken into account the implications of climate change"	Climate change may have a large impact for some water companies. The technical guideline sets out the approach for assessing climate change for supply and demand using the latest information and methods available. Section 3 details impacts on supply and Section 4 details impacts on demand. A water company can decide to include an allocation with target headroom using the methods presented in the technical guideline. All water companies should follow these methods, clearly displaying the results and how they achieved them. If a water company follows an alternative approach it must give reasons for not following guideline.	The company has assessed and detailed the impacts of climate change within its final planning scenario. It should have used the methods covered in the water resources planning guideline technical section. See Sections 4.6 and 5.5.6.
3e	"how it has estimated future household demand in its area over the planning period, including the assumptions it has made in relation to population and housing numbers, except where it does not supply, and will continue not to supply, water to domestic premises,"	A company must describe how it has estimated current and future household demand unless it only supplies industrial/commercial customers.	A company has included a demand forecast for households that are based on the methods detailed in the guideline. The company will need to detail in its plan how it has derived these forecasts and how it has involved local authorities in building them. See Sections 5.3, 5.4 and 5.5.
3f	"its estimate of the increase in the number of domestic premises in its area, over the planning period, in respect of which it will be required to fix charges by reference to volume of water supplied to those premises under section 144A".	Section 144A of the Water Industry Act 1991 relates to the right of a consumer to elect to be charged by reference to volume of water. A water company must provide an estimate of how many additional meters it will install as a result of customers asking for them (optants) over the planning period.	See Sections 5.5.4 and 5.5.5

3g	"where the whole or part of its area has been determined by the Secretary of State to be an area of serious water stress under regulation 4(1) of the Regulations, its estimate of the number of domestic premises which are in the area of serious water stress and in respect of which it will fix charges by reference to volume of water supplied to those premises over the planning period;‖	Those water companies whose areas (or part of whose areas) are designated as an area of serious water stress must provide an estimate of the number of households in that area that will be compulsorily metered over the planning period.	Not in area of Serious Water Stress, see Section 4.5.7 and Appendix 11.2 which contains confirmation of this from the Environment Agency.
3h	"its estimate of the increase in the number of domestic premises in its area (excluding any domestic premises which are included in the estimate referred to in sub-paragraph (g)), over the planning period, in respect of which section 144B(2) will not apply because the conditions referred to in section 144B(1)(c) are not satisfied and in respect of which it will fix charges by reference to volume of water supplied to those premises"	Those water companies designated within an area of serious water stress need to provide information on the number of households that they would plan to compulsorily meter using powers associated with being designated as an area of water scarcity over the planning period. s.144B(1)(c) refers to the conditions to be satisfied in limiting the ability of water undertakers to compulsorily meter. The Water Industry (Prescribed Conditions) Regulations 1999 set out a number of situations in which those conditions will not be satisfied. These include situations relating to the use of premises, and the use of the water supplied. They also include areas determined to be areas of Serious Water Stress, where a programme of metering applies, or areas of Water Scarcity Water undertakers should estimate the number of domestic premises (not already accounted for under paragraph 2(b) above) where it will compulsorily meter under s.144B(1)(c). This does not apply to companies wholly or mainly in Wales.	Not in area of Serious Water Stress, see Section 4.5.7 and Appendix 11.2 which contains confirmation of this from the Environment Agency.

3i	"full details of the likely effect of what is forecast pursuant to sub-paragraphs (f) to (h) on demand for water in its area;"	A water company must assess the impact on household demand forecast under paragraphs (a)-(c) as a result of metering schemes for optants and compulsory schemes. Water companies in an area of serious water stress need to establish programmes of metering installation for optants and compulsory metering, under sub section (a) to (c). This does not apply to companies wholly or mainly in Wales.	The company has provided a forecast of demand as a result of different metering options if appropriate for the company. This is regardless of the option appraisal mechanism outlined in the guideline. See Sections 5.5.4, 5.5.5 and 8.3.
3j	"the estimated cost to it in relation to the installation and operation of water meters to meet what is forecasted pursuant to sub-paragraphs (f) to (h) and a comparison of that cost with the other measures which it might take to manage demand for water, or increase supplies of water, in its area to meet its obligations under Part III of the Water Industry Act 1991"	A water company must assess the cost of installing and operating of estimated opt-in metering and compulsory metering. As part of its options appraisal a water company must set out, for comparison, the cost of metering programmes and alternative programmes to balance supply and demand. This does not apply to companies wholly or mainly in Wales.	The company has provided detailed cost of additional metering as an option. See Section 8.3
3k	"a programme for the implementation of what is forecasted pursuant to sub-paragraphs (g) and (h)."	A water company must set out its implementation plans for its programme of compulsory metering. This does not apply to companies wholly or mainly in Wales.	Only applied if a company has outlined it will implement a compulsory metering programme. Not applicable
4	"Except where the Secretary of State or the Welsh Ministers otherwise permit, a water undertaker must send its draft water resources management plan to the Secretary of State or the Welsh Ministers in accordance with section 37B(1) before 31 March 2013	A water company must submit its water resources plan to the Secretary of State or Welsh Ministers by 31 March 2013, unless directed otherwise	A water company has submitted its plan on time. Confirmed – submission to Defra of draft WRMP on 28 March 2013.

5	"Except where the Secretary of State or the Welsh Ministers otherwise permit, a water undertaker must publish its draft water resources management plan in accordance with section 37B(3)(a) within 30 days of the later of the date on which the Secretary of State or the Welsh Ministers — ….‖	The water company must publish its draft plan within the set timescale and exclude information that is determined to be commercially confidential or contrary to the interests of national security.	The company has published its plan within the timescales and removed information in accordance with the Secretary of State/Welsh Minister's direction. Confirmed – submission includes a security endorsement statement for Company's Security Manager.
6	"Except where the Secretary of State or the Welsh Ministers otherwise permit, 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 of the date of publication of the draft water resources management plan"	The water company must publish its statement of response within 26 weeks of the publication date of the draft water resources management plan. The statement of response must be sent to any person that has made a representation. Within the 26 week period, Government suggests a period of 12 weeks for the consultation.	The company has published its statement of response.

11.9 Water resources planning guideline checklist provided by Environment Agency

This audit checklist has been designed to help water companies ensure they have considered and completed everything set out in the water resources planning guideline.

