Veolia Water Central

Water Resources Management Plan

March 2010

Main Report

Chairman's Foreword

Our purpose is to provide safe and wholesome drinking water in sufficient quantities to meet the needs of all our customers. We want to do this at a price that is affordable and which takes into account the effects of climate change and the need for sustainability. We want to uphold the trust not only of those who use or oversee our services, but also of the public at large.

The ways in which we will fulfil our obligations will change over the next 25 years and beyond. We will have to adapt to evolving circumstances in the environment. There will be demographic shifts; changes in markets, in regulation, in political thinking and, of course, in what our customers expect and what they are willing to pay for. These changes will shape how we will supply water from source to tap.

Resource management is at the heart of our business. There is currently sufficient clean, wholesome water available to us, but we have to wrestle with the competing pressures of economic growth, pollution risk, climate change and environmental protection. Our job is to find a way of balancing those pressures whilst ensuring that supplies of water to our customers remain secure and of the highest quality.

In April 2008 we published our Draft Water Resources Management Plan setting out our strategy for dealing with the challenges we face over the next 25 years. We have consulted with our customers and stakeholders. We asked you to consider the range of issues we presented in our Draft Water Resources Management Plan and to tell us your views on our proposals. We have now explained the consideration that we have given to the responses that we received in our Statement of Response to Representations Received. In September 2009 we were invited to submit our Statement of Response to DEFRA and are now pleased to be able to publish this document, our Final Water Resources Management Plan detailing the changes that we have made to the draft Plan. Our plan remains much as submitted to DEFRA. In the short term, as a result of the recent price review, we are constrained to defer our metering and leakage plans. But in the long term our plan remains;

- To make the best use of our resources through improving and enhancing their performance and to continue to reduce leakage;
- To meter systematically after 2014 to reduce installation costs and to minimise disruption to local communities to achieve about 90% meter penetration by 2030 to minimise environmental impacts;
- To offer water efficiency advice and water saving devices to our customers;
- To investigate new methods of charging for water in the future so as to encourage more efficient use of water.
- To maintain a comprehensive programme of studies, working with other water companies to ensure we can bring forward investment in new resources should the need arise.

This Plan is an important strategy document which outlines how we propose to provide reliable water services to you all.

Frederic Devos

Chairman

The Directors of the Company

Non-Executive Directors

Frederic Devos (Chairman)

David Alexander

Jean Claude Banon

Baroness Peta Buscombe

Olivier Grunburg

Philippe Guitard

Dr Neil Summerton CB

Fiona Woolf CBE

Executive Directors

R. Bienfait (Managing Director)

J A Bishop (Operations Director)

R Brimble (Customer Relations Director)

You can obtain a copy of our Final Water Resources Management Plan by:

- Looking on our website www.veoliawater.co.uk
- Writing to us at Veolia Water Central Limited, Tamblin Way, Hatfield, Hatfield, Hertfordshire AL10 9EZ or
- Contacting us on 01707 268111

OVERVIEW OF OUR WATER RESOURCES MANAGEMENT PLAN

Our Water Resources Management Plan identifies the actions that we need to take to ensure that we can supply our customers with the water they need over the next 25 years. We consider a wide range of factors such as climate change, changes in lifestyle, the condition of our rivers and groundwater, pressures of housing and population changes, and our customers' expectations of us in terms of the standard of the services we provide. Our Plan is prepared in accordance with the relevant Regulations[1] and guidance from the Environment Agency[2].

Over the last ten years we have been investing to increase our usable resources, reduce leakage, improve the reliability of our equipment, and increase our ability to move water around to be able to meet demand. We have also installed meters when properties change hands and encouraged voluntary metering. We have sought to enable customers to be better informed about their consumption to allow them to reduce the amount they use.

The severe drought in 2006 enabled us to look closely at the performance of our system so that we can base our plans on a more thorough understanding of our supply infrastructure and what it can achieve. The drought also emphasised the need to continue to reduce leakage. In 2008 we are better prepared than ever to meet the challenges of an area of serious water stress.

In preparing our plan for the next 25 years we considered factors likely to influence the amount of water available, such as climate change and pollution. We compare these with demand forecasts that take account of our statutory duty to supply the predicted 25% increase in the number of dwellings in our area, and an associated 13% increase in population. We have allowed for a reduction in water availability of around 2% by 2030 as a result of climate change. Any reduction in the amount of water that we may be permitted to withdraw from rivers and aquifers has been omitted as the Environment Agency's guidance does not allow for this. However, other planning documents, for example, the Secretary of State's own *Future Water*, suggests that we can expect such reductions over the period.

Our forecasts of demand take account of our proposal to increase the proportion of households with water meters to 90% by 2030. This will be achieved by continuing our current compulsory 'change of ownership' metering programme after 2014 and we will explore 'smart' technologies to deliver enhanced metering services for our customers for future price reviews. We will also provide better water efficiency advice, such as improved bills with clearer information on consumption so that both domestic and commercial consumers can modify their usage. We predict that per capita consumption will continue to fall until 2030, when it is then likely to increase again.

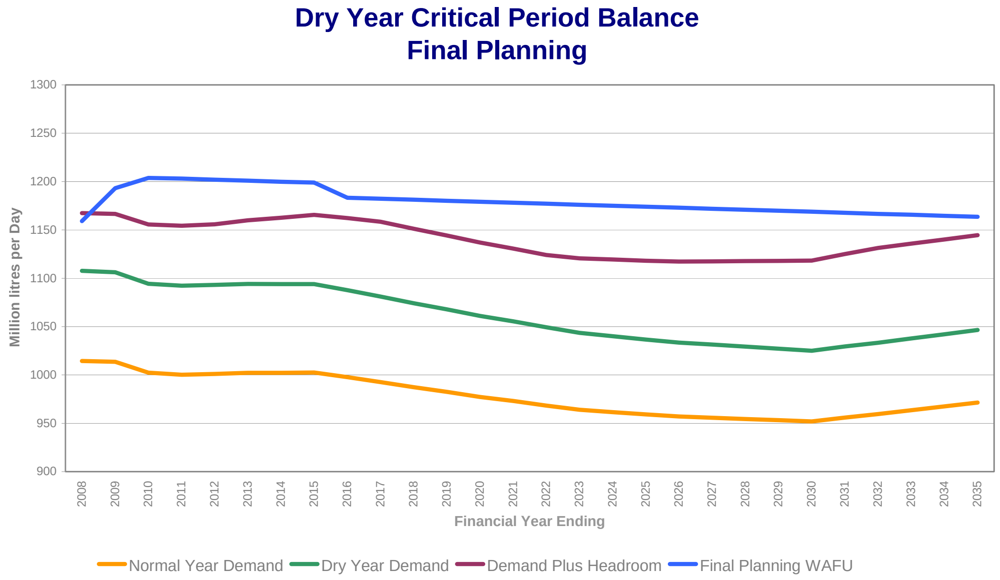
We include safety margins in our plans to take account of the risks and uncertainties in our planning, for example, those caused by pollution or plant failure.

---

[1] The Water Resources Management Plan Regulations 2007 http://www.opsi.gov.uk/si/si2007/pdf/uksi_20070727_en.pdf
[2] Environment Agency Water Resource Planning Guideline, http://www.environment-agency.gov.uk/subjects/waterres/981441/408371/?version=1&lang=_e

We have been working with some of our customers to help us shape our plan. That work indicates support for actions to improve water efficiency, reduce greenhouse gas emissions and reduce non-essential use of water. Our consultation to date suggests that customers are content that we should continue to plan on the basis of hosepipe bans on average every 10 years. Our consultation also indicated that we should lead by example on leakage. We have accepted this and have revised our plan to include for 20Ml/d of leakage reductions over the next 20 years.

Our work shows that, if expected reductions in water use as a result of metering are sustained in the longer term coupled with further leakage reductions, we will not need to develop any new water resources until after 2035. Having a proactive 'water neutral' strategy means we will be able to defer the need for investment in new resources until that time. But it takes a long time to plan, get consent for, and build major new sources of water so we need to continue to explore options for resource development. We will continue working with other water companies in the South East with a view to building a new regional reservoir to store winter rainfall.



Managing demand is good for sustainability and avoids the need for any additional impact on the water environment or greenhouse gases as we will not have to use more energy to pump water. However, uncertainty over whether demand reductions resulting from metering and behaviour changes will be permanent remains and we expect to work with Ofwat to ensure we can reflect this balance of risk.

Between 2010 and 2015 we intend to carry out trials of new methods of charging for water, such as a higher charge for using water during the summer months when it is scarcer. Understanding the best way of charging for water is another way we can prepare to meet unexpected challenges in the future.

Whilst we can reduce leakage both from our own and our customers' pipes and encourage economy through metering and tariffs, customers are free to use as much as they can afford. It remains possible that demand may rise more quickly than we predict. Because of this uncertainty, we propose to continue exploring future resource development options over the next 5 years and to work with other companies in the region to ensure we make best use of our natural resources. In this way our plans will remain flexible and we will be prepared to bring forward investment if we see demand rising.

We operate in an area of severe water stress. Our draft plan was to continue with our change of occupier compulsory metering programme. Ofwat disagreed with this and as a result we are deferring our compulsory metering programme by 5 years. After 2014 we will resume metering of households on a geographical basis, either in conjunction with our programme of mains renewal to minimise overall disruption, or prioritised by degree of local water stress. Metering in this way means we can reduce the cost of installing meters. Our strategy means we aim to complete around 90% of meter installations by 2030. The remaining 10% of properties would, so far as economically possible, be metered in the longer term.

We have followed advice from the Environment Agency that we should not plan for changes in our licences to abstract water from the environment other than when directed. We are concerned that this approach neglects the possibility that changes in licences may be required to redress local environmental problems. This possibility is indicated in the Environment Agency's own Catchment Abstraction Management Strategies[3] and in turn River Basin Management Plans to meet targets set under the Water Framework Directive.[4] The potential impact of meeting these challenges is substantial, would be very difficult to achieve and would cause a significant increase in water charges. We will continue to work with the Environment Agency to ensure this risk is properly managed.

CONCLUSION

The key aims of our strategy are:

- **Utilisation :** To make best use of our existing resources through improving and enhancing their performance and by protecting them from pollution as well as continuing to reduce leakage.
- **Metering :** To meter systematically after 2014 to reduce installation costs either when homes have a change of ownership or where water stress is highest or in conjunction with our mains renewal programme, so as to minimise disruption to customers and local communities.
- **Leakage :** After 2014 to continue to reduce leakage by a total of 20 Ml/d over the period to 2030.
- **Water Efficiency :** To offer water efficiency advice and water-saving services to our customers.
- **Energy and Sustainability :** To meter to achieve about 90% meter penetration by 2030 to minimise environmental impacts and greenhouse gas emissions.

[3] Catchment Abstraction Management Strategies are published by the Environment Agency and consider the pressures on water bodies in the local water environment. They form the building blocks for the assessment of the Programme of Measures that will be required to meet targets to be set for River Basin Management Plans as required by the Water Framework Directive.
[4] Water Framework Directive came into force on 22 December 2000 and was transposed into UK law in 2003. It relates to EC legislation designed to improve and integrate the way water bodies are managed throughout Europe

- **Tariffs :** Investigate new methods of charging for the future to encourage more efficient use of water, particularly at times of greatest stress.
- **Resource Development :** To maintain a comprehensive programme of studies - working with other water companies - to ensure we can bring forward investment in new resources, should metering and other measures not reduce overall demand sufficiently, should the effects of climate change be more rapid than expected, or to be able to respond to reductions in our resources.

By delivering these aims we will ensure enough good quality water to meet the needs of our customers until 2035 and beyond.

CONTENTS

ABBREVIATIONS USED IN THIS DOCUMENT

ADPW	Average day demand peak week
AISC	Average incremental social cost
ALC	Active Leakage Control
ALF	Alleviation of low flows
AMR	Automated Meter Reading
CAMS	Catchment Abstraction Management Strategies
CAPEX	Capital expenditure
CLG	Communities and Local Government Department
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of Environment, Transport and the Regions; (now Defra)
DoE	Department of the Environment; (now Defra)
DMP	Drought Management Plan
DMG	Drought Management Group
DO	Deployable Output
DP/O	Drought Permit/Order
DWRMP	Draft Water Resources Management Plan 2008
EA	Environment Agency
EIA	Environmental Impact Assessment
ELL	Economic Level of Leakage
ES	Environmental Statement
LPA	Local Planning Authority
LTA	Long Term Average
GCM	Global circulation models
GCCM	Global climate change models
GVA	Gross Value Added
JR07	June Return 2007, annual report to Ofwat
Ml/d	Megalitres per day; Megalitres = one million litres (1000 cubic metres)
MLE	Maximum Likelihood Estimation
MOC	Marginal Operating Cost
NEP	National Environment Programme
OASIS	Operational Assessment of Summer Impacts and Stress
ODPM	Office of the Deputy Prime Minister (now replaced by CLG Dept.)
Ofwat	The Water Services Regulation Authority
ONS	Office for National Statistics
OPEX	Operating expenditure
PCC	Per capita consumption - consumption per head of population
SEA	Strategic Environmental Assessment
SEMD	Security and Emergency Measures Direction
SMD	Soil moisture deficit
SRO	Source Reliable Output
SSSI	Site of Special Scientific Interest
TVW	Three Valleys Water
TW	Thames Water
UKCIP	UK Climate Impacts Programme
UKWIR	United Kingdom Water Industry Research Limited
VWC	**Veolia Water Central**
WAFU	Water available for use
WIA	Water Industry Act 1991
WRP	Water Resources Plan 2004
WRMP	Water Resources Management Plan 2008
WTW	Water Treatment Works
Water UK	Water UK (formerly known as the Water Services Association)

A glossary of terms is included in section 10.7.

PUBLIC NOTICE

Codes have been used in this document for

specific locations for security purposes

1 GENERAL INFORMATION

1.1 Regulations and Guidance for Water Resources Management Plans

We produced our last Water Resources Management Plan (WRMP) in 2004. The Water Resources Management Plan Regulations 2007[5] implementing the powers given in the Water Act 2003 set a statutory framework for the preparation of future plans and require statutory consultation on them that includes consultation with our customers and stakeholders.

Our Plan demonstrates how we propose to meet our customers' needs for water in the period 2010 to 2035. The plan has been prepared in accordance with guidelines issued by the Environment Agency (EA) and has been approved by the Secretary of State. We have added information required by DEFRA and the EA following our draft and revised plans and have included how our plan has been amended to reflect the recent determination of price limits by Ofwat. This determination has resulted in a need to defer our metering proposals and leakage reduction activity until after 2014. Our supply demand balance is insensitive to these changes.

Our Plan is consistent with our Strategic Direction Statement[6] and our Drought Management Plan and all documents are available on our website.[7] Water Resources Management Plans must also comply with the requirements of the Environmental Assessment of Plans Regulations 2004 which implement the requirements of the European Union's Strategic Environmental Assessment Directive[8]. A separate report is published on our website for this purpose.

Our final WRMP consists of five parts :-

Part 1	Main Report for the Veolia Water Central Revised Water Resources Management Plan *(this document)*
Part 2	Tables
Part 3	Supporting Data (Technical Reports)
Part 4	Environmental Report

This document is the Main Report but it also makes reference to the Tables and Supporting Data that are included in a separate volume. In addition we have published an environmental report to accompany the plan. Copies of all documents are available from our website or by request.

1.2 Objectives of our plan

It is our statutory duty to provide safe and wholesome drinking water in sufficient quantities to meet the needs of our customers. At present we have enough good

[5] The Water Resources Management Plan Regulations 2007 http://www.opsi.gov.uk/si/si2007/pdf/uksi_20070727_en.pdf
[6] Our Strategic Direction Statement was published in December 2007 and represents our vision of the future in the water industry and the service we will provide our customers
[7] Veolia Water Central - Our website address is http://www.veoliawater.co.uk/
[8] The environmental Assessment of Plans Regulations, http://www.opsi.gov.uk/si/si2004/uksi_20041633_en.pdf

quality water to achieve this. But, in the longer run, there is a real risk that rising demand and limitations on water availability will put at risk our ability to carry out our duty. We intend to meet this risk by managing demand and taking timely steps to reduce leakage to maintain the amount of water available to meet that managed level of demand.