Section 2 – Building your plan – the basics

No.	Action or approach	WRPG ref.	WRMP ref. and comment
How long should a water company plan for?			
1	Describe the planning period used in the plan and how and why this may be different from the statutory 25-year period (from April 2015 to March 2040).	2.4	25 year planning period used.
2	If relevant, explain the risks and uncertainties of extending the planning period.	2.4	N/A
3	Describe the base year used in the plan and how and why this may differ from the recommended year of 2011/ 12.	2.4.1	2011/12 used as base year.
4	The whole life costs of all schemes should be accounted for in the option appraisal process. Describe how the plan complies in this regard.	2.4.1	Section 8.2. All costs / benefits considered over an 80 year horizon.
5	Describe the price base for scheme costing used in the plan and how and why this may differ from the recommended year of 2012/ 13.	2.4.2	Section 8.2. Schemes used 2012/13 for the price base.
What area should water companies plan for?			
6	Explain how the water resource zones (WRZ's) meet the UKWIR/ EA definition of a WRZ and present the findings of the assessment as a separate section in the plan, along with any relevant discussions that have taken place with the Environment Agency.	2.5.3	Section 3.2 and appendix 11.3.
7	Ensure that the guidance produced by Government to cover national security issues and commercial confidentiality has been followed.	2.5.3	Statement included in Summary for Consultation on commercial confidentiality. The Company's security manager has provided Defra with an endorsement concerning national security issues.
What planning scenario should a water company use?			
8	Supply and demand should be forecasted under the dry year (annual average) daily demand planning scenario.	2.6	Confirmed. Section 5
9	If relevant, describe the dry year critical period scenario and explain why it is exists and the underlying factors affecting the critical period supply demand balance.	2.6	Section 5.2
10	Describe how the dry year forecast has been developed from base year figures and explain any assumptions or adjustments made due to weather patterns experienced that year.	2.6.1	Section 5.2
11	Explain the derivation of the dry year demand and present the data as a continuous profile over a year at monthly or weekly intervals.	2.6.1	Section 4.9.2

No.	Action or approach	WRPG ref.	WRMP ref. and comment
12	The baseline dry year (annual average) demand forecast should be presented in Table *WRP2 BL Demand* and the final planning forecast in Table *WRP6 FP Demand.*	2.6.1	Confirmed
13	Explain the derivation of the weighted annual average demand forecast, for both the baseline and final planning (where required) scenarios.	2.6.2	Section 5.2.2
14	Calculate and set out in Table *WRP2b Weighted BL Demand* the weighted annual average demand components, explaining the approach taken in the table commentary.	2.6.2	Section 5.2.2
15	The utilisation forecast should be set out in Table *WRP2b Weighted BL Demand* with an explanation in the commentary on the derivation of the forecast, including any assumptions made.	2.6.3	N/A
17	Explain, if relevant, the assumptions supporting the critical period demand forecast, such as deployable output, outage and headroom and describe the relationship between these different factors with reference to the equivalent relationships for the dry year forecast.	2.6.4	Section 5 and specifically 5.2.1
18	Planning tables showing the baseline and final planning forecasts under the dry year in Tables *WRP2 BL Demand* and *WRP6 FP Demand* should be submitted with commentary on how the final planning solution will deliver under both dry year and critical period supply demand scenarios.	2.6.4	N/A
19	If relevant, the utilisation forecast for the critical period should be set out in Table *WRP2b Weighted BL Demand* with an explanation in the commentary on the derivation of the forecast, including any assumptions made.	2.6.6	N/A
Links to other plans and Government policy and aspirations			
20	Confirm that the costs of the company's preferred solution are based on utilisation and will directly inform the company's 2014 business plan.	2.7.1	Confirmed, but subject to consultation, Ministerial direction and other developments prior to December 2013.
21	Describe how the plan has been informed by a Strategic Environmental Assessment (SEA) and Appropriate Assessment of the environmental impact of the options, where appropriate.	2.7.2	Section 9.2.2 and Section 9.2.3
22	Explain how Government policies have been followed within the baseline forecast and provide a breakdown of costs the company has incurred by complying with Government policy/ aspirations.	2.7.3	Government policies – Section 5.9.1 Costs – Sections 8.3.3 and 8.5.2
Level of service			
23	Describe the customer engagement in preparing the plan in relation to levels of service.	2.9	Section 4.10
24	Explain any proposals to change the planned levels of service.	2.9	None, confirmed in Section 8.1.5
25	Describe whether a given level of service can be delivered more efficiently by taking a flexible approach.	2.9	Grid project is making our supply network a lot more flexible. Section 3.1

No.	Action or approach	WRPG ref.	WRMP ref. and comment
26	Explain how the planned levels of service in all WRZ's can be met and how the deployable output relates to levels of service (graphically demonstrating the sensitivity of the relationship).	2.9.1	Section 4.10
27	As a minimum, the baseline deployable output (without climate change) should be assessed for the following levels of service scenarios: No Restrictions Planned levels of service Reference scenario levels of service Describe any differences in the assumptions between the three scenarios.	2.9.1	Section 4.10
28	The deployable output derived from the planned levels of service should be used to develop the baseline supply demand balance.	2.9.1	Confirmed
29	Explain how the outputs from the UKWIR project 'WR27 – water resources planning tools' has been consulted and used in deriving relationships between deployable output and levels of service (including that of groundwater sources).	2.9.1	Section 4.10
30	Describe whether a change in levels of service is a feasible option for consideration in the options appraisal process.	2.9.2	Not appraised as significant supply demand surplus, confirmed in 8.1.5
31	Explain the differences across the planning period between the actual and planned levels of service, clearly setting out actions to reconcile the differences.	2.9.3	Section 9.2
32	Describe the levels of service restrictions that customers have recently experienced and explain where these are not consistent with planned levels of service.	2.9.4	No restrictions since 1976. Section 3.4.
33	Explain the consistency, in terms of levels of service, between the water resources management plan and the drought plan. Describe plans to resolve any discrepancies.	2.9.4	They are consistent. Confirmed in Section 3.4
Optimisation of existing operations			
34	Describe the action that the company has taken to lower the overall costs (financial, environmental, social and carbon) of its existing operations.	2.1	Use of the Miser model operationally as well as for WRMP. Section 4.9.1

Section 3 - How much water is available for supply?

No.	Action or approach	WRPG ref.	WRMP ref. and comment
Deployable output			
35	Describe how deployable output has been assessed. Explain what is included and excluded in the deployable output calculations and the uncertainties.	3.1.1	Section 4, specifically 4.9 for DO modelling
36	Describe any recent changes to deployable outputs.	3.1.1	Section 4.
37	Describe the discussions and agreements with the Environment Agency concerning the deployable output assessment.	3.1.1	Section 2.1 and Appendix 11.2
38	Explain that the planned levels of service in all WRZ's can be met and how the deployable output relates to levels of service (graphically demonstrating the sensitivity of the relationship).	3.1.1 (& 2.9.1)	Section 4.10

No.	Action or approach	WRPG ref.	WRMP ref. and comment
39	Describe if a new assessment of deployable output is required (as defined by the criteria in section 3.1.2 of the guidelines). Where a new assessment is required, analyse and report any revisions at least as thoroughly as the yield assessment work carried out in 1997.	3.1.2	Section 4
40	Describe how the outputs from the UKWIR project 'WR27' (water resources planning tools) have been consulted and used in deriving deployable output and levels of service (and the relationships between them). Describe the confidence ratings applied to the deployable outputs.	3.1.3 (& 2.9.1)	Section 4
41	Explain and justify what length of record has been used to assess deployable output and describe the critical events which define the assessment.	3.1.4	Section 4
42	Describe how all the time series used to estimate deployable output have been kept updated to account for recent dry years.	3.1.4	Section 4
43	As a minimum, baseline deployable output (without climate change) should be assessed for the following levels of service scenarios: No Restrictions Planned levels of service Reference scenario levels of service Describe any differences in the assumptions between the three scenarios. Ensure that Table '*WRP1 BL Licences*' is fully completed.	3.1.5 (& 2.9.1)	Section 4.10
44	Describe the progress made and proposed future work on linking levels of service to groundwater deployable outputs. This should include categorisation of sources into the 3 categories outlined in section 2.9.1.	3.1.5 & 2.9.1	Impact of level of service on deployable output considered on a source by source basis. Section 4.10
45	Describe, if relevant, where the sum of deployable outputs does not aggregate to the WRZ, providing an explanation of the conjunctive use benefits and system constraints.	3.1.5	N/A
46	Describe the events and factors which constrain deployable output, presenting comparisons against actual drought events. Options to remove the constraints should be explained and taken forward to the option appraisal process.	3.1.5	Section 4
47	Describe if alternative levels of service (explaining the impact on deployable output values) have been carried forward to the company's options appraisal process.	3.1.5	Section 8.1.5
Reductions in deployable output			
48	Describe the impact of sustainability reductions (both confirmed and likely) on deployable output.	3.2.1	Section 4.5
49	Show that investigations and options appraisals on water resources investigations will be completed in time to inform the final plan.	3.2.2	Section 4.5
50	Describe how the options appraisal process, for sustainability reductions, has been undertaken in determining the preferred options set.	3.2.4	Section 4.5

No.	Action or approach	WRPG ref.	WRMP ref. and comment
51	List all sustainability reductions in the water resources planning tables, using scheme identifiers that have agreed with the Environment Agency. Names of schemes should match those listed in the company's Business Plan.	3.2.4	Section 4.5
52	Confirm that no allowance for sustainability reductions in target headroom has been made.	3.2.4	Section 4.5.3 and Section 6
53	Describe the agreed outputs with the Environment Agency on selecting appropriate scenarios to investigate the impact of sustainability reductions. Explain the sensitivity scenarios undertaken to understand the selection of appropriate and flexible options.	3.2.5	Section 4.5
54	Describe the implementation timetable for sustainability changes.	3.2.5	Section 4.5
55	All sustainability changes should be listed in the plan and in the planning tables. Any voluntary sustainability reductions should be clearly listed in Table *WRP1 BL Supply*.	3.2.5	Confirmed
56	Confirm that the company's proposed solutions for non-statutory sustainability reductions are only for those reductions classified as 'confirmed' by the Environment Agency, have customer support and are cost beneficial.	3.2.5	Confirmed
57	Where investigations are incomplete, confirm that solutions proposed for sustainability reductions are cost effective, and that the reduction is judged as likely to be required by the Environment Agency, and that there is a statutory requirement for the reduction.	3.2.5	Impacts on deployable output based on February guidance from EA. Section 4.5.3
58	Only pragmatic, additional sustainability reductions that have agreed with the Environment Agency should be accounted for; no account should be considered for the Abstraction Incentive Mechanism.	3.2.7	Confirmed
Impacts of climate change on water supply			
59	Describe the discussions that have taken place with regulators, during the pre-consultation phase of the planning process, on the appropriate level of climate change analysis for a WRZ.	3.3	Section 4.11 and Appendix 11.2
60	Describe and detail how the joint UKWIR and Environment Agency project '*Climate change in water supply planning*' outputs and tools have been consulted and used in formulating the plan.	3.3.1	Section 4.11
61	Explain how a basic climate change vulnerability assessment has been completed for each WRZ.	3.3.3	Section 4.11.1
62	Explain how the vulnerability assessment results are shown in the plan.	3.3.3	Section 4.11.1
63	Following the vulnerability assessment, describe the subsequent decision making process in determining the level of climate change analysis.	3.3.4	Section 4.11.1
64	Explain how, for schemes which are driven by non-climate change factors and where the WRZ is considered to have a low vulnerability to climate change, a robust assessment of the impacts on climate change has been undertaken.	3.3.4	N/A

No.	Action or approach	WRPG ref.	WRMP ref. and comment
65	Where appropriate, describe how the joint UKWIR/ Environment Agency/ et al project '*Future flows and groundwater levels'* outputs and tools have been consulted and used in formulating the plan.	3.3.6	Section 4.11.2
66	Describe the period of record that has been used to determine the deployable output for the climate change assessment.	3.3.6	Section 4.11.2
67	Where flow factors have been used, companies should explain why these have been used in preference to rainfall runoff-modelling	3.3.6	Section 4.11.1
68	Describe the selection of the best estimate climate projection for assessing the direct impact on the baseline deployable output.	3.3.6	Section 4.11.3
69	Explain how the uncertainty of climate change has been included in target headroom, in relation to the other components of target headroom, to assist review by stakeholders.	3.3.6	Section 4.11.5 and Section 6
70	Explain how the approaches in assessing deployable output between the baseline scenario and the climate change impacted scenario are aligned. Describe any assumptions.	3.3.7	Section 4.11.3
71	Describe the need for any reductions in deployable output by other causes (other than climate change or sustainability reductions), and provide supporting information. Discuss whether options to restore capacity, as part of the wider options appraisal, are appropriate.	3.3.9	N/A
Outage allowance			
72	Describe how the UKWIR report '*Outage allowances for water resources planning*' (UKWIR, 1995) has been consulted and used. If an alternative approach has been used describe the agreement (and timing) with the Environment Agency.	3.4.1	Section 4.12
73	Describe the current data sources and data collection system. Where outage is not based on recorded data, a clear plan to collect outage data should be defined.	3.4.1	Section 4.12
74	Describe how legitimate outages have been identified from the outage data for a given planning scenario. Outages should be summarised to provide an overview of the risks to the WRZ.	3.4.1	Section 4.12
75	Explain if significant changes to the supply system are planned and how the outage allowance will be reassessed across the planning period.	3.4.1	Section 4.12
76	Describe how, to help resolve supply demand balance issues, options for reducing outage allowances have been considered within the options appraisal process.	3.4.1	N/A
77	Outage should be considered separately from target headroom.	3.4.1	Confirmed
78	Summarise results of outage assessment by outage type and by sourceworks, where appropriate.	3.4.2	Section 4.12
Sharing and transferring resources – including raw and potable water transfers/ bulk supplies			

No.	Action or approach	WRPG ref.	WRMP ref. and comment
79	Describe existing transfers, for each step of the planning period, ensuring that the values used by the donor match those used by the recipient.	3.5.1	Section 4.7
80	Explain the maximum transfer capacity and its limiting factors.	3.5.1	Section 4.7
81	Explain how any transfers will be managed under a dry year scenario.	3.5.1	Section 4.7
82	Describe any assumptions made about the reliability of the transfers and, in the case of inter-company transfers, information on agreements between companies. Explain occasions when the full transfer was requested but was not made, including reasons agreed with the other company.	3.5.1	Section 4.7
83	Describe potential future transfers included in the preferred options.	3.5.1	Section 4.7 and Section 9.5
Treatment works			
84	Describe treatment works losses within each WRZ and show how these have been calculated, providing, where appropriate, diagrams and other supporting evidence.	3.6	Section 4.4
85	Describe how the estimation of treatment losses has been considered equitably and consistently across all WRZ's.	3.6	Section 4.4
86	Explain how reductions in treatment losses have been accounted for in the options appraisal process.	3.6	N/A

Section 4 – What is the demand for water?