The Plan has a number of objectives:-

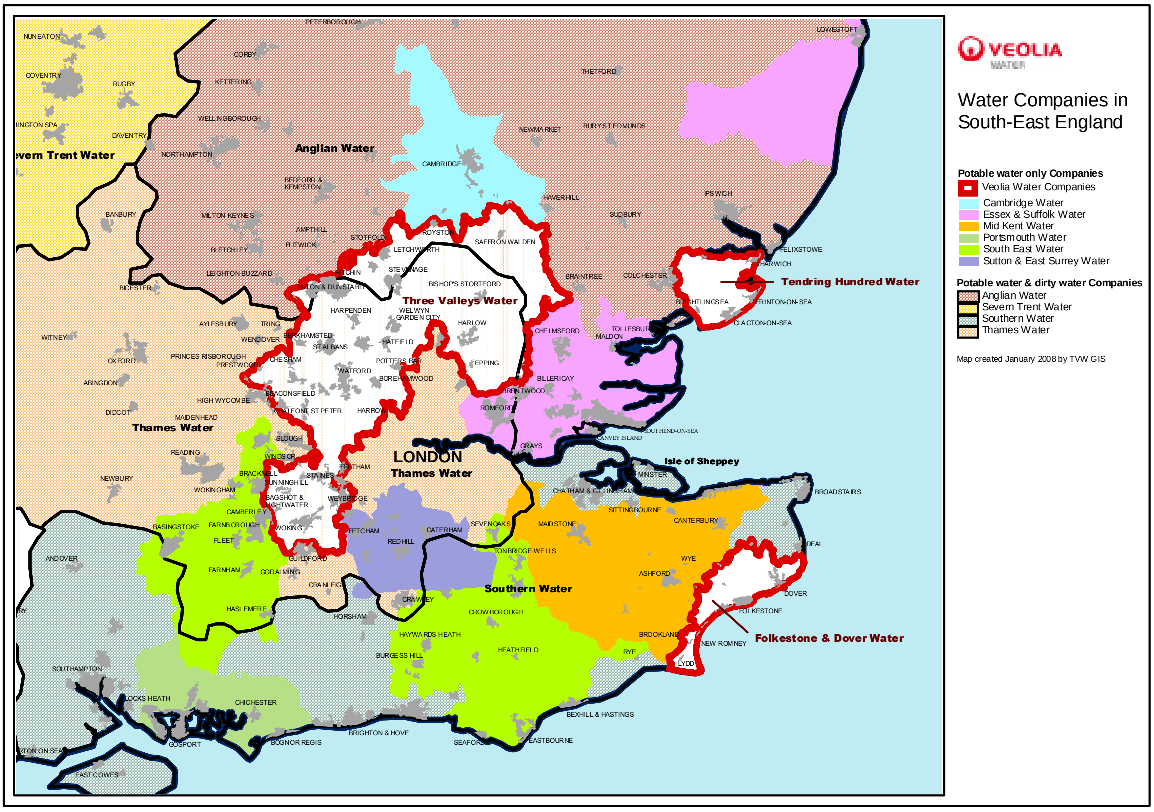
- To improve operational capability of our assets and operate them efficiently to maximise water output and minimise our carbon footprint and operational costs
- To support sustainable development by balancing water stress and the need to sustain economic growth
- In recognition that our area is one of 'serious water stress', after 2014 to install meters on a systematic and compulsory 'change of occupier' basis so as to achieve around 90% penetration by 2030
- To implement a water efficiency programme to underpin demand reductions through metering and new homes standards.
- To reduce leakage in a timely way to maintain the supply demand balance.
- To demonstrate how our strategy takes account of the overall strategy for water resources in the South East
- To meet the water needs resulting from population, housing and economic growth as envisaged in the regional plans and estimates of government institutions
- Take account of customers' views and preferences as expressed in 'willingness to pay' surveys; and of 'cost-benefit analysis' studies relating to security of supply (including judgements about the levels of risk which are appropriate) and levels of service (including judgements about public tolerance of restrictions of supply, for example, by means of hosepipe bans)
- To review a full range of 'twin track' supply and demand management options so that an optimum combination of schemes can be implemented to maintain supply throughout the planning period
- To assess threats to the resource base from pollution, climate change and the implementation of the Water Framework Directive (WFD);
- To improve customer information in order to sustain demand reductions in the longer term
- To illuminate how far further significant resource developments and demand management could be necessary to offset reductions in permitted abstractions after 2015 to meet the environmental requirements of the Water Framework Directive

1.3 Background Information

1.3.1 Veolia Water Central: Our operating area

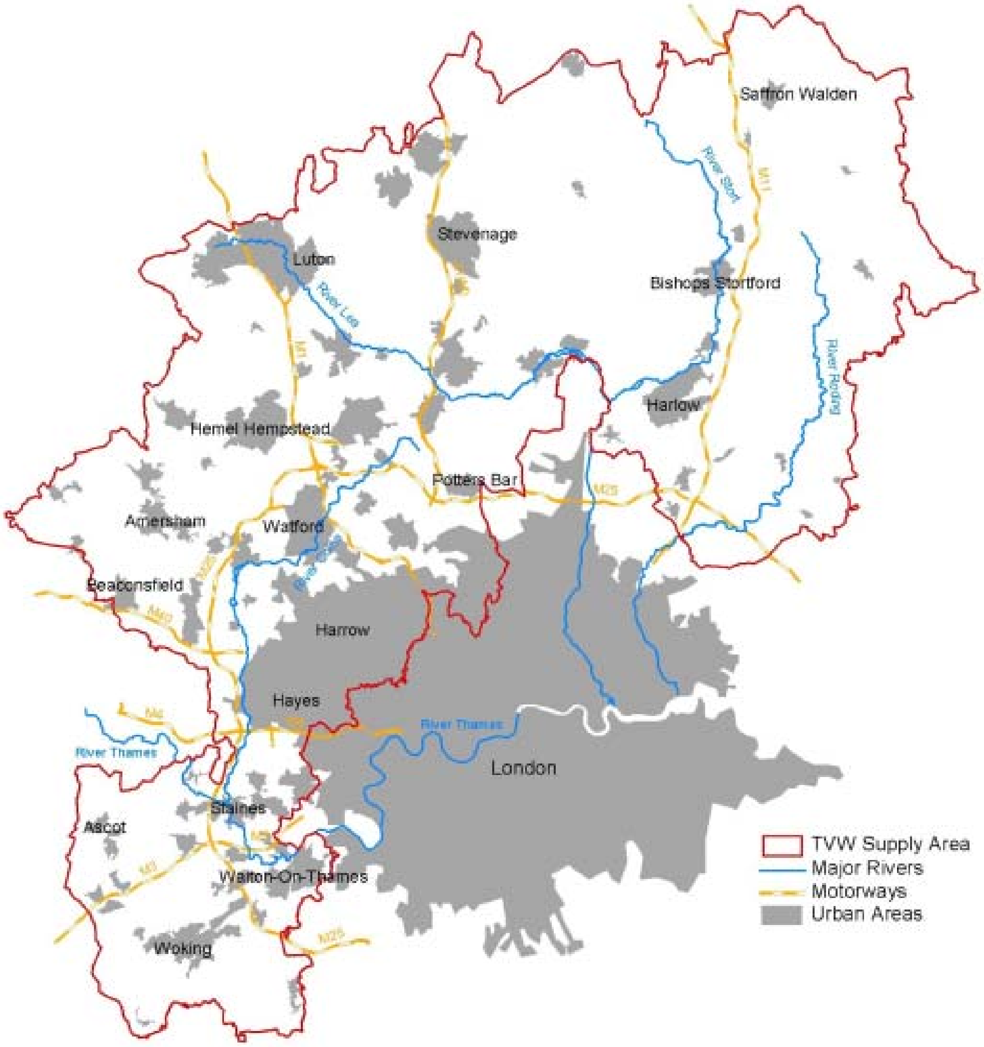
We operate in the South East of England (see Figure 1.3.1), a very dry region of the UK, with only half the average UK rainfall, supplying 1.1 million households and a number of commercial businesses.

Figure 1.3.1: Veolia Water Central (formerly Three Valleys Water) within the South East of England



We provide public water supplies to a population of 3.2 million in the Home Counties to the North and West of London. The area includes a number of North London Boroughs and extends into urban and rural parts of Essex, Hertfordshire, Bedfordshire, Surrey and Buckinghamshire. A map of our operating area is shown below

Figure 1 : Outline map of the Veolia Water Central (formerly TVW) operating area



Key statistics for Veolia Water Central

- Over 3 million population served
- Over 30% of customers pay by water meter
- Daily demand for water per person is 8% above the national average

Assets

- 60% of our water is abstracted from groundwater sources
- 40% of our water is abstracted from river sources
- 82% of water put into supply requires complex treatment
- 14,000km of water mains
- 87 water treatment works
- 260 boreholes, 130 service reservoirs, 63 water towers, 187 pumping stations

Some 60% of our water is from groundwater. We have 260 boreholes spread across North London and the Home Counties. Groundwater is contained in the underlying porous rock, predominantly chalk. Around 40% of our water is from rivers, notably the River Thames. Our abstractions from the Thames are limited only by total volume, but a number of our abstractions from groundwater have environmental constraints on them to prevent local damage during droughts.

The underground aquifer is rich in water resources from rainwater that falls on the Chiltern Hills and is stored within the fissures and pore matrix of the chalk. However, the very porosity that makes chalk a valuable aquifer makes it vulnerable to pollution. We do what we can to protect these resources from pollution by third parties. When we cannot do so, we are obliged to install costly and complex treatment to deal with the problems.

The chalk aquifer also supports river flows throughout the Chilterns, which are a unique habitat of international importance. Chalk streams are naturally low in summers following low winter rainfall and have a tendency to dry up altogether in dry summers. These low flows can be worsened by our abstraction and this is particularly noticeable at times of severe drought. We will continue to operate our sources in a responsible way to minimise these effects and their environmental consequences.

Making best use of our water resources also means ensuring that we can move water around our operating area to the places where it is needed. Our demographic planning indicates that population growth will be most likely in those parts of our area where water is scarcest. We therefore have to be able to move large quantities of water from one part of the area to another. Over the past two decades we have built a water grid in our area of supply. This means we can optimise the energy and cost of transferring water from areas of surplus to where it is needed.

1.4 Supply/Demand Balance

In simple terms the underlying requirement of the Water Resources Management Plan may be expressed as a balance such that supply should be greater or equal to demand, or more explicitly:

Deployable output + safety margin to offset asset unavailability (outage)	**≥**	**consumption + system use + safety margin for uncertainty and risk (headroom)**

If supply falls below demand to the planning horizon of 2035, then the Plan will identify the combinations of investments that will be required to restore the balance. The base year of our Plan is 2006/7.This assumes 'business as usual', that is that investment programmes and expenditure patterns from the Periodic Review[9] in 2004 (PR04) will continue unchanged into the new Plan. The new Plan is based on the previous plan but with all aspects reviewed and amended to address identified future challenges.

[9] Periodic Review. This is the term used to describe our Business Plan that is considered by Ofwat every five years.

Although our Plan has a planning horizon of 25 years we have looked beyond that in order to assess the impacts of climate change, (to 2050 and 2080), and in the context of infrastructure development for sustainable communities that will have an asset life of 100 years or more.

To build our Plan a number of studies have been carried out including forecasts of the amount of water available to meet the demand of our customers. These are combined to assess any actions needed to maintain security of supply. The study elements are shown below in Figure 1.4 and listed in Table 1.4. Copies of the technical reports are included on our website.

Figure 1.4 : Schematic representation of dWRMP Studies

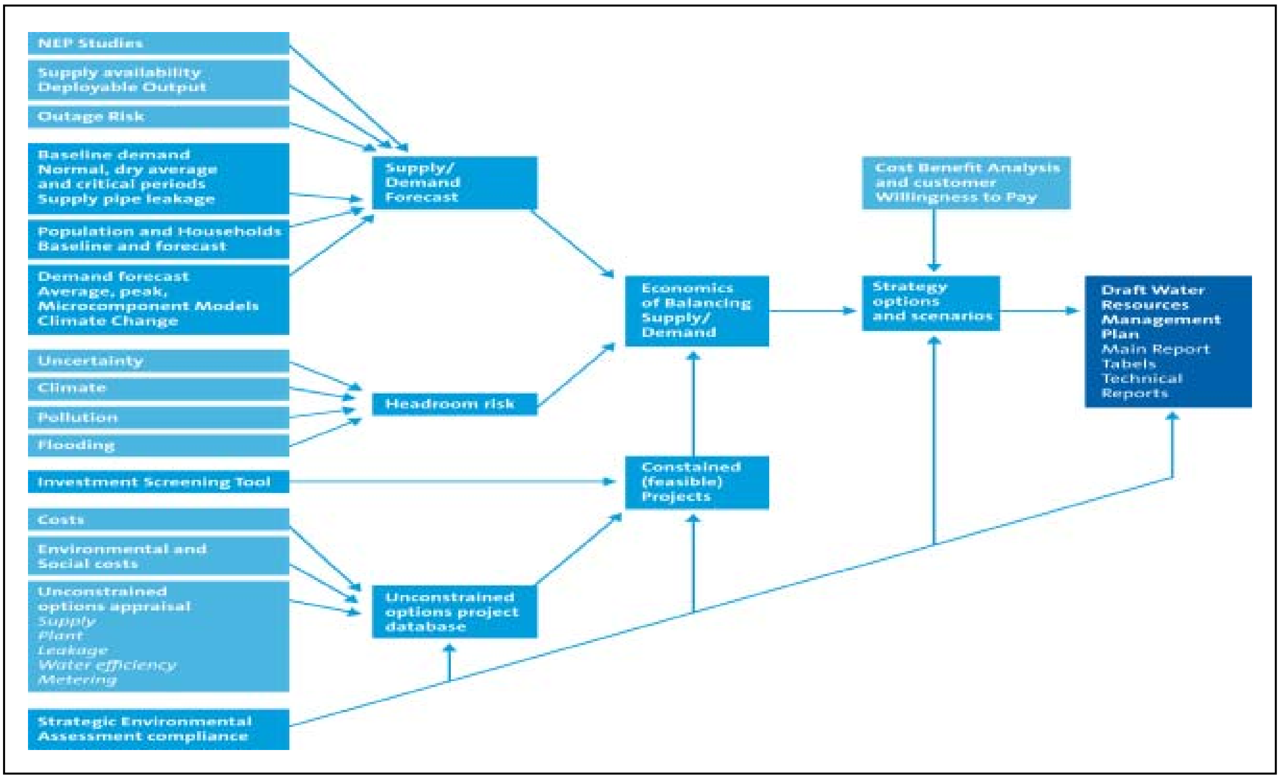


Table 1.4 : Schedule of Supporting Technical Reports

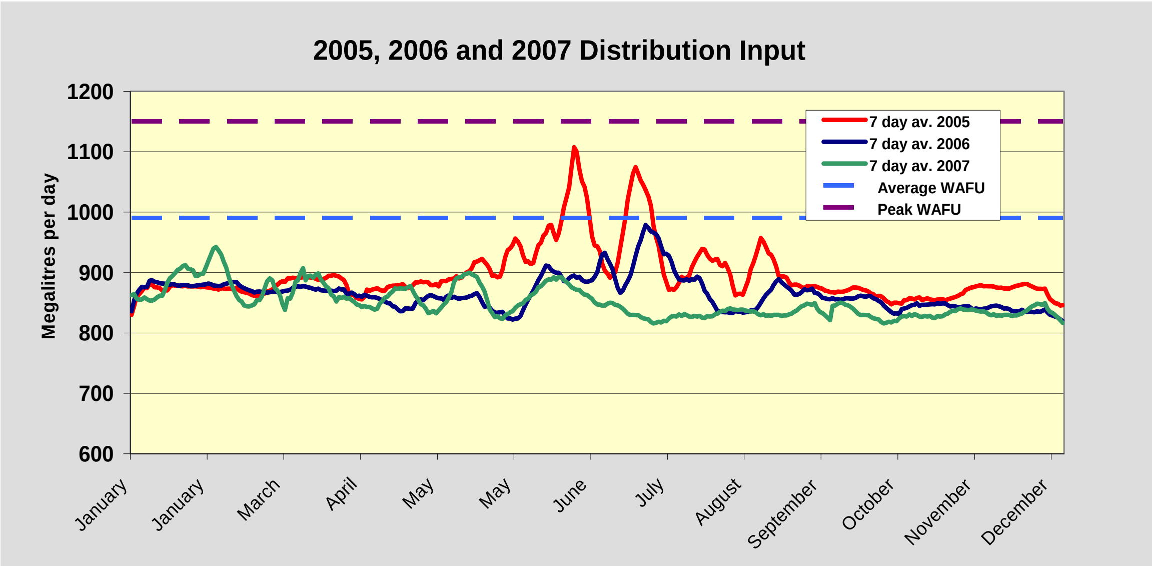
Final Water Resources Management Plan Technical Reports
Climate Change
Commercial Demand Forecast
Deployable Output (Summary Report)
Deployable Output Surface Water Works
Headroom
Housing Forecast
Metered Occupancy
Micro-Component Base Year and Forecast
Minor Components
Options Appraisal (including Optioneering Model)
Population Forecast
TVW Outage Assessment
Economics of Metering

1.5 Water Resources and Water Available for Use

Around 60% of our water is abstracted from groundwater wells and boreholes, with the remaining 40% abstracted from surface water. In dry years the yield of these sources can reduce.