No.	Action or approach	WRPG ref.	WRMP ref. and comment
Introduction			
87	Explain how the policies and aspirations presented in 'the guiding principles for developing a water resources management plan' have been incorporated into the demand forecast.	4.0	Section 5.9
What do regulators expect from a demand forecast			
88	Detail which demand forecasts have been prepared and used: For the dry year (annual average) scenario: baseline dry year; baseline weighted annual average; baseline utilisation (where a deficit exists); final planning dry year; final planning weighted annual average. For the dry year (critical period) scenario, if relevant : baseline dry year (critical period); baseline utilisation; final planning dry year (critical period).	4.1	Section 5.2
87	Confirm that the baseline demand forecast includes, as a minimum, achievement of the savings associated with water efficiency, leakage reduction and metering activities assumed in price limits up to 2015.	4.1	Section 5.5, 5.6 and 5.7

No.	Action or approach	WRPG ref.	WRMP ref. and comment
88	Confirm that the plan, beyond 2015, describes the continuation of optional metering and agreed programmes of universal metering, maintenance of leakage at the forecast 2015 level (or include any leakage reduction associated with the optional and agreed universal metering programmes), and inclusion of any savings associated with water efficiency requirements that Ofwat set out in its price review methodology.	4.1	Confirmed
89	Explain how the current best estimates of demand have been reconciled with other parts of the water balance.	4.1	Section 5 follows the WRPG using 2011/12 as based year.
90	Describe how the baseline demand forecast is expected to change in a dry year assuming existing management policies continue.	4.1	Section 5, summarised in Section 5.9.
91	Detail the assumptions made about how aspects of the baseline demand will change through the planning period (including any changes brought about by retail licensees under the Water Supply Licensing regime).	4.1	Section 5
92	Describe how the dry year unrestricted demand has been used in developing the demand forecast.	4.1	Section 5.2
Defining a normal year and dry year base demand			
93	Detail how the normal year and dry year base demand estimates have been prepared, including the assumptions and adjustment factors that have been used and support this with appropriate historical data.	4.2	Section 5
94	Explain how the methodologies from the 1995 reports '*Demand Forecasting Methodology*' and '*Forecasting Water Demand Components*' (NRA and UKWIR, 1995) have been incorporated into the plan.	4.2	Section 5
Critical period demand forecasts – if required			
95	Describe the type and duration of the critical period demand including when this demand typically occurs.	4.2.1	Section 5.2
96	Describe the operational constraints that occur in the resource zone, how they affect managing the critical period demand and the approach to managing the operational constraints.	4.2.1	Considered via Miser model – so built into deployable output. Section 4.9.1
97	Detail the assumptions made in developing the critical period scenario	4.2.1	Section 5.2
98	Explain how the methodologies from the report '*Peak Water Demand Forecasting Methodology*' (UKWIR 06/WR/01/7) have been incorporated into the plan.	4.2.1	Section 5.2.1
Base year population and properties			
99	Describe historic and planned future engagement with local authorities to gather and use household and non-household population and property data.	4.2.2	Section 5.3 and 5.4. In particular see Box in section 5.3.2
100	Describe how base year population data has been developed.	4.2.2.1	Section 5.4.1

No.	Action or approach	WRPG ref.	WRMP ref. and comment
101	Describe how WRZ population estimates have been reconciled with the most recent population data from local authorities and ONS, showing adjustments for population in properties that are not connected to the mains.	4.2.2.1	Section 5.4.1
102	Explain how local authority data has been proportioned to the WRZ's.	4.2.2.1	Section 5.4.1
103	Explain how household population has been derived from property billing data (and/ or other sources) and how the various sub-categories of population have been estimated.	4.2.2.1	Section 5.4.1
104	Explain if and how smaller area estimates (for example, super output areas) have been used to derive WRZ forecasts. Present the allocation of these estimates to the WRZ's.	4.2.2.1	N/A
105	Describe how the base year population data has derived from the available population data.	4.2.2.1	Section 5.4.1
106	Explain how the total connected population data for a WRZ agrees with the sum of the household and non-household population estimates. For each WRZ describe the measured and unmeasured household population, properties, assumed occupancy rate and PCC (as completed for Tables *WRP2a BL Customers* and *WRP6a FP Customers*).	4.2.2.2	Sections 5.3, 5.4 and 5.5
107	Describe how the communal non-household population is distributed within each WRZ. In projecting the data, any assumptions made should be clearly described.	4.2.2.2	N/A
108	Describe the method used to estimate non-communal non-household population and justify any population allocated to the unmeasured non-household category.	4.2.2.2	Section 5.4.1
109	Describe how household data has been allocated to WRZ's using information from the billing system.	4.2.2.3	N/A – one resource zone
110	Explain how household figures have been reconciled against the figures produced by the DCLG and/ or the Welsh Government household forecasts and describe any adjustments made.	4.2.2.3	Sections 5.3.2 and 5.4.2
111	Describe how the measured, un-measured and void properties (both household and non-household) have been estimated.	4.2.2.4	Section 5.3.2
112	Describe how the measured households have been distributed into more detailed categories (in Table *WRP2a BL Customers*).	4.2.2.4	Section 5.4.2
113	Explain any adjustments made for non-connected properties.	4.2.2.4	Sections 5.3.1 and 5.4.1
Forecasting population and property numbers			
114	Explain which census data been used and any assumptions or adjustments made.	4.2.3.1	Section 5.4.3
115	If supplying water in England describe how the most recent local authority plan based forecasts have been used to produce population forecasts.	4.2.3.2	Section 5.4.2
116	Explain how trend based data has been used to validate, develop or modify the demand forecasts.	4.2.3.2	Section 5.4.2