Normal year demand of our customers is approximately 880 Ml/d average but this can increase to around 900 Ml/d in a dry year with a 7 day peak of over 1100 Ml/d. This compares with Water Available for Use (WAFU) of 990 Ml/d and 1150 Ml/d respectively in a drought year as assessed for our Plan. This relationship is shown in the Figure 1.5.

Figure 1.5 : 2005 to 2007 Distribution Input Compared with Water Available for Use



1.5.1 Groundwater

We have over 260 operational boreholes at 110 locations distributed across the company's area and in particular the unconfined Chalk aquifer that comprises the Chiltern Hills. The boreholes range in depth and groundwater levels vary seasonally dependant on rainfall patterns. Experience of previous droughts has shown that lowest groundwater conditions are seen only after severe multiple year drought conditions with a minimum of two dry winter seasons. Water available for use is assessed under drought conditions for our Plan.

Our current source yield assessment methodology is based on the approaches outlined by UKWIR in 1995, with subsequent modifications. This methodology is focused on determining deployable outputs for ground water sources under drought conditions only.

Following the process of adjustment of the current year (2007/08) deployable outputs, the results were compared with those projected for the base year in the previous Water Resources Plan 2004 (WRP). It was found that there had been several changes to deployable output with the overall company level being increased under both average and peak demand conditions.

1.5.2 Surface Water

Surface water used by the company for potable supply is abstracted from the River Thames and treated at four river water treatment works. These sources have permanent abstraction licences with no flow constraints under drought conditions and therefore when combined are capable of providing sufficient quantities of raw water following prolonged dry spells, such as the dry period encountered during the long hot summer of 1995. The deployable output of the surface water treatment works is constrained marginally by licence volumes at average conditions and by treatment capacity during the critical period.

Maintaining minimum flows in the River Thames is the responsibility of Thames Water. Thames Water's abstraction licences for the River Thames are linked to a control curve that links minimum flows over Teddington Lock with drought measures such as restrictions on supply. These conditions are as a result of Thames' historical responsibilities for management of the river catchment prior to the creation of the EA These were made possible through the construction of major storage reservoirs that were built for river management on behalf of the regional community including other water companies. The reservoir storage and responsibility for maintaining minimum flows was vested in Thames Water when the industry was privatised and continues to this day.

We have secured the use of some bank side storage as protection against short term pollution of the River Thames. Water stored can be used as an emergency source for blending with river water when polluted such as at times of high nitrate concentrations in the river. The lakes can provide a substantial volume for relatively short periods by drawing down the levels but have no significant impact on drought deployable output either at average or during critical period.

Bank-side storage at CHERS is utilised continuously. The gravel wells are operated constantly at their maximum yield, supplemented by stored raw water from the bank side reservoir. Bank side storage at WALS is utilised continuously as a balancing reservoir and is maintained by flow in the main river. Storage at WALS is modest, and is supplemented by local emergency groundwater source from the gravel. As these water bodies are integral to the function of the sites they are taken into account when assessing deployable output.

At our HWFS water treatment works (WTW) we have the option to utilise a supply from Thames Water's QMOT Reservoir under emergency conditions such as pollution of the River Thames and this is used for blending or support of water abstracted from the river at SUNN.

A link main exists between EGHS, CHERS & WALS WTW to enable water to be moved between these sources. In addition a second link main between EGHS and HWFS WTW enables further operational flexibility of the system under periods of stress. This has provided additional transfer capacity since 2004 to improve the security of supply in each water resource zone.

In light of the robust nature of the surface water resources available to us and the responsibilities of Thames Water to maintain minimum flows in the River Thames at Teddington we do not link our drought actions to surface water conditions.

1.5.3 Imports and exports

Bulk imports of treated water are available from Thames Water (TW), Anglian Water (AW) and Cambridge Water (CW). We also provide a bulk export of treated water to South East Water (SEW) from EGHS Treatment Works.

We participate in a shared supply from Anglian Water Services (AWS) at ANGL, with 91 Ml/d available at average and 109 Ml/d at peak. The supply from ANGL is not affected by drought conditions, pursuant to the Great Ouse Water Act of 1961, the Great Ouse Water Order of 1971 and following judicial review in January 2001.

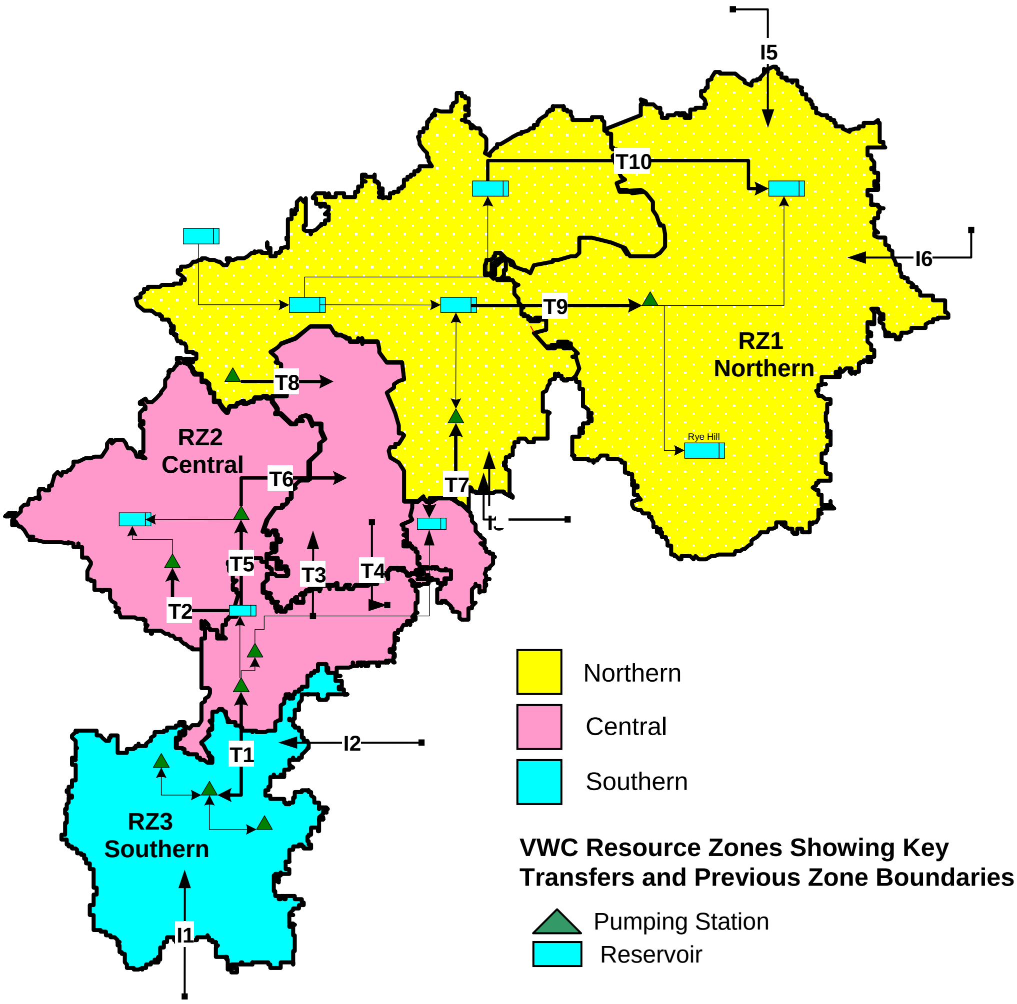
We have a number of cross-border bulk supplies that are used in normal circumstances but the specific contractual conditions for each means that not all installed capacity is guaranteed under drought conditions. The volumes available from Thames Water during a drought are as follows; 10Ml/d from FORT and 2.3Ml/d from LADY.

There are no specific contractual arrangements in place for additional water supplies, beyond those stated, to be supplied between companies during a drought, however companies would be expected to provide mutual assistance to the extent that they were able in drought conditions.

1.5.4 Strategic Mains Network

A schematic diagram of our strategic mains network is shown in Figure 1.5.4.

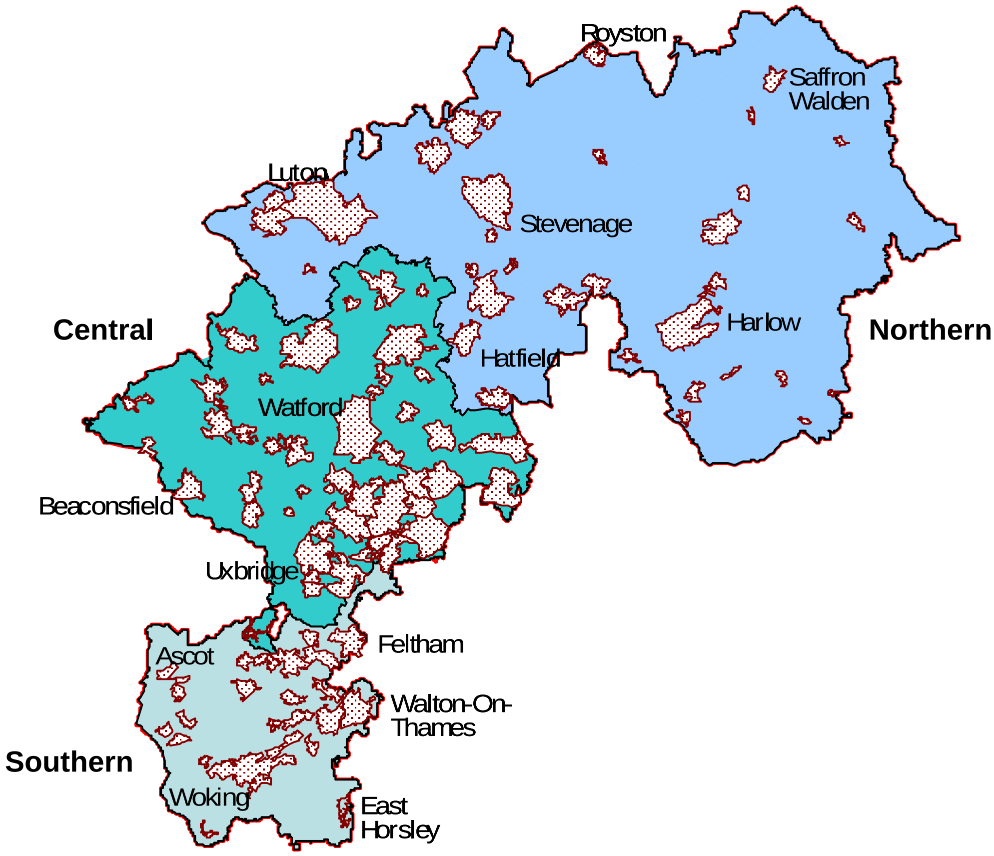
Figure 1.5.4 : Schematic of Operating Area of Veolia Water Central Company



1.6 Resource zones

A resource zone is the largest possible zone in which all resources, including external transfers can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall. Whilst our supply network is highly integrated there remain some constraints to water transfers. Our assessment indicates that risk of supply failure divides the company into three resource zones. The diagram below shows our resource zones and major towns. These zones remain unchanged from the previous Water Resources Plan.

Figure 1.6 : Water Resource Zones



1.7 Planning scenarios

Our Water Resource Plan uses a dry year planning scenario and a dry year critical period scenario. The normal year annual average scenario for this Plan has been based on the 2005-06 year. This year was characterised as normal in our 2006 June Return to Ofwat and provides the most recent climatically normal year upon which the Plan can be based. In the 2006-07 year there was a hosepipe ban across our company and much of the south east. This, and the high level of publicity surrounding water resources in the South East produced significant reductions in demand for water. This makes the 2006-07 year unsuitable as a base year for the Water Resources Plan. Demand reductions were maintained in the 2007-08 partly as a result of the very wet nature of the year. We have therefore maintained 2005-06 as a base year.

The dry average and critical period[10] scenarios have been based on an analysis of the years 2002 to 2007 including the dry year of 2003 which exhibited the highest peak week consumption we have experienced. Peak, dry peak and dry year average factors have been derived for each zone by comparing the annual average and peak week demands for normal and dry years from this set. Separate factors have then been developed for the four categories of customer, measured and unmeasured domestic and measured and unmeasured commercial. Assumptions were made for commercial customers. Measured domestic customers are assessed to have a peak factor that is 15% lower than for unmeasured. Each zone has then been calibrated to the overall peak for the zone by adjusting the unmeasured domestic peak factor. This approach allows for the variations in future meter penetration to be linked directly into the demand forecast. More detailed numbers for peak and dry year factors and methodology can be found in chapter 3: Water Demand.

Our supply demand balance considers both the annual average and critical period scenarios as both have an impact on the future investment programme. The critical period is the dry year peak week unconstrained demand.

1.8 Reconciliation of data

A water balance for each zone derives the base year (2005-06) components of demand. This is illustrated in Table 1.9a. We develop a component by component estimate of demand (Table 1.9b) and sum these “bottom up” estimates. These are compared with the “top down” estimate of the amount of water put into supply (distribution input). There is an inevitable discrepancy between the top down and bottom up estimates. The imbalance that occurs is then reallocated amongst the components of demand and distribution input in proportion to the perceived uncertainty in the estimates. This maximum likelihood estimation process is consistent with the methodology recommended in the UKWIR/NRA report *Demand Forecasting Methodology Main Report (NRA/UKWIR 1995)*. The uncertainties are shown in Table 1.9c.

[10] Critical period – This is assessed in the case of Veolia Water Central as average day peak week.

Table 1.9 a, b and c : Components of the base year water balance.

Northern		2005-06 Pre MLE	2005-06 Post MLE
Water Delivered - Volumes			
Billed measured household	Ml/d	41.30	41.40
Billed measured non-household	Ml/d	46.31	46.41
Billed measured	Ml/d	87.61	87.81
Billed unmeasured household	Ml/d	131.18	132.56
Billed unmeasured non-household	Ml/d	2.77	2.84
Billed unmeasured	Ml/d	133.94	135.40
Water Delivered - Components			
Estimated water delivered per unmeasured non-household	l/pr/d	1,099.41	1,128.87
Per capita consumption (unmeasured household-excluding supply pipe leak)	l/h/d	176.00	177.96
Per capita consumption (measured household - excluding supply pipe leak)	l/h/d	148.56	148.89
Underground supply pipe leakage (unmeasured households)	l/pr/d	50.00	50.28
Underground supply pipe leakage (excluding metered households)	l/pr/d	20.00	20.11
Underground supply pipe leakage (other metered households)	l/pr/d	50.00	50.28
Underground supply pipe leakage (void properties)	l/pr/d	50.00	50.28
Meter under-registration (measured households)	Ml/d	1.24	1.25
Meter under-registration (measured non-households)	Ml/d	2.42	2.42
Distribution system operational use	Ml/d	0.40	0.41
Water taken legally unbilled	Ml/d	2.28	2.34
Water taken illegally unbilled	Ml/d	0.08	0.08
Water taken unbilled	Ml/d	2.36	2.43
Water delivered (potable)	Ml/d	223.91	225.64
Water delivered (non-potable)	Ml/d		
Water delivered (non-standard rates: potable)	Ml/d		
Water delivered (non-standard rates: non-potable)	Ml/d		
Distribution losses	Ml/d	38.51	39.30
Total leakage	Ml/d	54.66	55.53
Distribution input	Ml/d	262.82	265.35

Central		2005-06 Pre MLE	2005-06 Post MLE
Water Delivered - Volumes			
Billed measured household	Ml/d	56.01	55.82
Billed measured non-household	Ml/d	89.24	88.96
Billed measured	Ml/d	145.25	144.77
Billed unmeasured household	Ml/d	239.03	235.45
Billed unmeasured non-household	Ml/d	7.52	7.24
Billed unmeasured	Ml/d	246.55	242.68
Water Delivered - Components			
Estimated water delivered per unmeasured non-household	l/pr/d	1,110.17	1,068.00
Per capita consumption (unmeasured household-excluding supply pipe leak)	l/h/d	172.25	169.54
Per capita consumption (measured household - excluding supply pipe leak)	l/h/d	159.81	159.31
Underground supply pipe leakage (unmeasured households)	l/pr/d	50.00	49.61
Underground supply pipe leakage (excluding metered households)	l/pr/d	20.00	19.84
Underground supply pipe leakage (other metered households)	l/pr/d	50.00	49.61
Underground supply pipe leakage (void properties)	l/pr/d	50.00	49.61
Meter under-registration (measured households)	Ml/d	1.69	1.68
Meter under-registration (measured non-households)	Ml/d	4.66	4.64
Distribution system operational use	Ml/d	0.67	0.64
Water taken legally unbilled	Ml/d	3.78	3.63
Water taken illegally unbilled	Ml/d	0.13	0.12
Water taken unbilled	Ml/d	3.91	3.76
Water delivered (potable)	Ml/d	395.71	391.21
Water delivered (non-potable)	Ml/d		
Water delivered (non-standard rates: potable)	Ml/d		
Water delivered (non-standard rates: non-potable)	Ml/d		
Distribution losses	Ml/d	82.19	93.88
Total leakage	Ml/d	109.97	121.45
Distribution input	Ml/d	478.57	485.74

Southern		2005-06 Pre MLE	2005-06 Post MLE
Water Delivered - Volumes			
Billed measured household	Ml/d	21.16	21.33
Billed measured non-household	Ml/d	31.54	31.77
Billed measured	Ml/d	52.70	53.10
Billed unmeasured household	Ml/d	67.63	69.97
Billed unmeasured non-household	Ml/d	1.00	1.09
Billed unmeasured	Ml/d	68.63	71.05

Water Delivered - Components			
Estimated water delivered per unmeasured non-household	l/pr/d	1,110.00	1,207.49
Per capita consumption (unmeasured household-excluding supply pipe leak)	l/h/d	172.60	178.89
Per capita consumption (measured household - excluding supply pipe leak)	l/h/d	155.19	156.32
Underground supply pipe leakage (unmeasured households)	l/pr/d	50.00	50.91
Underground supply pipe leakage (excluding metered households)	l/pr/d	20.00	20.36
Underground supply pipe leakage (other metered households)	l/pr/d	50.00	50.91
Underground supply pipe leakage (void properties)	l/pr/d	50.00	50.91
Meter under-registration (measured households)	Ml/d	0.64	0.64
Meter under-registration (measured non-households)	Ml/d	1.65	1.66
Distribution system operational use	Ml/d	0.20	0.22
Water taken legally unbilled	Ml/d	1.14	1.24
Water taken illegally unbilled	Ml/d	0.04	0.04
Water taken unbilled	Ml/d	1.18	1.29
Water delivered (potable)	Ml/d	122.51	125.44
Water delivered (non-potable)	Ml/d		
Water delivered (non-standard rates: potable)	Ml/d		
Water delivered (non-standard rates: non-potable)	Ml/d		
Distribution losses	Ml/d	17.42	15.07
Total leakage	Ml/d	25.64	23.44
Distribution input	Ml/d	140.13	140.73

Table 1.9d : Estimate basis for each water balance component

Component	Unit	Estimate Basis
Billed measured	Ml/d	Bottom Up
Billed unmeasured household	Ml/d	Reweighted
Billed unmeasured non-household	Ml/d	Company Level Estimate
Per capita consumption (unmeasured household-excluding supply pipe leak)	l/h/d	Reweighted
Per capita consumption (measured household - excluding supply pipe leak)	l/h/d	Bottom Up
Underground supply pipe leakage (unmeasured households)	l/pr/d	Company Level Estimate
Underground supply pipe leakage (excluding metered households)	l/pr/d	Company Level Estimate
Underground supply pipe leakage (other metered households)	l/pr/d	Company Level Estimate
Underground supply pipe leakage (void properties)	l/pr/d	Company Level Estimate
Meter under-registration (measured households)	Ml/d	Company Level Estimate
Meter under-registration (measured non-households)	Ml/d	Company Level Estimate
Distribution system operational use	Ml/d	Company Level Estimate
Water taken legally unbilled	Ml/d	Company Level Estimate
Water taken illegally unbilled	Ml/d	Company Level Estimate
Water taken unbilled	Ml/d	Company Level Estimate
Total leakage	Ml/d	Bottom Up
Distribution input	Ml/d	Bottom Up

Table 1.9e : Uncertainties applied to each component.

Component	Component Errors %ge
Billed measured	2%
Billed unmeasured household	10%
Billed unmeasured non-household	25%
Underground supply pipe leakage (unmeasured households)	5%
Underground supply pipe leakage (excluding metered households)	5%
Underground supply pipe leakage (other metered households)	5%
Underground supply pipe leakage (void properties)	5%
Distribution system operational use	25%
Water taken legally unbilled	25%
Water taken illegally unbilled	25%
Water taken unbilled	25%
Distribution Losses	5%
Distribution input	2%

1.8.1 Adjustments to the Base Year Water Balance

Leakage Calculation

We have had a consistent basis of calculating the pre-Maximum Likelihood Estimation leakage figure from district meter night flows for a number of years since before the start of AMP3 (year 2000). When Three Valleys Water and North Surrey Water merged each had a different approach and for consistency of reporting leakage this separate calculation has been maintained. The Three Valleys Water area is based on lowest night flow in the third week of the month and the former North Surrey Water on a weekly average night flow. As our district meter data collection via telemetry has matured, we have had the intention and aspiration to move to best practise using rolling time but this has been inhibited by the recognition that the numbers were likely to be different, the need to maintain consistency, demonstrate leakage is reducing and meet the leakage target.

We met with Ofwat in 2007 and agreed with them that re-basing of the baseline water balance and leakage for the Draft Plan and for other PR09 submissions would be an appropriate time for us to move to a best practise leakage calculation in order to provide a robust calculation of the economic level of leakage and setting of future leakage targets and a sustainable future closure error that will provide confidence in accuracy of our figures and leakage progress and performance for all stakeholders.

Our Draft Plan reflects the changes set out above and the effect on the base year water balance compared to that included in the June Return for Ofwat is shown in the table below.

Table 1.9f : Comparison of Existing and New Methods of Measuring Total Leakage for 2005/6

Report	Distribution Input Ml/d	Water Balance Closure Error	Leakage (Ml/d)
Leakage as reported in JR08 *	834.6	2.3%	141.8
Restated leakage using Best Practice Leakage Methodology *	838.4	0.3%	187.2
Change	**3.8**		**45.4**

* All figures post MLE correction

We recognise that this re-calculation gives a very large apparent change in reported leakage and we will deteriorate in comparative terms. However the actual leakage from our network has not changed. We are operating below the current economic level of leakage when assessed on a consistent basis and we are meeting our 2 Ml/d per annum target to reduce leakage in the five years of AMP4. The new figure for reported leakage has produced a similar relative change in the economic level of leakage. It is the relative change in leakage not the absolute level of leakage that continues to be the most important aspect of the leakage calculation to demonstrate a contribution to improving the supply/demand balance. Despite these presentational drawbacks we believe it appropriate to adopt fully the best practice methodology for future planning.

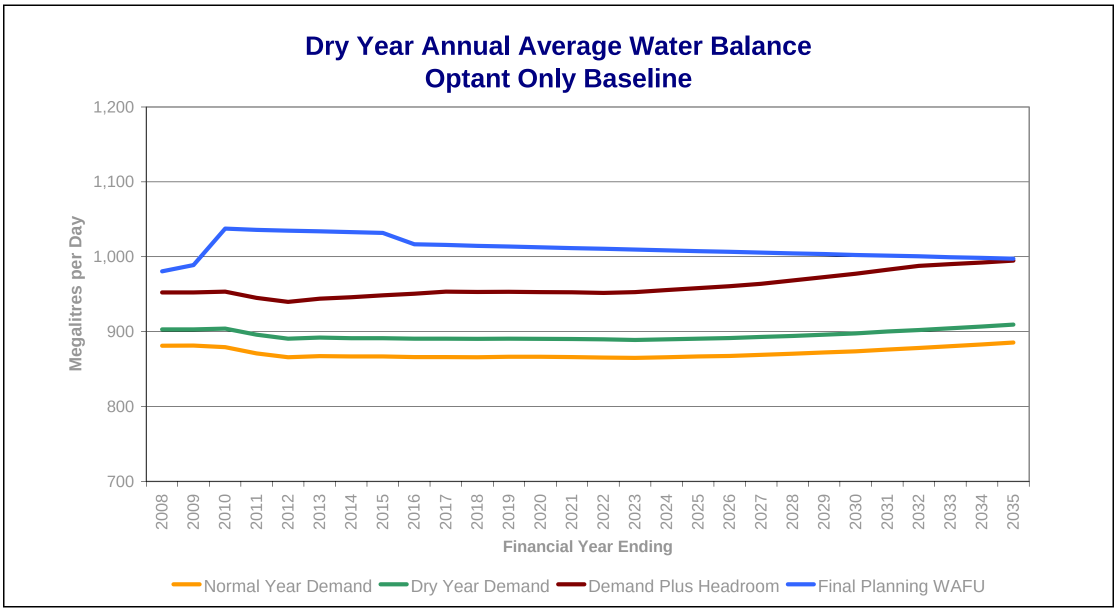
1.9 Demand Forecast Scenarios

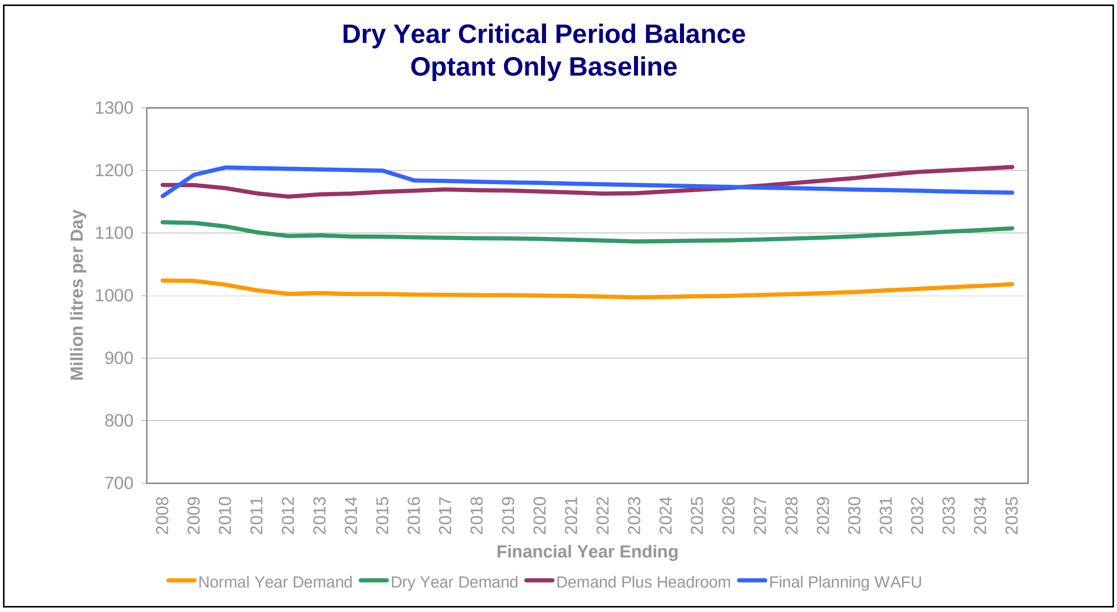
Our preliminary view of the unconstrained supply/demand balance is shown in Figure 1.9a. These graphs assume no additional demand management measures other than metering of properties where customers elect for one (known as 'optants'). This type of metering has a marginal effect on the demand for water. The graphs do not include any future water resource developments.

Figure 1.9a shows that a supply deficit would occur in 2026 for critical period conditions and 2035 under annual average conditions. This is because as the blue 'water available for use' line crosses and then falls below the red demand line that includes a safety margin (known as 'headroom').

Therefore meeting the unconstrained demand needs of our customers over the next 25 years will require us to make new investment in either demand-side and supply-side measures to ensure we have enough supplies to meet demand. These investments will increase the overall cost of water supply for our customers. The Government and regulators will have a central role to play in managing customers' expectations of price increases.

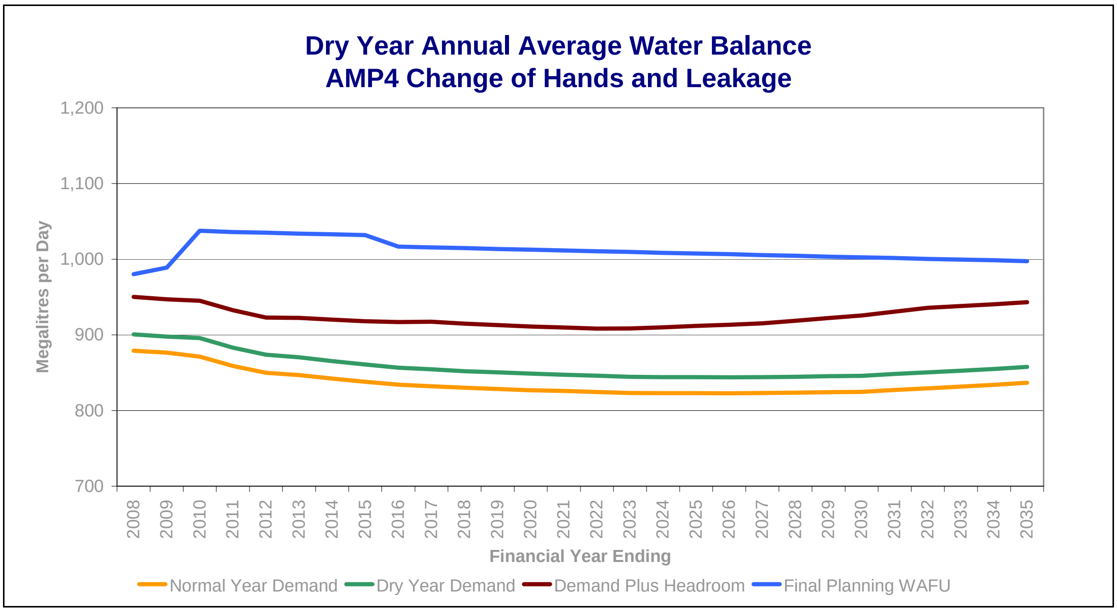
Figure 1.9a: Initial Supply/Demand Forecast Assuming only Meter Optant and New Connections

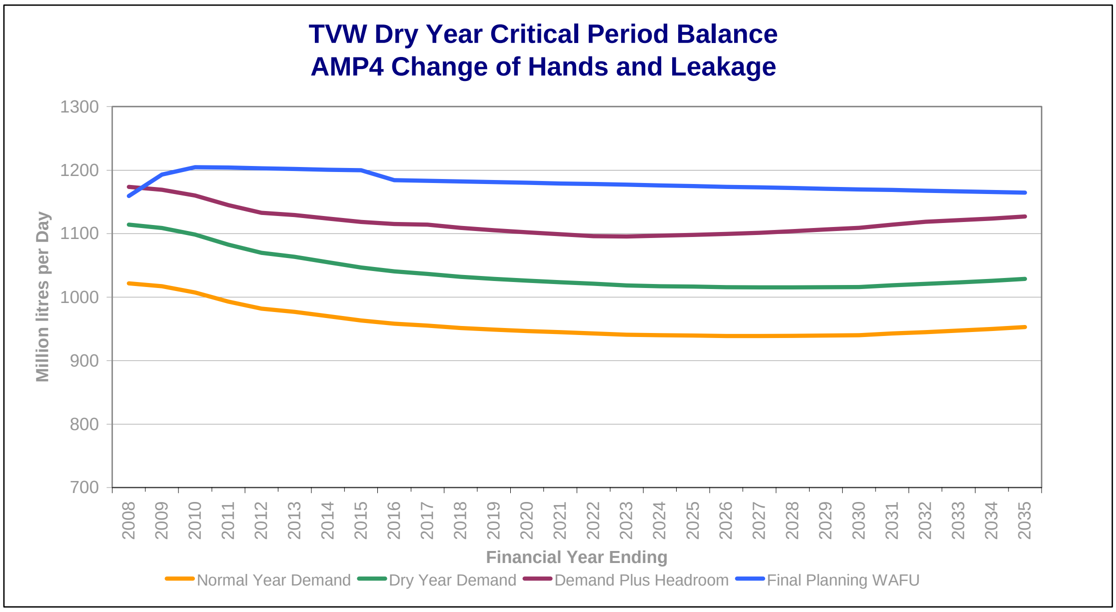




Our water environment is classified as water stressed and we have the highest consumption levels in the UK. It is important therefore that we consider reducing demand for water where practicable. In our consultation there was general support for our metering proposals. There was also some concern regarding the pace of metering and the protection of vulnerable customers. Leakage was raised in the context of equity and the company needing to keep its own house in order. We have considered these in our planning and concluded that we need to maintain an approach which reduces leakage as well as increasing the number of metered customers. Figure 1.9b below shows the benefits we could expect to see from additional metering and leakage reductions.