No.	Action or approach	WRPG ref.	WRMP ref. and comment
117	Explain the growth rate used for population and household projections in years beyond the last published data (see *Methods of Estimating Population and Household Projections* (Environment Agency, 2012)).	4.2.3.2	Section 5.4.2
118	If supplying water in Wales, describe how the latest local authority population and household projections published by the Welsh Government have been used and how these forecasts have been reconciled with the national population projection for Wales produced by ONS data.	4.2.3.3	N/A
119	Describe how the planned metering programme allows the division of the household projections into measured and unmeasured and explain trends across the planning period. Information should be detailed in Table *WRP2a BL Customers*.	4.2.3.4	Section 5.5.5 and WRP2a
120	Detail the disaggregation of new build housing from existing housing stock and justify the differences in terms of population and occupancy.	4.2.3.4	Section 5.4.2
Base year household demand			
121	Detail how the household PCC (measured and unmeasured) has been divided into micro-component categories at the WRZ and company levels. Justification for the level of division should be provided.	4.2.4.2	Section 5.5.3
122	Describe the method used to derive measured and un-measured PCC including the origin of the observed PCC and any adjustments made to the data.	4.2.4.2	Section 5.5.3
123	Describe the assumptions that underpin the base year estimate of unmeasured and measured PCC. Explain how socio-economic and geographical factors influence the pattern of water use in each WRZ.	4.2.4.2	Section 5.5.1, 5.5.2 and 5.5.3.
124	Describe how metering and demand management affects consumption, clearly stating the overall company policies.	4.2.4.2	Section 5.5.4 and 5.5.5
125	Report micro-components as set out in the guideline or with a more detailed breakdown dependent on the supply-demand balance and data available to the company. Explain the reason for the choice.	4.2.4.2	Section 5.5.3
126	Include completed Tables (*WRP2 BL Demand* and *WRP6 FP Demand*) for micro-components for both the baseline and final planning (if appropriate) scenarios.	4.2.4.2	See Tables WRP2 and WRP6
127	Describe how sufficient micro-component information will continue to be collected (or newly obtained) to support the forecasts of demand in the next planning period.	4.2.4.2	Section 5.5.3
Forecast Household Consumption			
128	Describe how Defra and the Welsh Government water efficiency and demand management aspirations have been considered.	4.2.5.1	Sections 5.5.5, 8.1, 8.3 and 8.4

No.	Action or approach	WRPG ref.	WRMP ref. and comment
129	Explain the approach used to prepare the forecasts of demand and how micro-component data has been utilised.	4.2.5.2	Section 5.5.3
130	Describe the assumptions that underpin each micro-component category.	4.2.5.2	Section 5.5.3 and supporting appendix on micro-component data sources.
131	Describe the sources of data and the methods used to forecast demand.	4.2.5.2	Section 5
132	For each metering category explain how the pattern of water use changes from baseline to forecast (and final planning) and justify the assumptions that underpin the growth factors.	4.2.5.2	Section 5.5
133	Detail the expected water savings (sustainable over time) and assumptions of current and future planned demand management options (both household and non-household) and how these can be used to help manage the supply demand balance. These could be over and above the measures taken to meet Ofwat's water efficiency requirements.	4.2.5.2	Section 5.5.5, 8.3 and 8.4
134	Explain where supply side resource options have been offset or avoided as a result of water efficiency measures.	4.2.5.2	N/A
135	Describe how the various codes of practices, regulations and evidence bases have taken account of, as set out in the guideline.	4.2.5.2	Section 5.5.5, 8.4 and the supporting water efficiency options appendix
136	Describe how *A good practice manual and roadmap for household consumption forecasting* (UKWIR project 12/CU/02/11, 2012), or other approaches, has been used to adjust for the impact of metering on consumption, setting out the methods and assumptions that have been used.	4.2.5.2	Section 5.5.3
137	Explain how further metering beyond the baseline as a supply demand option has been considered and implemented.	4.2.5.2	Section 5.5.5 and 8.3
138	Explain how an allowance for the impact of climate change on household demand and non-household demand (if appropriate) has been considered.	4.2.5.2	Section 5.5.6
Non-household consumption			
139	Provide base year and forecast assessments for non-household demand by WRZ and chosen categories of use and describe the methods used to produce these.	4.3.1	Section 5.6
140	Describe the components of non-household demand in the different sectors.	4.3.2	Section 5.6
Leakage forecast			
141	Describe how the base year leakage figures for each WRZ have been derived.	4.4.1	Section 5.7
142	Provide details of the company's current policies on leakage detection and control including quantified descriptions of the contribution of each element of its current policy (and practice) to achieving the current and forecast baseline leakage.	4.4.2	Section 5.7 and SELL report (appendix)

No.	Action or approach	WRPG ref.	WRMP ref. and comment
143	Explain how baseline leakage is not being allowed to deteriorate from the SELL identified at the end of the current pricing period (2014/ 15).	4.4.2	Section 5.7
144	Describe and quantify the factors influencing the baseline leakage forecast to the end of the planning period including Defra and the Welsh Government policies on leakage.	4.4.2	Section 5.7
145	Confirm that the recommendations of the report *Review of the calculation of Sustainable Economic Level of Leakage and its integration with water resource management planning* have been considered in establishing both the baseline and final planning leakage forecasts.	4.4.2	Section 5.7 and SELL report (appendix)
146	Include the most up to date SELL calculations clearly explaining how the SELL figures were derived.	4.4.3	Section 5.7 and SELL report (appendix)
147	Explain how current operations will continue to control leakage.	4.4.3	Section 5.7 and SELL report (appendix)
148	Detail the impact of new options (including non-supply demand balance options such as mains replacement) on SELL.	A11	Section 5.7
149	Explain how customer views through willingness to pay surveys have been accounted for in setting or amending SELL.	A11	Section 5.7, SELL report (appendix) and Section 8

Section 5 - A buffer on the supply and demand forecast– calculating target headroom

No.	Action or approach	WRPG ref.	WRMP ref. and comment
Defining target headroom			
150	Describe how the approach to determining target headroom is well-informed and balances the costs and risks to customers and the environment of a low headroom allowance against those of a high headroom allowance. Explain how the greatest sources of uncertainty have been identified and options considered for reducing this uncertainty.	5.1	Section 6
151	Confirm that the company's allowance for target headroom, capturing uncertainty around supply and demand, only reflects factors that will reduce water available for use or increase the demand for water.	5.1	Section 6
Risks and uncertainty in supply and demand			
152	Describe the assumptions of risk and state what has and has not been included in the calculations. Explain any comparisons with the previous level of target headroom.	5.2	Section 6
153	Describe how the levels of risks will be resolved and reduced over the planning period.	5.2	Section 6.4
154	Describe the certainty thresholds chosen throughout the planning period and provide justification.	5.2	Section 6
Risks associated with a revocation of a licence or time limited licences			
155	Explain how time-limited licences have been treated in the plan. Definite time-limited licences, or ones likely to have an effect on the	5.3	Section 6 – time limited licences risks not included in headroom as per

	environment, should be entered as a sustainability reduction in Table *WRP1 Supply*.		guidance.
156	Describe the process in ensuring that overall headroom uncertainty is not significantly influenced by the 'accuracy of supply-side data' and 'accuracy of sub-component data' components.	5.3	Section 6
157	Describe how the chosen level of risk reflects the target level of service.	5.3	Section 6
Choice of method			
158	Describe which approaches and methodologies have been consulted on and used in deriving the target headroom allowances, for each WRZ.	5.4	Section 6
159	Describe how the target headroom assessment (applicable to dry years) has been applied to critical periods, where relevant.	5.4	Section 6
Companies that use the 2003 methodology			
160	Explain how the probability distribution of headroom uncertainty has been interpreted to develop estimates of target headroom, including how exceedence percentiles have been used.	5.5	Section 6.2
161	Describe the reasons for choosing the probability distributions and level of variances attached to each of the headroom sources.	5.5	See Section 6 and Mott MacDonald's technical appendix on Headroom.
162	Describe the treatment of inter-dependencies, correlation, and mutual exclusion, between the different sources of uncertainty.	5.5	See Section 6 and Mott MacDonald's technical appendix on Headroom.