Figure 1.9b : Supply/Demand Balance with Metering as PR04 Rate





Continuing our PR04 strategy on reducing leakage and compulsory metering on 'change of occupier' would have the effect of deferring the need to develop new resources until after 2035 at average and critical period. In view of the recent designation of our operating area as 'water stressed' by DEFRA and Environment Agency we have considered the cost-benefit of moving to an targeted 'street by street' metering strategy both in conjunction with our mains renewal programme and where demand for water is highest. An approach such as this means installations costs will be lower and therefore customer charges will be lower than they otherwise would be, however only 53% of customers are in support of compulsory metering. The outcome of our cost-benefit analysis is detailed in section 8.4 however this indicates that in light of our surplus of supply in the short term a 'street by street' metering programme is not cost-beneficial even taking account of wider financial benefits. However when considering the wider benefits of non-financial measures there is justification for a least cost approach to further demand management measures after 2014 such as continuation of our AMP4 leakage reduction and compulsory metering programme on change of occupier particularly at a lower pace than AMP4 reflecting current recessional impacts.

Our preliminary customer consultation programme suggested our stakeholders would support investments that would reduce greenhouse gas emissions. We have responded to this and considered options to accelerate our metering to reduce demand at a faster rate than our PR04 metering programme would achieve and therefore to reduce the energy we use in pumping. Our cost benefit analysis indicates that in light of our surplus of supply in the short term an accelerated metering programme is not cost-beneficial even taking account of wider financial benefits.

With controls on demand through reductions in leakage, a continuation of our current compulsory 'change of ownership' metering and supporting water efficiency measures, there would be enough capacity to meet demand for water to 2035 without further resource development. However in the longer term there is a significant risk that household demand will rise again as measured customers become accustomed to paying for what they use. We are exploring the possibility of implementing a new way of charging for water by carrying out a pilot trial of charging a higher rate for water during the summer higher demand period. We will use this pilot to determine if a seasonal tariff will be effective in mitigating the decay in demand reductions.

Reducing demand alone will be insufficient in the long term, (post 2035) and we need to plan to increase supply as well to cope with the rapid rise in population in our area. In addition it is important we plan well in advance as the lead time for new significant sources of supply is long, for example up to 20 years for a large reservoir, and the environmental consequences can be considerable.

We cannot and do not want to prevent our customers from using the tap water they need and are prepared to pay for and so it is important that we plan for both supply and demand measures. We are also aware that as the numbers of meters rises and customers have been paying by measured charges for some time they may be less responsive to keeping demand low and they may expect to see an improvement on levels of service such as less frequent restrictions on supply; we need to bear this in mind for future plans and therefore have considered the potential impact on our current plan in the next section. Accordingly, actions to provide new resources cannot be left until it is clear after the event that demand management is insufficient to maintain security of supply. Such an outcome will be unacceptable to customers. Reducing the demand for water should minimise wastage and inefficient use, but the assurance of resource development and adequate headroom is essential for customers and must be planned for on a long-term basis, not as emergency measures.

1.10 Sensitivity testing

Once we have determined our preferred strategy based on an assessment of the water balance components and demand forecasts and taking account of customer views on levels of service it is important we assess the robustness of that strategy to variation in key factors. This process is known as sensitivity testing.

The sensitivity tests we have carried out in this Plan are therefore as follows:-

1. High Headroom (high demand)
2. Impact of loss of time limited licences
3. Reversion to Optant only metering rate
4. Reversion to flat total leakage profile
5. Less than anticipated demand savings from metering programme
6. Less than anticipated leakage reductions from metering programme
7. Combination of 5. and 6.
8. Effect and costs to achieve Defra 130 PCC target.
9. Water Framework Directive (utilising 130 PCC target scenario)

The results of this analysis are included in section 8.9 and details of modelling outputs are included in Supporting Information, section 10.5. We have also shown the effect of Ofwats 2010 final determination of prices in section 8.6.

1.11 Company Policies including level of service

1.11.1 Leakage

Our policy is to meet our leakage target set by Ofwat from the calculation of the economic level of leakage in order to assist with balancing supply and demand, to respond to customers' expectations that leaks be repaired in a timely fashion and to demonstrate that we have achieved an appropriate economic balance between leakage control activity and the amount of water lost through leaks. Our current target is based on our assessment of our long term economic level of leakage and requires year on year reductions in the volumes leaked throughout the period to 2010.

For the Water Resource Plan we continue to assume that the economic level of leakage will remain the key influence on leakage targeting. For our Plan we have relied on the assessment of the economic level of leakage ELL carried out for JR07. The calculations that rely on the ELL in our Plan in comparison to other options for balancing supply and demand have been updated for changes in the costs and benefits of leakage control activity and a greater weight given to social and environmental costs and benefits in determining the long term level of leakage.

1.11.2 Supply Pipe Leakage

Customers own the pipe that connects from our water main between the property boundary and the property itself. Leakage from these pipes, known as supply pipe leakage, is difficult to measure and especially for non-metered properties. So accordingly we base our plan on estimates of supply pipe leakage from both research and industry data. We have contributed to this research programme through the industry's research organisation UKWIR[11] and in partnership with other water companies[12]. Customers who are on a meter that is located at the property boundary are more likely to detect leakage both in terms of the amount of flow and the time that the leak has been running as there may be a continuous flow through

[11] United Kingdom Water Industry Research
[12] Tynemarch 2007

the meter. Therefore leakage from properties measured at the boundary are estimated to have approximately one third of the leakage of properties that are not on a meter.

When supply pipe leaks are detected by either a customer or our leakage technicians we have a duty to see that repairs are undertaken expeditiously. Our policy is to progress all supply pipe leaks we identify to conclusion, through our free repair/subsidised replacement scheme or through waste notice procedures which compel the customer to arrange for a repair.

We offer our free repair scheme with a framework agreed with Ofwat. Where we attempt a repair, we carry this out free of charge to the customer. Our scheme offers backfilling and making safe of excavations, but not permanent reinstatement of surfaces excavated. We offer a £100 contribution towards renewal of supply pipes. Where a customer is in default of a waste notice, we will effect a repair or replacement of the supply pipe, charging the costs of work, including where necessary the costs of securing warrants to enter premises, to the customer.

Our Water Resources Management Plan is constructed assuming continuation of these supply pipe leakage policies.

1.11.3 Metering

Our current policy is to increase the proportion of customers who are metered by metering all new properties, offering free meters to customers who request them and compulsory metering of properties on change of ownership. In addition we compulsorily meter customers who own sprinklers or swimming pools greater than 10,000 litres. We are constrained by the recent price review to defer our compulsory metering plans for 5 years however we are proposing to continue our policy on compulsory metering from 2015 as we operate in a region that is designated as under serious water stress[13]so that we will achieve 90% metering penetration by 2030. We will continue to offer free meters for those wishing to opt, metering new properties and pool and sprinkler owners.

Currently 34% of domestic customers are metered, in line with projected numbers in AMP 4. This was forecast to reach 44% by 2010 however the current recession has had a significant impact on home movers and we are now expecting to reach only 38% by 2010.

1.11.4 Water Efficiency

We operate within an area designated as "water stressed" that has a relatively affluent customer base giving rise to one of the highest average per person water usage in the UK. Therefore we believe that there is scope for water efficiency

[13] Environment Agency: Areas of water stress: final classification. Reference number/code GEHO1207BNOC-E-E. http://www.environment-agency.gov.uk/commondata/acrobat/finalclassification_1935752.pdf

activities to deliver cost effectiveness benefits to our customers in terms of water that can be saved.

The profile of water efficiency in the UK is rising rapidly and we believe it is important that we maintain the current momentum in our water efficiency activities to keep pace with the changing culture of water efficiency.

Preliminary work with our stakeholders in preparing this Plan revealed our customers have expressed a preference for more help with water efficiency and this has informed our strategy. We have reflected the importance of water efficiency in the Strategic Direction Statement for our next business plan which is available from our website.

This section sets out our plan for delivering water efficiency as part of our Water Resources Management Plan.

What we mean by "Water Efficiency"

Here at Veolia Water Central, we take water efficiency to mean using less water, by using water wisely and reducing water wastage. We do not take water efficiency to mean restricting or reducing the use of water appliances (for example by showering less or not watering the lawn at all).

Examples of water efficiency include,

- Alterations in behaviour - such as turning off the tap when brushing teeth, watering the lawn less or using a bucket instead of a hose to wash the car,
- The use of more efficient fixtures and appliances – such as trigger nozzles for hose pipes or dual flush toilets and
- Alterations to existing appliances or processes so that they use less water without suffering a drop off in performance – such as fitting displacement devices to toilets or fixing leaking taps.

Water metering and tariffs are useful tools to support changes in consumption patterns and water efficiency activity by raising awareness of the costs associated with water and energy wastage and indeed our experience indicates that measured customers, on average, tend to use 10 to 15% less water than unmeasured customers.

There may be a number of factors causing this however, and we believe that it is important that economic methods are strongly reinforced with raised awareness and information so that

- An awareness of the requirement for water efficiency, the need for water efficiency in the South East of England is promulgated and becomes widely known,
- Water efficient behaviours become "learned" and second nature,
- Water efficient activities are based on where, when and how much water is used around the home and

- Consumers can turn to and rely upon us for practical and knowledgeable advice about water efficiency methods, information and products.

Regulatory History of Water Efficiency

Historically, the requirement to promote water efficiency stems from the Water Act 1991. A real focus was created after the Labour Government came to power and water companies were asked to define their water efficiency strategies.

Water efficiency activities are now reported annually in Table 1 of the June Return to Ofwat.

The "Duty to promote" was augmented by a "Duty to conserve water in water company operations" under the Water Act 2003.

In July 2006, the House of Lords Science and Technology Committee published their report into Water Management. The sub committee considered legislative and regulatory framework; demand for water; water supply; the interaction between water and the environment and water efficiency.

The report placed some criticism on Ofwat for taking a purely economic approach to water efficiency which Ofwat accepted in the follow up report which was published in January 2007 as follows

> *"The new OFWAT board should make it a top priority to provide incentives to encourage water companies to invest more in promoting water efficiency. Equally, during future price reviews the resumption should be in favour of funding water efficiency initiatives proposed by companies, unless there is a compelling reason not to do so. We recommend that ministerial guidance to OFWAT be framed accordingly."*

In 2007 Ofwat published a "Good Practice Register" indicating the type and range of water efficiency activities that are actively promoted by UK Water Companies and giving a range of possible savings that can be achieved.

In August 2007 Ofwat announced, in a letter to Regulatory Directors of all water companies, the introduction of voluntary targets as a first step to developing new incentives for promoting water efficiency. Subsequently Ofwat have set water efficiency targets for all water companies over the AMP5 period. We have considered Ofwat's WE Targets approach in drafting our strategy but we are concerned that the approach which indicates a substantial increase in cost to deliver sufficient activities to meet the targets in not cost-effective in the short term as we have a supply surplus until after 2015. We are also of the view that our current programme of activity is sufficient to meet our obligations to promote the efficient use of water with our customers and details of both activities and costs have consistently been published in our June Return; additional activities would need to be included in water prices and would place an unnecessary burden on customers in the short term. Nevertheless we are committed to a programme of water efficiency to support our customers and metering programme so we are working with Ofwat to ensure all relevant activities such as education services and communications campaigns are fully recognised in making a contribution to the targets. We will also adapt our current programme of activity to deliver the best outcome compared with the target benchmarks. An example of this and we have already made preparation to issue "home mover packs" offering water efficiency advice to all compulsory metered properties. At present Ofwat have not set targets using their powers[14]. When they do then we will meet the target however this will constitute a new obligation which will need to be funded under the periodic review process.

Why We Should Promote Water Efficiency

Water efficiency is important to us as:-

- we have a legal duty to promote water efficiency
- our stakeholders have expressed a high preference for us to do so
- reducing the amount of water means less water abstracted from the environment and therefore more water left in the environment
- we have a statutory responsibility to conserve water in our own operations such as in our treatment processes.
- water efficiency helps reduce operational costs as it helps us to reduce pumping and energy use
- reducing the amount of water we pump means less energy used which reduces greenhouse gas emissions and our customers also want us to reduce these
- we gain in terms of corporate reputation with our customers and other stakeholders
- water efficiency helps us to defer future new resource schemes

Current Situation

Currently within our organisation water efficiency has a role to play in many different ways. Our Strategic Direction Statement (SDS) features water efficiency as a key activity and clearly sets out the Company belief that it is an important role in the overall supply demand balance moving forwards.

The future role of water efficiency is essentially a dual role, water efficiency in its own right and as a major support component to our Metering Strategy and in support of future new tariff trials.

By utilising water efficiency in such a supporting role it will enable us to maximise the return from those projects in terms of water savings. This will include taking steps to minimise the "bounce back effect" seen after initial savings from water meter installation. (This is where higher initial water savings are not sustained and reduce after an initial period of time after a water meter has been installed).

In the options appraisal for our Water Resources Management Plan we have considered a range of water efficiency schemes in the project screening process. These schemes are shown in the list in section 10.1. Twelve water efficiency and five reuse schemes were considered in the final screening process to be considered for

[14] Ofwat may set mandatory targets under Sectio 38b of the Water Industry Act 1991.

PR09. These projects will be assessed using the same criteria as all other new resource and supply/demand schemes. The Ofwat good practice register was consulted when calculating water savings where appropriate.

We envisage that moving forward from 2010, water efficiency projects will make a substantial contribution to the metering projects to support customers in making informed choices about their water use and ease their transition onto a measured tariff

We are currently working to understand the impacts and effectiveness of variable or seasonal tariffs in terms of reducing demand and to broaden the Company knowledge. A pilot trial is starting in April 2009 and we feel that seasonal tariffs have a role to play after wider scale metering has been implemented. A seasonal tariff is where water charges are adjusted to reflect lower charges during the winter but higher charges in summer months. This will allow customers to understand the true value of water. It is important that we develop detailed knowledge of the impact of new tariffs so we can better understand and quantify the overall impact that it is likely to have on our customers and the longer term supply demand situation.

Seasonal tariffs will make customers more aware of the need to reduce water wastage and save water during periods of peak seasonal demand. Supporting our customers with water efficiency information at strategic times will help to improve their understanding and awareness.

Our Water Efficiency Strategy - The way forward

During the next 5 years we are planning to extend our programme of water efficiency activities by building on past successes coupled with new initiatives.

We will build on industry research and ensure that we have a wide ranging, far reaching water efficiency strategy to engage stakeholders and customers alike to offer up to date information, suitable products and advice.

Our current water efficiency strategy as outlined within our Strategic Direction Statement is that the successful promotion of water efficiency to domestic customers requires the bedrock of the economic incentive provided by metering. Through our strategy we aim to achieve a leading role in terms of water efficiency in the long term.

This strategy sets out the plans for the future in eight distinct strands: Objectives for each strand are shown in the table 1.11.4 below.

- Promotion of water efficiency
- Influence water efficiency behaviours
- Measure water efficiency
- Support the supply demand balance
- Set challenging targets fro water efficiency
- Reduce and account for operational use of water
- Work with commercial users of water
- Develop water efficiency expertise and skills

Table 1.11.4 : Statements of objectives for the strands of the water efficiency strategy

Activity	Objectives
Promotion	• To discharge the Company's statutory duty to promote water efficiency to our customers and the duty to conserve • To satisfy customer expectations regarding water efficiency advice • To offer added value services for customers to highlight potential water efficiency savings (e.g. sale of water butts) • To support enhanced activity during drought conditions • To seek external partnerships to discharge the duty to conserve
Influence Behaviour	• To maintain our commitment to our Education programme and develop the service provided to education establishments • To carry out consumer research and engage with our customers in order to understand the motivations and water efficiency behaviours. • To engage with our regulators to influence approach/concept of water efficiency. • To form strategic partnerships with influencers and policy advisors so that they begin to promote credible and appropriate water efficiency messages.
Measurement	• To carry out projects and tasks in accordance with best practice • To identify opportunities for joint working partnerships to deliver more for less • To provide an accurate and robust measurement and sustainability of the impact of water efficiency measures • To ensure appropriate business decisions can be taken on the cost-effectiveness of future plans and subsequent implementation
Supply/Demand Balance	• To demonstrate to our Regulators (EA, Ofwat & Defra) that water efficiency measures are assessed appropriately within an economically optimal supply/demand investment programme • To support the company's supply/demand balance to reduce domestic PCC.
Target Setting	• To set measurable annual targets representative of all strands of water efficiency activity carried out by the company. • To establish baseline position and monitor our performance against the targets. • To consistently measure our performance against other water companies in the South East of England using audited and published data. • To actively seek to challenge and better previously set targets on an annual basis to continuously improve when compared to previous years.
Operational use of Water	• To ensure we are able to demonstrate a responsible attitude with its use of water • To put in place a culture of efficient use of water in our own operations • To satisfy our 'Duty to Conserve' by reducing wasted volumes • To enable realistic targets to be set and achieved to demonstrate efficient use of water in its own operations • To provide robust audit trails of operational and waste volume.
Industry	• To work with others in partnership: • To maintain a leading position in the industry • To exchange measurement data to improve the robustness of the effects and sustainability of water efficient measures. • To continue the development of new initiatives that enable wider distribution and understanding of WE devices and techniques.
Company R & D	• Develop expertise in achieving and delivering water efficiency • To continue to identify and consider innovative WE opportunities

Strand 1– Promotion of Water Efficiency
We will continue to maintain and build upon the current level of promotion. We recognise the benefit from participating in join promotional activities, working with regional partners such as the campaigns in conjunction with CCWater, Water in The South East and Waterwise. Conducting joint promotions has a wider reach and greater impact on the public consciousness.

We are very proud of the achievements of our Educational and Environment Centre which this year won a golden Green Apple Award for its innovative water-saving project for schools.

Around 13,000 children and adults participate in water efficiency activities at the Centre annually and overall 26,000 children and adults learned about water efficiency and good citizenship practices throughout the year. We propose to maintain our educational programme and seek to improve the assessment of its impact on our 'future generation'.

A suitable database will offer the company a new and unique starting point for future research. The current evidence base for water efficiency products is not as robust as the industry would like, a commitment to future research would enable us to participate in strengthening that position.

The Environment Agency paper "Towards Water Neutrality in the Thames Gateway" reports that the public are happy to receive information, advice and simple tips on how they can save water around the home.

We will therefore allow for and incorporate the promotion of good water efficiency advice and literature at every opportunity in conjunction with all external and internal projects including PR09, tariffs and metering projects.

Strand 2 – Influence Water Efficiency Behaviours
We will offer a wider range of products and services to our customers through strategic alliances and partnership arrangements with knowledgeable and competent service providers to ensure that our customers are getting the most appropriate water efficiency technology and advice/support to support lifestyle choices by our customers.

These services will include:

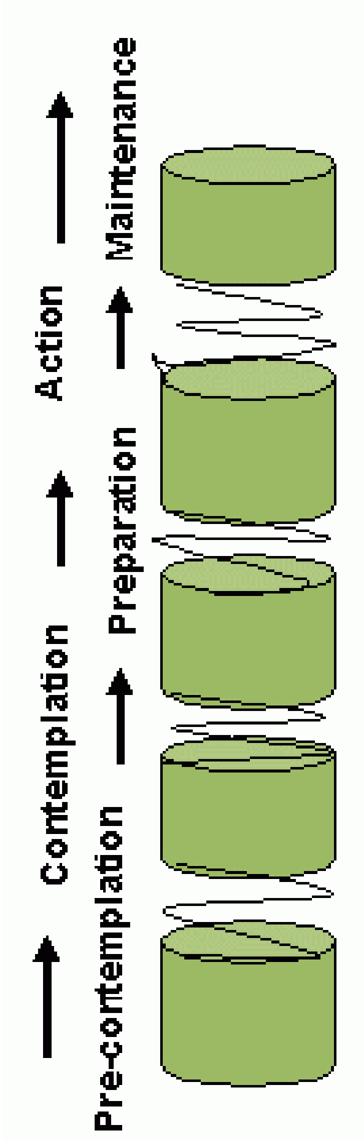
- Water efficiency audits and advice for domestic customers.
- An updated water efficiency section on the Company website, to include:
    - Water efficiency shop
    - Water efficiency library with access to research and published papers
    - Advice
    - Audits
    - Project information
    - Real time water information
    - Access to educational resources for schools
    - Games for children

Offering customers a wider range of water efficiency products, either through an online shop or other avenue will allow us to create a unique partnership to provide sound advice to customers while they are purchasing water efficiency products.

We will find ways of widening the avenues through which we can communicate with our customers to gather data in relation to water use and the perception of water efficiency devices, in an attempt to influence product choices leading to long term behavioural changes. The changes that people must go through to become consciously aware of water efficiency are set out in the figure below[15].

Figure 1.11.4 : behavioural Model of Water Efficiency

Water Efficiency Behaviour model



MAINTENANCE: practice required for the new behaviour to be consistently maintained, incorporated into the repertoire of behaviours available to a person at any one time.

ACTION: people make changes, acting on previous decisions, experience, information, new skills, and motivations for making the change.

PREPARATION: person prepares to undertake the desired change requires gathering information, finding out how to achieve the change, ascertaining skills necessary, deciding when change should take place, may include talking with others to see how they feel about the likely change, considering impact change will have and who will be affected.

CONTEMPLATION: something happens to prompt the person to start thinking about change perhaps hearing that someone has made changes or something else has changed resulting in the need for further change.

PRECONTEMPLATION: changing behaviour has not been considered; person might not realise that change is possible or that it might be of interest to them.

[15] Prochaska, JO and Di Clemente, CC (1986) Towards a comprehensive model of change. In: Process of change: New York: Plenum Press. Modified by Di Pietro, G and Hughes, I. www.travelsmart.vic.gov.au

Strand 3 – Measure Water Efficiency
All water efficiency activities require measurement of both the costs and benefits in order to assess its effectiveness compared to other supply/demand measures.

We played an active role in the recent UKWIR[16] research project called 'Quantification of the Savings, Costs and Benefits of Water Efficiency' and we will continue to carry out water efficiency activity in accordance with these best practise guidelines.

We will improve the overall co-ordination and management of the thrust of water efficiency activities and implement a system to robustly measure water use (where possible) and build on work to date, to conduct benchmarking to ensure the impact of future initiatives are measured so that progress can be closely monitored, and successes clearly identified.

Strand 4 – Support our Supply/Demand balance
Our Strategic Direction Statement and our Plan make clear that an enhanced role for water efficiency measures are essential for the delivery of sustainable reductions in demand. Water efficiency forms a component of our 'twin track' approach towards demand management.

In planning for both supply and demand in the long term there is less risk in solutions that expand supply (supply measures) than in those that reduce demand (demand measures). This is because demand measures require reductions in consumption and there is considerable uncertainty whether savings will endure into the future. We consider that water metering and the implementation of tariff measures alone are not enough for the promotion of water efficiency however water efficiency schemes go through the same robust project screening and economic appraisal as other water resources projects.

Our water environment is classified as water stressed so it is important we reduce the demand for water where cost beneficial and to this end we consider both financial and non-financial benefits of water efficiency measures. Where water efficiency measures are not cost-effective or cost-beneficial in their own right they remain part of our baseline programme and in particular where they are required to ensure other measures are optimised such as metering.

Strand 5 –Set Challenging Targets for Water Efficiency
We will strive to achieve continuous improvement of our water efficiency performance.

A vehicle for achieving this is the introduction of targets. Ofwat has indicated an intention to introduce targets which will become mandatory in 2010. Prior to this we aim to set ourselves stretching targets for an integrated programme of measures to ensure the Company is well on the way to delivering the level of activities and savings made year on year.

We have considered the Ofwat proposals for water targets which would require activities to be carried out whether cost effective or not. We estimate that when

[16] UKWIR United Kingdom Water Industry Research

Ofwat set tagets under the Water Industry Act it will cost an additional £671k per annum to meet the water efficiency targets using activities defined by Ofwat and we are concerned that this may place an unnecessary burden on customer bills particularly as operating costs directly impact on prices. Nevertheless we are supportive in principle of the targets and we have adapted our existing baseline programme of water efficiency measures to align with the Ofwat proposals and for example in 2008 we introduced a new 'Movers Pack' in support of our compulsory metering programme. We are of the view that a pragmatic interpretation of activity contributing to targets might be appropriate in supporting companies who are seeking to provide a cost effective water efficiency to customers. We see an opportunity in particular if account is taken of alternative measures such as education and communications activities where we have a strong track record. Ofwat have indicated they are willing to consider alternative measures to contribute to the targets and we will be working with them to see how this can be achieved.

Internal targets will be set in accordance with our rolling programme of activity which may include achieving a set number of audits or distributing a set number of audit packs or cistern displacement devices (CDD). Progress towards reaching internal targets is reported in our performance management quadrant reporting for water efficiency. This provides a clear reporting structure, allows progress to be closely monitored and facilitates annual reporting of our achievements for the June Return and Annual Water Resources Plan reporting process.

Strand 6 – Reduce and Account for Operational Use of Water

Water use in all areas of our operations will be addressed through the new water efficiency strategy. There would be many aspects to this element of the strategy:

- Operational water use
- Office water use
- Mains flushing

We will promote the completion of a full company wide audit to quantify and account for all water use. This will assist in the public campaign as we will be going beyond the steps that we will be encouraging our customers to take towards water efficiency.

In the long term we will encourage a strategic alliance between different areas of the Company. For example water efficiency activities alone are unlikely to present a long term means to reach targets and raise our standing against other companies. We need to look beyond the immediate requirements. In the long term we believe that water efficiency would have the most impact when linked to compulsory metering and alternative tariffs. When people begin to see the true worth of water (through changing price /tariff structures) evidence suggests that water efficiency information for example through more consumption information on bills, and will provide a valuable tool by which people can control their household costs.

Strand 7 – Work with Commercial Users of Water

We currently undertake water efficiency audits (NW 041 Water Efficiency Audit) to selected commercial premises following a Fittings Regulations inspection or following a customer request. We will offer more water efficiency services to commercial customers, advice and audit services could be offered through a strategic alliance or partnership with recognised industry experts.

We also offer self Water Audits through the internet site and with 'self audit' packs distributed to customers. We are working to develop with the commercial development departments specific services for commercial customers through the website and part of our offer of other services to customers.

We will seek strategic partnerships with housing developers and encourage them to implement high standards of water efficiency in their developments. We will in particular actively seek innovative solutions such as grey-water recycling and rainwater harvesting where these can be shown to be cost-effective.

Strand 8 – Develop Water Efficiency Expertise and Skills

We will develop and expand our range of water efficiency expertise and skills, in all areas, products and project management and also behavioural aspects of water use and efficiency.

Through knowledge development and sharing between departments it will ensure that we can manage projects efficiently and develop a core of people within the business who are highly skilled in the area of water efficiency.

We co-ordinate and manage our water efficiency programme through our Water Efficiency Programme Manager and we will establish a framework for setting project objectives and monitoring performance against those objectives in terms of activities, costs and water volume saved. This will ensure that water efficiency is closely aligned with the regulatory process for example with the Strategic Development Statement (SDS), Water Resources Management Plan (WRMP), and Drought Management Plans etc. ensuring a common thread through these important documents

Development of theses skills within the Company will ensure that delivery projects such as toilet retro-fitting can be undertaken with confidence in future and ensure that there are limited issues arising related to product guarantees and liability.

Support of industry and academic R&D groups is fundamental in order to understand the issues involved in promoting water efficiency nationally on a larger scale. This also benefits the sharing of information and best practise throughout the industry and associated parties.

We will also continue to participate in such groups as the Water UK/Ofwat/Defra/EA Hexapartite, the Water UK water efficiency Network, Waterwise, UKWIR, the EA Anglian Region Water Efficiency Group, the National Water Conservation Group, the Imperial College led WaND project and the Watersave network.

Water Efficiency Summary

We will build on work to date to expand the range of initiatives and services undertaken and offered to our customers. This will raise awareness of water efficiency and allow customers to make informed choices about their own water use.

At present Ofwat have not set targets using their powers[17]. When they do then we will meet the target however this should constitute a new obligation which will need to be funded under the periodic review process.

1.11.5 Level of Service

1.11.5.1 Hosepipe ban return period

Our neighbouring water companies' current levels of service for demand restrictions are presented below:

Company	Hosepipe Ban
Essex & Suffolk Water	1/20 years
Thames Water	1/20 years
Sutton & East Surrey	1/10 years
South East Water	1/10 years
Cambridge Water Co.	1/20 years
Veolia Water Central	1/10 years

This table reflects the differing supply capabilities of the different companies.

The current levels of service are described in our Drought Management Plan. These estimate that a hosepipe ban will occur with an average not more than 1 in 10 year frequency.

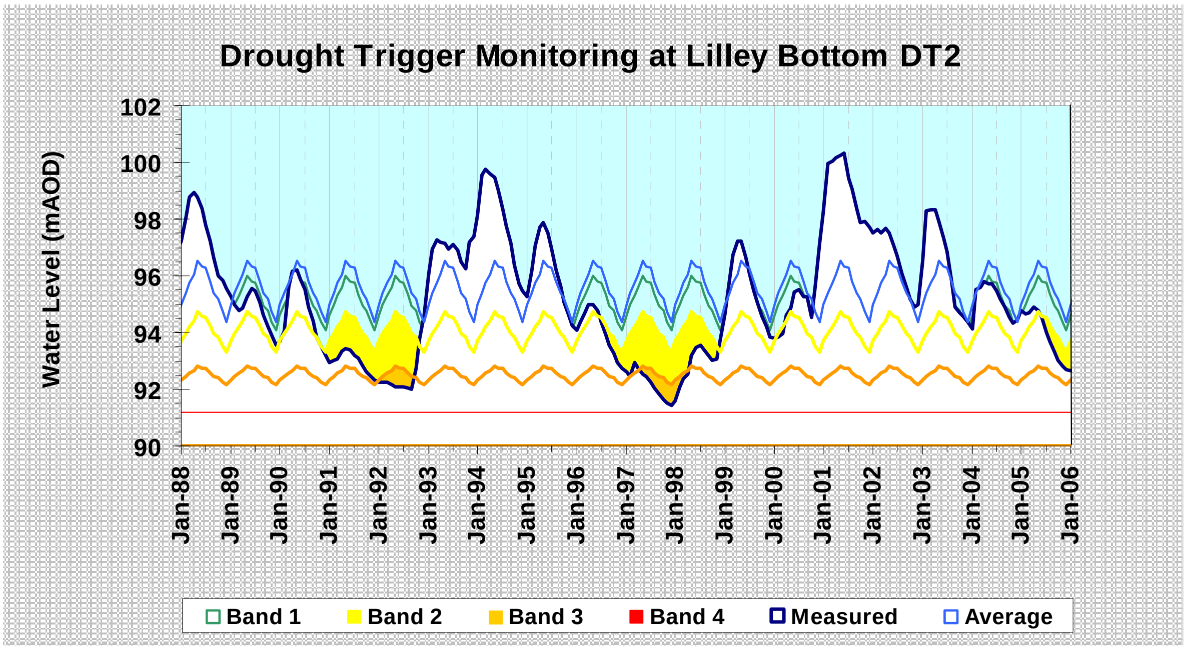
As over 60% of our supply is obtained from groundwater, and our surface water sources are not subject to drought constraints, it is the availability of groundwater that is critical to the impositions to restrict demand. Low groundwater levels impact on both the availability of water from our boreholes and have significant environmental impacts. Reducing the demand for water decreases the stress on our groundwater sources, conserves water in the aquifers and reduces the impact of abstraction on river flows.