Section 6 - The balancing act and will a water company need investment

No.	Action or approach	WRPG ref.	WRMP ref. and comment
What option to implement in the final plan? – The principles			
163	Describe the overall decision making process in selecting the preferred option, ensuring that the process, as outlined in the plan, is clear and transparent.	6.1	Section 8
164	Explain how specific options, requested by Government, have been appraised.	6.1	Section 8
165	Explain how customers views, for example through willingness to pay surveys, have been taken into account in the option appraisal process.	6.1	Section 8
166	Explain how water companies (and other third parties) have had the opportunity to provide information and options pertinent to the plan development.	6.1	Section 2
Methods to find the preferred option			

No.	Action or approach	WRPG ref.	WRMP ref. and comment
167	Describe how following methodologies have been used in selecting the preferred option: '*The economics of balancing supply and demand*' (UKWIR and Environment Agency, 2002) '*Benefits Assessment Guidance*' (Environment Agency, 2012) *Guidance on Strategic Environmental Assessment and Habitats Regulations* Assessment *of Water Resources Management plans* (UKWIR, 2012) *Involving customers in price setting* (Ofwat, August 2011) Carrying out Willingness to Pay Surveys (UKWIR, 2012)	6.2	Section 8
168	Explain any alternative methods used in deriving the preferred option, detailing the differences and improvements over the recommended approaches.	6.2	N/A
169	Describe how options proposed by third parties have been evaluated equitably and consistently alongside the other options.	6.2	No options proposed by third parties.
Stage one – unconstrained list of options			
170	Describe how the UKWIR WR27 '*Water resources tools'* project and the '*Economics of Balancing Supply and Demand'* report have been consulted in preparing a comprehensive list of water management options.	6.4	Unconstrained options list not prepared as no deficit. This was discussed with the EA during pre- consultation – see Appendix 11.2
	Explain the timing and content of the customer/ stakeholder consultation process that has taken place to discuss and help form the unconstrained list of options.	6.4	See comment above, but customer views were taken into account in appraising what has been termed 'do the right thing options'.
171	Confirm that the company has consulted water companies and third parties to ensure a complete list of unconstrained options are identified.	6.4	N/A, see comment for 170.
172	Have specific options from the following categories been considered: Demand management – water efficiency Demand management – leakage Resource sharing Options proposed by third parties	6.4 Appendices 9 - 13	Yes, see Section 8 and the WRMP Tables
173	Describe assumptions made about the components of the options i.e. the water savings, flexibility and interdependencies with other options.	6.4	Section 8 and the technical appendices on options.
Stage two – Create a list of feasible options			
174	Explain how the unconstrained options have been screened to derive the feasible options and how the feasible list provides a set of realistic options from which to derive the preferred programme (the feasible options should be stated in Table *WRP 3a Feasible Options Detailed*).	6.5	N/A
175	Describe each feasible option and include supporting information such as a conceptual and schematic diagrams, as appropriate.	6.5.1	Section 8 and the technical appendix Options Descriptions

No.	Action or approach	WRPG ref.	WRMP ref. and comment
176	Detail and explain how the following have been derived for each feasible option: capital costs operational costs Environmental, social and carbon costs and benefits customers willingness to pay. The costing should be evaluated over the whole life cycle (80 years) of the options.	6.5.3	Section 8 and the technical appendix Options Descriptions
177	Confirm that any supplementary costs for supply side options, including water transfers, have been included in feasible options costs.	6.5.3	Extent of distribution costs is detailed in the Options Description document
178	Describe how the feasible cost estimates have been scored based on the key principles relating to estimating best practice.	6.5.3	Section 8.2
179	Explain how the AISC and the AIC costs based on the maximum capacity/output for each feasible option has been derived. The costs should be set out in Table *WRP3a Feasible Options Detailed.*	6.5.3	Section 11.1.4
180	Describe, for each feasible option: the sources of risks and uncertainty assessment of the impacts from climate change the flexibility of the option the interdependencies with other options the investigation and implementation time of the option further factors or constraints specific to the option	6.5.4	Section 8 and the technical appendix Options Descriptions
181	Describe the inter-dependencies, links and synergies that exist between feasible options.	6.5.5	Technical appendix Options Descriptions
182	Explain how the policies and outputs from the Defra White Paper '*Water for Life'* and from the Welsh Government, on water transfers, have been considered.	6.5.6	See Section 8.1.1.
Stage two continued - Economic appraisal of feasible options to determine the least cost solution			
183	Explain how the feasible options have been assessed to determine the least cost solution that removes the potential deficit in the planning scenario (the dry year (annual average) and if relevant (critical period)) but is assessed using the company's assumption for utilisation to determine variable costs.	6.6	N/A
184	Confirm that no aspects of the least cost solution have been determined outside of the optimisation process and have been included as fixed inputs to the solution.	6.6	N/A
185	Confirm that all options, including those proposed by third parties and neighbouring companies, were assessed consistently with the company's own options.	6.6	Section 8. No third party options proposed
186	Describe how the utilisation demand forecast has been used in determining the variable costs of the options.	6.6	N/A – proposed demand side options have 100% utilisation
187	Confirm that the whole life costs of any options that are required in the planning horizon have been assessed as part of the optimisation process.	6.6	N/A

No.	Action or approach	WRPG ref.	WRMP ref. and comment
188	Describe each option of the least cost solution in table WRP3b, showing the timing of when each scheme is required, the amount it will be used (as determined by the utilisation forecast), and profiling fixed and variable costs for each option. Confirm that the total usage for all schemes is consistent with the utilisation forecast set out in table WRP2 BL Demand.	6.6 Appendix 5	Section 9.1 and Table WRP4
189	Include the minimum operating costs in Table WRP3b for those schemes of the least cost solution that will not be used under the utilisation approach, to reflect their requirement as standby resources to meet the maximum potential supply demand deficit in a dry year (annual average) (or critical period) scenario.	6.6 Appendix 5	N/A
Stage three – Programme appraisal, Strategic Environment Assessment and Habitats Regulation Assessment consideration of non-monetary costs and benefits			
190	Describe how the SEA process and/ or sensitivity testing has been considered to both assess alternative options to the least cost plan and derive the preferred programme (set out in Table *WRP4 Preferred [Scenario Yr]).*	6.7	Sections 9.2.2 and 9.3
191	Describe how financial, environmental and social costs have been taken into account in deriving the preferred solution.	6.7.1	Sections 8 and 9
192	Explain any risks and uncertainties that have not been captured by the options appraisal process and how these factors have been included in determining the preferred solution.	6.7.1	Section 8 and technical appendix Options Descriptions
193	Explain how the requirements of the Habitats Regulations Assessment (HRA) and Strategic Environmental Assessment (SEA) have been considered and met. In particular, describe how the SEA and HRA applicability and scoping has been determined and undertaken at an early stage of the plan's development.	6.7.2	See Section 9.2.2 and 9.2.3.
194	If undertaking SEA, explain how the '*Strategic Environmental Assessment and Habitats Regulations Assessment of Water Resources Management Plans' (*12/WR/02/7, UKWIR, 2012*)* and *Practical Guide to the Strategic Environmental Assessment Directive* (ODPM, 2005) guidance have been considered and used, with particular regard to the environmental and social impacts of the options and the non-monetised elements. It SEA has not been undertaken the reasons should be clearly stated.	6.7.5	See Section 9.2.2 and supporting SEA screening statement prepared by Cascade.
195	In preparing the SEA Environmental Report ensure that it meets the requirements of Annex 1 of The Strategic Environmental Assessment Directive (2001/42/EC).	6.7.9	See Section 9.2.2 and supporting SEA screening statement prepared by Cascade.
Stage four – a preferred programme of options and a final water resources management planning solution			

No.	Action or approach	WRPG ref.	WRMP ref. and comment
196	Detail the preferred programme in the water company total tables, as well as in Tables *WRP3c Preferred* (utilisation) and WRP4 Preferred (Scenario Yr) with costs based on utilisation, reflecting the timing of when each option is required.	6.8	Confirmed, see Tables
Developing the feasible options list: Appendix 10 – Water Efficiency and metering			
197	Describe the baseline (everyday) water efficiency and metering activities that are being implemented and how these are being promoted to other organisations and the process for accounting for the wider benefits of the activities.	A10	Technical appendix Water Efficiency Strategy
198	Explain how water efficiency and metering options have been considered to manage household and non-household demand (these should be in addition to the activities being implemented as part of normal operations).	A10	Section 8
199	Explain the differences between the baseline water efficiency and metering activities and the new activities/ options.	A10	Section 8
200	Describe how customers‘ preferences through willingness to pay surveys have been taken account of when considering water efficiency and metering options.	A10	Section 8
201	Describe how the UKWIR project WR 25C – *Cost effectiveness of demand management*, and the Waterwise reports – *Evidence base for large-scale water efficiency* have been considered in compiling the unconstrained list of options.	A10	Technical appendix – Water Efficiency Option Descriptions
202	Explain, if applicable, why demand management options have not been progressed to the feasible options list.	A10	N/A
203	Describe how impacts to customers have been considered if a compulsory metering programme has been selected as part of the preferred solution and how these impacts will be managed.	A10	N/A
204	Provide details of assumptions made about how metering and increase in water efficiency will help to adapt to climate change.	A10	Section 8
Developing the feasible options list: Appendix 11 – Leakage reduction			
205	Describe how leakage control options are fully considered as part of the options appraisal and the consideration of synergies with other demand management measures.	A11	Section 8 – link with metering in particular
206	Explain how customers' preferences have influenced leakage proposals.	A11	Section 8
207	Confirm that the full range of feasible leakage options have been considered as part of the company's options appraisal.	A11	Range of options considered in Section 8 and detailed in technical appendix Option Descriptions
208	Explain why leakage control options have or have not been selected in the final planning solution.	A11	Section 8 (leakage benefits of metering on change of occupier are included in final planning solution)

No.	Action or approach	WRPG ref.	WRMP ref. and comment
209	Confirm that the recommendations of the report *Review of the calculation of Sustainable Economic Level of Leakage (SELL) and its integration with water resource management planning* have been considered in establishing leakage options.	A11	Section 8 and SELL technical appendix
Developing the feasible options list: Appendix 12 - Resource sharing (including bulk supplies, transfers of water, shared assets and water trading)			
210	Explain how the company has fully investigated sharing resources. A company should consider all options to: Share resource(s) with another water company(ies) (neighbouring or not) in the form of "bulk supply contracts and shared asset ownership"; Share, trade or transfer water with non-water company providers or users of water This should include a description of the company's contact plan.	A12	Sections 2.1.2 and 9.3.1
211	Confirm that the company, if in deficit, has contacted neighbouring water companies when developing its unconstrained options list to see if they have water available that could be provided by a bulk supply or develop joint resources. The plan should also show how a company has maintained an audit trail to show it entered into these discussions (contact plan).	A12	N/A
212	Confirm that the company, if in surplus, has identified if it is feasible to export any surplus water from its resource zone (optional for water companies operating wholly or mainly in Wales) and carried out a preliminary assessment of the costs of doing so.	A12	Sections 2.1.2 and 9.3.1
213	Describe where and why bulk import or export options (or other options of resource sharing) were not progressed to the feasible options list.	A12	N/A
214	Explain whether permanent or temporary (short term) trades of water were considered.	A12	N/A
Developing the feasible options list: Appendix 13 - Options proposed by third parties			
215	Explain how possible options and solutions by third parties have been investigated and considered in the plan. This should include a description of the company's third party contact plan.	A13	N/A
216	Describe where and why third party bids/options were not progressed to the feasible options list.	A13	N/A
Appendix 14 - Environmental and social impacts of an option			
217	Describe how the impact of changes to the operation of existing sources and/or the impacts of new abstractions on water body status (Water Framework Directive) has been taken into account.	A14	Section 4.5 and technical appendix Options Description

Section 7 - Final planning supply - demand balance

No.	Action or approach	WRPG ref.	WRMP ref. and comment
Introduction			
218	Explain how the solution affects both the dry year and the critical period scenarios, where relevant. The preferred solution should be presented in Table *WRP4 Preferred*, the final planning demand forecast should be presented in Table *WRP6 FP Demand* and the final planning supply forecast should be presented in Table *WRP5 FP Supply*.	7.0	**Section 9.2 and these tables**
219	For the dry year (annual average) scenario, a summary of the final planning weighted annual average demand forecast should be submitted. The final planning weighted average demand forecast is calculated in Table *WRP6b Weighted FP Demand*, which automatically accounts for demand management measures from Table *WRP3c Preferred (utilisation)*.	7.0	**See tables**
Production of a final plan and justifying the final planning solutions			
220	Explain the water resources planning problems and the proposed solutions, confirming that the preferred options set resolves the deficits.	7.1	**Section 9 – note no deficit to overcome**
221	The optimum solution should be: in line with industry good practice robust and flexible to the range of risks and uncertainties identified selected to make a positive contribution to sustainable development Describe how the decision on a preferred solution set has been reached, particularly in relation to alternative options and existing schemes.	7.1	**Section 8 and 9**
222	Explain how the timing of scheme implementation has been derived.	7.1	**Section 5.5.5**
223	Describe the alternative options that are planned should the preferred option set not be deliver.	7.1	**N/A – for scenarios see Section 9.3**
224	Describe the risks and costs that the company is accepting in the plan; this should include the social and environmental impact of the options including the potential effect on WFD ecological status.	7.1	**See technical appendix Options Descriptions**
225	Explain how much headroom is provided by the preferred options set. Also comment on the company's' confidence in being able to deliver the preferred option set.	7.1	**Sections 6 and 9**
226	Where relevant, describe the cases for further supply demand investigations.	7.1	**N/A**
227	Show how the company has complied with Government Directions. A list of Directions should be provided that show the evidence of compliance.	7.1	**See table in Appendix 11.8**
228	Checklist of water resource management plan tables that the company should complete		**Appendix 11.1**