Based on recently available information for the Veolia Water Central (formerly Three Valleys) area, hose pipe bans were introduced in, 1976, 1991 and 1992 and 2006, giving a frequency of 1 every 10 years. However in 1997, despite low groundwater level conditions, no hosepipe ban was introduced and efforts focused on constraining demand by other methods. Had a hosepipe ban been introduced, this would have reduced the frequency to 1 in 8 years, so the current level of service is considered appropriate.

The drought plan relies on triggers based on observed groundwater levels, and is illustrated by the graph below. Band 3 is where hosepipe bans are to be considered and Band 4 is when Drought Orders or Permits may be used.

[17] Ofwat may set mandatory targets under Section 38b of the Water Industry Act 1991.

Figure 1.11.5.1 : Long Term Drought Monitoring Chart with Trigger levels



Unfortunately the length of groundwater records is insufficient to derive a reliable return period for such low water level conditions. Low groundwater levels usually occur when there has been a deficit of winter rainfall over two years or more. Long term rainfall records exist, and work has been undertaken to analyse these to determine the frequency of winter rainfall that will lead to low groundwater level conditions. The outcome of this work is included in section 1.11.5.4 below.

1.11.5.2 Drought Permits and Orders

Drought permits and orders may be used either to restrict the non-essential use of water or to increase the amount of water abstracted from the environment. We have never implemented a drought permit or order (although one was obtained in 1992) so have no historical precedent however, we are not proposing to implement permits or orders at a frequency of greater than 1 in 20 years.

1.11.5.3 Rota cuts

We are of the opinion that the use of rota cuts and standpipes are not a viable drought response as they are not compatible with regulatory water quality requirements and therefore these are not considered for drought planning however they remain operational tools in case of extreme emergencies.

1.11.5.4 Justification of Level of Service for Water Available for Use and restrictions on supply.

This analysis is necessary in order to validate the robustness of the current Level of Service for the frequency of restrictions on demand and in order to comply with the requirements of the Water Resource Planning Regulations.

Veolia Water Central current levels of service are currently 1 in 10 years for a hose pipe ban and a drought order for restriction of non-essential water use and 1 in 20 years return period for a drought order which could suspend abstraction licence or low flow agreements and introduce other measures.

A hosepipe ban is a measure to secure water supplies in a drought event. Hosepipe bans are preceded and supplemented by calls for voluntary reductions in use.

Records of groundwater hydrographs are not available prior to the 1970's and operational borehole water levels and local demand data are not available for the period before telemetry data was routinely archived in the early 1990's. Therefore it is not possible to directly compare operational borehole performance with long term hydrological records and in order to examine the robustness of the current Level of Service for restrictions on use of water a surrogate relationship is required. To achieve this we have compared the history of droughts, actual restrictions events and a long term sequence of rainfall.

Reviewing the available information on historical events, even though the stated VWC levels of service as are 1 in 10 years return period for hosepipe bans, the reality of such restrictions has actually been at least 1 in 15 years, as identified in Table 1.11.5.4

Table 1.11.5.4 : Actual frequency of implementation of a hosepipe ban by VWC

Years	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Drought Order-non essential use	Hosepipe ban															Hosepipe ban
Levels of service		1	2	3	4	5	6	7	8	9	10	11	12	13	14	1 in 15 yrs

Years	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Drought Order-non essential use	Hosepipe ban and drought order														Hosepipe ban
Levels of service	1 in 1 yrs	1	2	3	4	5	6	7	8	9	10	11	12	13	1 in 14 yrs

Events that resulted in restrictions on the use of water are as follows:-

- VWC (Rickmansworth Water Company) implemented a hosepipe ban in 1976, but colloquial evidence[18] indicates this was at the behest of Thames Water Authority, the incumbent regulatory authority although this was not justified by the prevailing supply/demand situation.
- After operating for 14 years without water restrictions in 1991 the company imposed restrictions on hosepipe use because of the very low rainfall in the period 1989/91.
- In 1992 the drought continued and a drought order was approved for restrictions on the non-essential use of water although implementation was limited to voluntary measures.
- Then after a further 15 years, in 2006 which saw the most recent restrictions on hosepipe use, VWC imposed a hosepipe ban to its customers on 3rd April 2006 which remained into force until 18 January 2007.
- In 1997, although the hydrological conditions were indicative of a drought period, no hosepipe ban was introduced.

The above sequence of events corresponds to a one in 10 frequency of hosepipe restrictions. Had restrictions been imposed in 1997, then the frequency of restrictions over this period of record would have been 1 in 8. The frequency for non-essential use drought orders is greater than 1 in 20. As there are no recorded

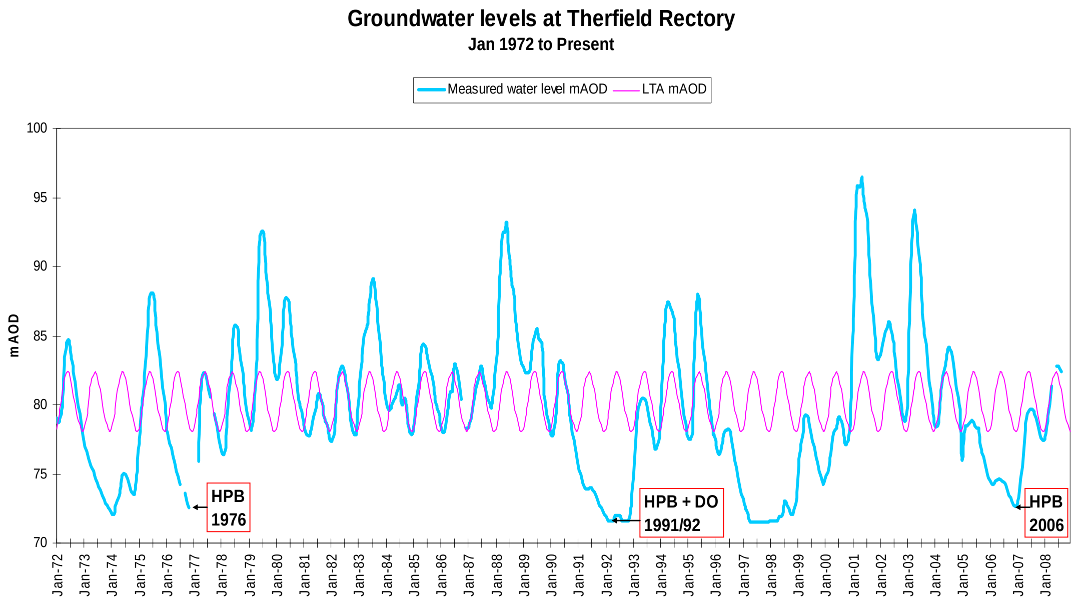
[18] Verbal report from Robert Simpson past Managing Director of Rickmansworth & Uxbridge Water Co

events for drought orders on emergency abstraction or rota cuts then the frequency for these is greater than the time series in question so at least 1 in 30 years.

Assessment of Hydrological Records

Veolia Water Central supply demand balance is dominated by groundwater behaviour as our surface water resources are unaffected by drought events. In order to assess the longer term periodicity of the conditions that require a hosepipe ban and other levels of service related events, groundwater levels and rainfall records have been reviewed. Within the VWC area, reliable groundwater hydrographs are only available from the early 1970's onwards, and so also do not give a longer term picture. However the hydrograph for Therfield Rectory indicates that the periods of hosepipe ban correlate to periods of low groundwater levels. These low groundwater levels are in turn caused by low rainfall periods, particularly winter rainfall, which contribute to maintaining water levels during the following summer. Generally, if one low rainfall period occurs, water levels can recover quickly, but of two successive periods occur, then the next groundwater recession period starts from a lower base level than previously and thus causes water levels to decline much further than normal. 1992, 1997 and 2006 were periods of multiple year low rainfall events and therefore this indicates an approximate correlation of multiple year rainfall events relating to Levels of Service.

Figure 1.11.5.4a : Groundwater Hydrograph for Therfield Rectory – 1972 to 2008



VWC currently use Meteorological Office Rainfall records in the form of MORECS data, which give weekly values for a variety of meteorological parameters. This data is available from 1962, thus is inadequate for long term statistical analysis.

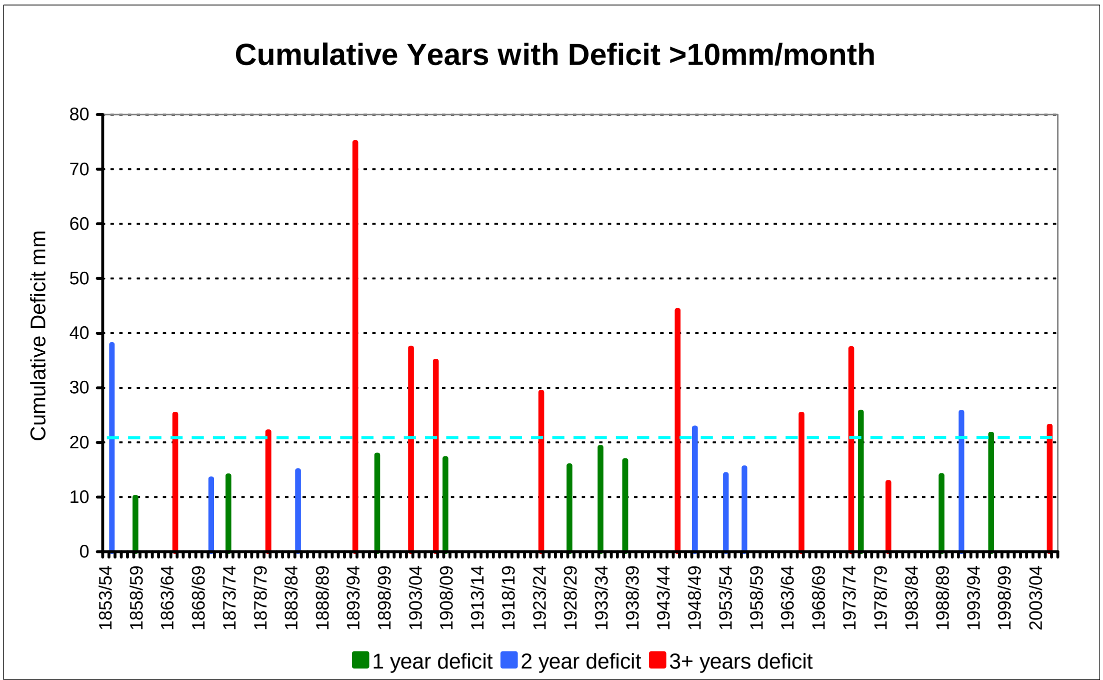
A long term rainfall data set has been obtained for Oxford, from 1853. Comparisons have been undertaken, which demonstrate that this is consistent with the MORECS data for the VWC area since 1991, particularly in relation to the recharge season rainfall from September to April. Accordingly the Oxford rainfall sequence provides a vehicle to consider the frequency of low rainfall events and in turn an approximation for the return event of restrictions on supply.

The Oxford rainfall data set was subjected to a number of statistical analysis to derive return periods of particular rainfall events. One of the most illustrative outputs from this is shown in Figure 1.11.5.4b below. Here, the cumulative deficit of average monthly rainfall from one, two or more successive winters is shown as mm deficit from the long term average, and is shown only for periods that have 10mm or greater deficits. The frequency of such deficits is high, with 28 occurrences in the 152 years of record, i.e. 1 in 5. However, not all of these deficits have caused issues with low groundwater levels. Based on current impacts, only when the deficits exceed 20mm are groundwater levels seen to decline to low levels and the historic record shows water restrictions were required. 15 occurrences of below 20mm deficit are indicated below during a 152 year period, giving a return period of just over 1 in 10. This supports the current level of service.

The data illustrates the variability in the data series. The extremely low value of -74.9mm deficit in 1893/4 is the result of seven years of below average rainfall. There were 9 periods where deficits extended over three or more years. In the most recent case, there was a small deficit of -1.32mm in 03/04, but it was the much higher deficits in 04/05 and 05/06 that caused water levels to decline in the way they did. However, ground water levels did recover close to normal levels in 07/08 as illustrated above.

Historically, it has been two successive winters of low recharge that has caused water levels to decline. Even one very low rainfall winter can have that impact, as illustrated by the 1975/76 or even 1996/97, however as a result of the nature of the Veolia Water Central resource base of 60% groundwater and 40% surface water our operational experience has shown that we are resilient to one year droughts.

Figure 1.11.5.4b: Distribution of Winter Low Rainfall Events – 1853 to 2005



The frequency of these low rainfall events in the past is not necessarily a guide to how they will occur in the future, particularly when climate change is considered. However, none of the climate models to date show a long term historic decline in overall rainfall patterns, only more variability. Of importance to maintaining groundwater levels is the return to more 'normal' rainfall patterns in between the periods of dry. Historic evidence such as seen over the winter of 1992/3, shows that 'normal' ground water levels can be recovered within one recharge season, thus re-setting the groundwater for the next recession period.

Extreme events such as these are managed by following our published Drought Management Plan. This explains our approach and guides the progressive implementation of measures to reduce demand, and where possible, increase supply via the use of voluntary reductions, hosepipe bans, non essential use bans and drought orders/permits. Reduced source outputs are allowed for in the calculation of deployable output.

1.12 Competition in the water industry

Our experience with the Water Act 2003 competition regime suggests little prospect of competitive activity in the near term. Potential new entrants have shown interest in retail-only entry but not in combined supply entry, either with or without the support of a secondary water undertaker. There are no licensees with whom we have concluded access agreements; hence no licensees are operating in any of our water resource zones and no customers being supplied by licensees. It follows that there are no volumes of water, either raw or potable, introduced by licensees to our system and therefore that there are no secondary or strategic supplies. There are no volumes of water bought wholesale by licensees. Although the competition regime is currently under review and it is probable that it will be developed to increase competition there are no reliable details about how this might happen. We have therefore prepared our water resources plan on the basis that there will be no material impact from competition on our supply/demand balance.

1.13 Strategic Environmental Assessment

Our Plan will recommend future projects and therefore will fall under the scope of the European Directive (2001/42/EC) 'on the assessment of the effects of certain plans and programmes on the environment', known as the Strategic Environmental Assessment (SEA) Directive. The Directive is transposed into English law by the associated Environmental Assessment of Plans and Programmes Regulations (SI 1633 2004). These Regulations require SEA to be undertaken on plans and programmes that are likely to have significant environmental effects and for these to be considered when making decisions about the plan.

The Environmental Report on our WRMP has been amended following feedback from the EA and Natural England and is republished with our Final Water Resources Management Plan.

SEA is a process for assessing the impacts of a plan or programme on the environment. The environment includes a wide range of receptors including ecology, the historic environment, landscape, material assets and human beings. It has formed part of the decision making process, influencing the choice of preferred outcomes. Table 1.13a describes the process used in determining the outcome of our Plan.

Table 1.13a : The stages of the Plan and SEA

SEA Stage	SEA questions	Plan Stage	Plan Description
Screening	Is SEA Required?	Supply Demand Balance	Is there a deficit?
Scoping	What are the key features likely to be impacted by the Plan?	Identify options	What are the options to reduce the deficit?
Assessment	What are the impacts of the options and the Plan on the environment?	Options appraisal	Which options meet the objectives of the Plan?
Environmental Report	How has the SEA influenced the Plan decisions?	Draft Plan	What options do we recommend?
Adoption	How has the SEA and consultation affected our decisions?	Final Plan	This is what we intend to do.
Monitoring	Are the environmental impacts from the Plan as predicted?	Implementation	Implement the options

Strategic Environmental Assessment has been integrated into the options appraisal. A screening test was applied to the unconstrained list of 269 options where any options potentially causing significant environmental impacts were dismissed. The resulting constrained list contained 84 options. These were put through a further environmental assessment split into two parts:

- ***Quantitative appraisal*** *– this will involved estimating actual costs of options on the environment. It will provide monetary value estimates for some of the impacts, which was then included into the least cost modelling.*

- ***Qualitative appraisal*** *– many environmental effects cannot be assessed in a quantitative way e.g. a person's perception of a landscape. The qualitative assessment involved using expert judgement to answer a series of questions based on whether an option is likely to meet environmental objectives. This is documented in the matrices in the Environmental Report.*

Both assessments were used when identifying the preferred option. Table 1.13b summarises the key SEA stages used for our Plan.