No.	Action or approach	WRPG ref.	WRMP ref. and comment
229	Ensure that correct tables have been submitted, as set out in Table 7.0, which shows the required planning tables to be submitted for each scenario.	7.2	**See tables**

Section 8 – Testing your plan

No.	Action or approach	WRPG ref.	WRMP ref. and comment
Scenario testing			
230	Explain how you have undertaken scenario testing to ensure that the plan is adaptive, flexible and resilient to minor changes in the near future and moderate changes as the plan progresses. As a minimum five scenarios should be undertaken, a maximum impact scenario, a least impact scenario and three intermediate scenarios.	8.1 & 8.2	Section 9.3
231	Describe how the scenario testing has considered the main risks, as appropriate, and has ensured that the company is not proposing a solution that exceeds stakeholders needs and is based on an extreme worst case scenario.	8.1	Section 9.3
232	Clarify how the company has used the target headroom analysis to explore the sensitivity of the plan; this will help determine and justify the chosen target headroom risk profile and show the consequential effects on the final planning supply demand balance.	8.1 & 8.2	N/A as no deficit
233	Describe what factors and uncertainties have a large impact on the plan and the possible timings of these impacts.	8.1	Section 9.3
Choosing scenarios			
234	Describe whether the scenarios include factors that are already covered in headroom, and if so what additional impact they have.	8.2	Section 9.3
235	Explain the potential level of impact the factors have on the plan and an estimation of the likelihood of those factors occurring.	8.2	Section 9.3
236	Explain, where relevant, how uncertainties from sustainability reductions have been tested.	8.2	Section 4.5.3 and Section 9.3
Using scenario testing			
237	From the scenario testing, explain the key decision milestones in the planning period i.e. when key events need to occur and which key events control the preferred solution.	8.3	N/A
238	Monitoring of the proposed final solutions is a key element of the planning process. Describe how the plan will be monitored and subsequently modified if required.	8.3	Section 9.1
239	If the scenario testing shows that the plan may need to be modified before the next plan is published, describe the drivers, tipping point and actions that will be undertaken to manage this change. This should include outlining how the alternative plan process will be managed alongside the preferred plan.	8.3	Section 9.3, and 9.3.5 in particular with requirement to install additional nitrate treatment under this scenario
Alternative plans (if relevant)			

No.	Action or approach	WRPG ref.	WRMP ref. and comment
240	Describe the parameters of the tipping point identified in the first five years of the plan and how a company would know when that tipping point was reached.	8.4	N/A
241	An alternative plan should contain sufficient detail to allow all interested parties to view the consequences of the plan. This should include details of the options appraisal process, costs, environmental impacts, impact to the supply demand balance and whether the SEA and Habitats Regulations have been considered.	8.4	N/A
What do the regulators expect to see within the plan?			
242	Explain how the scenario testing has helped reduce uncertainties in the plan and ensure decisions are made at the correct times. This timeline should be related to the proposed final solution dates.	8.5	Section 9.3

11.10 Glossary

Abstraction	The removal of water from any source, either permanently or temporarily.
Abstraction licence	The authorisation granted by the Environment Agency to allow the removal of water from a source.
AMP	Asset Management Period – water companies operate on five year cycles set by a Business Plan and subsequent price determination by Ofwat.
Bulk transfers	A legal agreement for exporting and importing water between a donor and recipient operator.
Compensation flow	A continuous release of water from an impounding reservoir to maintain a minimum prescribed flow in the downstream river.
Defra	Department for Environment, Food & Rural Affairs.
Demand management	The implementation of policies or measures which serve to manage, control or influence the consumption or waste of water.
Drought	A prolonged period of abnormally low rainfall leading to a potential shortage of water for the environment, agriculture or public water supplies.
Habitats Regulations	The Conservation of Habitats and Species Regulations 2010. The domestic legislation which transposes the EU Habitats and Wild Birds Directives into UK law and replaces the Conservation (natural habitats &c) Regulations 1994.
Level of service	The standard of service that water company customers can expect to receive from their water company, commonly setting out the frequency of restrictions that a company expects to apply to its customers.
Miser	A modelling software package that forecasts the optimal way for a water supply system to meet demand subject to specified constraints such as abstraction licence limits.
Ml/d	Mega (millions) litres per day
Ofwat	The economic regulator of the water and sewerage industry in England and Wales
Optional metering	Installation of a water meter and subsequent charging by metered volume arising from the customer‘s request.
River Basin Management Plans	Plans for protecting and improving the water environment developed by the Environment Agency for river basin districts across England and Wales under the Water Framework Directive.
SAC	Special Area of Conservation - Designated under the European Habitats Directive (1991).
SPA	Special Protection Area - Classified under the European Birds Directive (1979).
SSSI	Site of Special Scientific Interest - A site given a statutory designation by English Nature or the Countryside Council for Wales because it is particularly important, on account of its nature conservation value.

Stand-alone source	A source supplying an area with water which cannot be supplied by any other source.
Strategic Environmental Assessment (SEA)	The Strategic Environmental Assessment Directive ensures significant environmental effects arising from proposed plans and programmes are identified, assessed, subjected to public participation, taken into account by decision-makers and monitored.
Stream support	Where groundwater is pumped into rivers to maintain minimum prescribed flows in accordance with abstraction licences.
UKWIR	UK Water Industry Research – organisation facilitating research for the UK Water Industry.
Water Framework Directive (WFD)	European legislation which promotes a new approach to water management through river basin planning.
Water UK	Organisation representing the UK Water Industry.

11.11 Supporting documents and references

11.11.1. Technical documents supporting this Plan

Cascade (March 2013). Draft Water Resources Management Plan 2013 Habitats Regulations Assessment Stage 1 – Screening. Our ref: DM 1534665

Cascade (March 2013). Draft Water Resources Management Plan 2013 SEA screening statement. Our ref: DM 1534070

Cascade (November 2013). Wessex Water current imports effects assessment. Our ref: DM 1588325

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Mott MacDonald (November 2013). Headroom uncertainty analysis. Our Ref: DM 1588324

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Wessex Water (March 2013). PR14 Metering policy options. Our ref: DM 1504485.

Wessex Water (March 2013). WRMP Options Report. Our ref: DM 1535482.

11.11.2. Other references

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English Housing Survey (2009-10) Annex Table 4.1: Trends in moving households by current tenure, 1995-96 to 2009-10.

English Housing Survey (2010-11) Chapter 1, Figure 1.1: Trends in tenure, 1981 to 2010-11.

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