Table 1.13b: Summary of the key SEA stages for our Plan

SEA Stage	What we did or will do	Consultation
Screening	We produced a letter saying the plan would require SEA	The letter was issued to statutory organisations in May 2007
Scoping	We produced a scoping report which identified key issues to be included in the assessment based on a review of the baseline. We undertook a review of relevant plans, programmes and policies	The report was issued to statutory organisations for a 5 week consultation period in October 2007
Assessment	The SEA was split into a quantitative and a qualitative assessment. Thre results of these influenced the chioice of the preferred option. The cumulative effects of the plan options were assessed.	The matrices of these assessments are summarised in the environmental report.
Environmental Report	We have produced an environmental report to be published alongside the Plan. This summarises the SEA process.	The report is to be published alongside the plan.
Adoption	We will produce a post adoption statement to be published alongside the Plan	A post adoption statement will be published.
Monitoring	We will monitor the effects of the options as they are implemented at project level	Consultation will be undertaken on the individual projects that require planning permission.

The results of the SEA assessment are included in our Environmental Report published separately as Part 4 of our Plan.

2 WATER SUPPLY

2.1 Deployable output

A rigorous, quality assured procedure has been designed to ensure the accurate management, update and communication of Source Reliable Output (SRO) or Deployable output (DO) information for Veolia Water Central Abstraction Sources, for both groundwater and surface water sources.

The procedure is designed to address:

- Data capture and Transfer.
- Administration of the SRO database.
- Review & Generation of SRO results.
- Quality Assurance of SRO results.
- Distribution of SRO results and reports.

The basis for the SRO work will be the methodology documented in the 1995 UKWIR publication "A Methodology for the Determination of Outputs of Groundwater Sources" and as modified by the Combined Methodology (Halcrow 2003).

2.1.1 Methodology

Table 2.1.1: Deployable Output Definitions

Deployable Output (DO) Definitions	
SRO	Source Reliable Output, equivalent to *Deployable Output* (DO) of an abstraction source under a specified environmental and demand condition.
DO	Deployable Output: the output of a commissioned source or group of sources or bulk supply as constrained by: licence, water quality, environment, treatment, raw water mains, pumping plant, well, aquifer properties and transfer / output mains. Without further clarification applies to drought conditions only.
PY	The Potential Yield of a commissioned source or group sources as constrained only by well and/or aquifer properties for specified conditions and demands (UKWIR, 1995).
Source	This term is often used interchangeably with "pumping station". For the purposes of this work, the term "*source"* is used to describe the point of abstraction e.g. borehole or river intake.
Source-works	All assets between and including the point of abstraction and the point at which it is first fit for purpose (UKWIR, 1995).

RDO	Resultant Deployable Output - Moving up scale ("source" to "zone") progressively more potential constraints are applied to the abstracted water yield. In combination, the scale based definitions of DO are combined to form the *Resultant Deployable Output* (RDO). Although initially appearing overly complicated, this approach is particularly beneficial in determining options for improvement of source yields as it gives visibility to source capability as well as reliable yield. Without further clarification DO can generally be regarded as RDO.		
Scale	**Deployable Output Source Scale**	**Deployable Output Sourceworks Scale**	**Deployable Output Zone Scale**
Description	Borehole / Well / River Intake or Bulk Supply	Pumping Station Boundary or Post Treatment System	Group Licence / Resource Zone / Catchment
Definition	The output of a one or more wells/boreholes, River Intake or bulk supply as constrained by: individual licence, water quality, environment, pumping plant, well/borehole design and aquifer properties.	As for *Source Scale* plus: As constrained by on-site treatment plant, on-site storage and/or, raw water mains	As for *Sourceworks Scale* plus: As constrained by group licence (e.g. share of aggregate) distribution system, off-site storage, group treatment plant (e.g. LANE), etc.

The term *Deployable Output* as defined within our Plan can be applied at a number of scales. The primary objective of this procedure is to generate *Source Scale* and *Source works* scale deployable output and principal yield values. Zone Scale DO figures incorporate consideration of Group Licence constraints, distribution and operational factors which require input from other areas of the business.

2.1.2 Determination of Deployable Outputs

Our current source yield assessment methodology is based on the earlier approaches outlined in the following reports:

- *A Methodology for the determination of Outputs of Groundwater Sources (UKWIR): Beeson, van Wonderen and Mistear (1995).*

- *NRA R&D Note "Surface Water Yield Assessment" (1995).*

Both these methodologies are focused on determining deployable outputs under drought conditions only.

Practitioners have recognised that the existing methodology does not take into account factors such as seasonal resource availability and risk levels (e.g. levels of service/return periods). In addition, the 1995 methodologies are very source centred and fail to consider the wider aquifer and/or catchment.

Attempts have been made to expand and update the 1995 methodology by UKWIR and the Environment Agency in order to overcome limitations and reflect new regulatory requirements. This work is detailed in the following documents:

- *A unified Methodology for the Determination of Deployable Output from Water Sources*, UKWIR/Environment Agency (2000).

- *Critical Period Groundwater Yield*, UKWIR/Environment Agency (2001).

The UKWIR/Environment Agency proposed methodology revisions are both data intensive but are likely to be adopted as best practice in the future. We expect to continue working on this approach.

The Company has adopted a more rigorous approach to Deployable Output assessment by:

- Considering abstraction performance under non-drought conditions;
- Carrying out some determination of the likely impacts of climate change;
- Improving the visibility of the impact of output and water level constraints (Source, Source works and Zone DO definitions);
- Expressing some degree of uncertainty in the Deployable Output figures (now considered as part of Headroom assessment).
- Developing a method for assessing the Deployable Output of its run of river sources that complies with the Unified Methodology (2000).

The Deployable Output assessment method for PR09 examines the period in which the lowest groundwater levels occurred and highest demand during the historic period and builds on the 2003 assessments for AMP4. The average Deployable Output assessment for each source evaluates its annual average output at its lowest annual water level. The peak Deployable Output assessment for each source evaluates its output during the critical period (peak week) and the water levels that pertain to that output at that time. This can lead to a counter-intuitive understanding of water levels at peak output as compared to water levels at average since the lowest annual water levels do not necessarily coincide with the critical period. At some sources, peak flow does not coincide with the peak week and this has to be considered when developing the Deployable Output for each source.

A quality assured procedure based on the UKWIR 1995 methodology was developed to incorporate this extended approach and used to determine the figures required for the Draft Water Resources Plan 2008. New Deployable Outputs have been determined for new source works and existing AMP4 Deployable Output figures have been adjusted where relevant on the basis of new data.

2.1.2.1 Source Output and Water Level Data

Since the 2004 values, the period 2006/07 has been considered as a drought period, as groundwater levels approached their historic minima, last seen in 1997, providing an opportunity to assess source performance and where necessary, to update the drought Deployable Output figures using current operational data for pumping water levels and abstraction rates.

This data was extracted from our telemetry system and is held locally within the Water Resources electronic filing system (e.g. Excel workbooks). Excel based tools were developed to take weekly output and water level data, average it to monthly figures and plot the results in the form of Summary Diagrams. The reliability of the telemetry data for water levels has been verified with manual dips.

Site information, such as pump duty and depth settings are available from our Operations Manuals and asset data from our asset management information system database. Information gaps were filled by direct communication with our Production Managers.

2.1.2.2 Station Files, Drawings, Notes and Existing SRO Diagrams

The majority of our Pumping Stations had full Deployable Output Reports published at the time of or just following the AMP4 business plan submission. This documentation provided the basis for the current review. In addition to these files, new information arising from recent project work, downhole inspections and other activities have also been utilised in determining the latest Deployable Output figures. During the Deployable Output review, if there was insufficient or conflicting information, additional data was sought. All such correspondence was referenced appropriately. Information acquired via electronic correspondence was also documented and referenced similarly. All new data collected were filled as appropriate. This new combined body of data was used to determine the water level and pumping rate constraints for each source and/or borehole being reviewed.

2.1.2.3 Splitting of Group Licences

In some cases, the sum of the individual zone scale source work Deployable Output's in a licence group is greater than the maximum licensed abstraction rate. In these cases the individual zone scale Deployable Output was adjusted downwards according to the historic use. The adjusted individual values equate to the group licence limit corresponding to the relevant demand condition (e.g. Average Demand Deployable Output corresponds to the Average Annual Licence Limit).

2.1.2.4 Allowances for point source pollution and deteriorating raw water quality

The majority of short-term outages and longer term uncertainty from the impact of pollution incidents has been taken into account in both Outage and Headroom calculations. However, several sources have been marked down for loss of Deployable Output for water quality reasons.

For example, HATF Pumping Station has been given a Deployable Output value of zero in both the base year and all future years due to bromate contamination. However, schemes to provide temporary and long term replacement of the Deployable Output have been included in the AMP4 Schemes and are currently ongoing.

Sources that have been out of supply for long term quality issues have been given a Deployable Output value of zero, such as ICKE. A value of 5.82 Ml/d has also been given to BOWB, even though it is currently out of service due to the Buncefield incident, although there is no direct contamination but there are concerns over water quality and analytical results. It is envisaged this source will be returned to service shortly.

2.1.2.5 Surface Water Sources

We operate four surface water treatment works on the River Thames. For the AMP4 assessment, the DO of these surface sources was based on engineering estimates of treatment capabilities and any distribution constraints, as none of these sources are constrained by their licences, except for licensed daily averages and peak values. There are no flow constraints linked to the volume of water in the River Thames, thus these are unconstrained run of river licences. The lower Thames Operating Agreement and associated licences require that Thames Water Utilities Limited (TWUL) manages its river abstractions to maintain minimum flows over Teddington weir, into the tidal stretch of the River Thames. These conditions do not impact on our ability to abstract its full licensed volumes, and the TWUL water resources plan allows for these licensed volumes (and that from other abstractors on the Thames). Thus the state of flow in the Thames is not a constraining factor in our DO assessments.

The methodology [19] does not fully cover such run of river licences, and thus we have developed a methodology and have sought independent confirmation that this complies with the Unified Methodology principals.

This new methodology was applied to the four sources and separate reports written for each one. The methodology investigates each of the treatment processes and identifies rate determining steps for each one, identifies process losses and derives both a theoretical flow and an actual flow, based on historic site operation. For the current process, the years 2005 and 2006 were chosen as the operational period for this evaluation as they corresponded to current capabilities in a period of high demand under drought conditions.

The result of this re-assessment is a net change in DO of the surface sites. This is shown in table 2.1.2.5 below.

Table 2.1.2.5: Surface Water Sources

Source works	Difference Ave. Ml/d	Difference Peak Ml/d	Notes
EGHS	24.17	-0.44	Average increase allows group to achieve licence, minus process losses
CHERS	-13.75	-12.96	Refinement of process constraints, based on operational experience
WALS	-7.59	-5.48	Refinement of process constraints, based on operational experience
Group	**2.83**	**-18.88**	Increase in average, decrease at peak. Individual average site DO's constrained by group Licence.
HWFS	1.00	10.00	Increase in peak due to reassessment and current output capability
Total	**3.83**	**-8.88**	**Total = "Group" plus "HFWS"**

[19] UK Water Industry Research and the Environment Agency (2000), *A Unified Methodology for the Determination of Deployable Output from Water Sources*, Report Ref. No. 00/WR/18/2.

2.1.2.6 DO Changes post AMP4 base year

A number of schemes have been implemented during the current AMP4 period and have resulted in changes in DO. These include a mixture of outstanding AMP3 schemes and AMP4 projects. Some of these are accounted in for the new base year values (2007/08) as shown in Table 2.1.2.6a, and those schemes currently in progress but not yet implemented (Table 2.1.2.6b) or those completed after the 2007/8 DO assessment and therefore not incorporated. Table 2.1.2.6c shows future expected changes in DO.

Table 2.1.2.6a: Completed AMP3 and AMP4 Schemes with Changes in DO

Source works	Average Volume Change	Peak Volume Change	Notes
BLAF	**0**	**0.76**	New borehole pumps, power upgrade and pump testing (AMP4)
BULS	**3.3**	**3.41**	Installation of UV plant and two new pumps (AMP4)
CAUW	**4.45**	**3.30**	Licence variation in North Stortford group of licence (AMP4)
DEBD	**0.09**	**0.09**	Source Optimisation (AMP4)
DIGS	**0.88**	**1.50**	Lowering of Pumps, part of drought schemes (AMP4)
MUSL	**0.5**	**0.96**	Upgrading distribution assets (AMP4)
PERI	**0.69**	**-0.81**	Pump control optimisation increased average, but treatment constraints limit peak (AMP3)
ROES	**4.2**	**2.2**	Source Optimisation (AMP4)
RUNGS	**2.64**	**2.64**	Re-commissioning allowance made for treatment losses(AMP3)
STON	**0**	**0.33**	Installation of new pump (AMP4)
BOWR	**2.7**	**0.6**	Export surplus from RZ3 to RZ5 therefore output is not constrained by demand, now constrained by DAPWL (AMP4)
FULR	**2.1**	**0**	
Total	**21.05**	**14.89**	

Table 2.1.2.6b: Ongoing in AMP4 and Future Schemes with Changes in DO

Source works	Volume Change		Est'd Date Available	Notes
	Average	Peak		
BALD	1.00	2.00	07-08	Re-commissioning with new source pumps and new treatment under construction **Scheme completed after the base year assessment.**
CHERG 4th Well	4.00	15.00	2008	AMP3 scheme, now commissioned and licensed, 2008/09, post base year assessment.
STEV	2.00	2.50	09-10	Installation of new borehole pumps and new treatment under construction
DEBD	1.17	1.20	08-09	Source optimisation ongoing
NORS	1.81	2.83	08-09	New pumps, Licence Change and network changes/ boosters
HUNT	1.5	1.5	08-09	Upgrading borehole pumps and treatment facilities to level 3 disinfection under construction using borehole 3
MUSL	1.32	0.99	08-09	Upgrading distribution assets
NOMA	9.09	9.09	08-09	Hatfield replacement, new licence increased to 9 Ml/d, change not accounted for in base year assessment
NORO	0	2.00	08-09	Upgrade of chlorination to UV plant
PORT	0.40	0.40	08-09	New pump, new inverter and new treatment works
REDR	1.00	1.50	09-10	Drilling of satellite borehole and extension of the current treatment facility under construction
SHEN	0.84	1.47	09-10	Commissioning of new licence, installation of borehole pumps, network connection and treatment works
WATT	1.05	0.68	08-09	Source optimisation, up rating pumps and disinfection system
HFWS	34.00	5.00	08-09	Source optimisation
EGHS	1.8	0	09-10	Wastewater recovery
CHERS	2	0	09-10	
WALS	3.5	0	09-10	
Total	**66.48**	**46.16**		

Table 2.1.2.6c : Other Expected Future DO Changes

Source works	Average Volume Change	Peak Volume Change	Est Date Ava	Notes
LANE Group	-7.00	0.00	08-09	Hatfield Licence transfer expires
ESS	-2.90	-3.50	09-10	Part of Essendon replacement
FULL	-9.09	-9.09	15-16*	Sustainability Reduction (AMP 6)
WHEA	-2.00	0.00	08-09	Hatfield licence transfer expires
WHIT	-5.74	-5.74	15-16*	Sustainability Reduction (AMP 6)
EASH/WHEA	4.00	4.00	09-10	Part of Essendon replacement
Total	**-22.73**	**-14.33**		

2.1.2.7 Asset failure and DO

Asset failure was not considered to be relevant to changes in DO. Equipment failures, such as pump failure, are taken into account in the outage assessment and are only short term losses. The status of the boreholes was taken into account in the asset condition revaluation, and where appropriate, will lead to capital maintenance for repair/replacement. Asset failure due to changing water quality is accounted for in headroom.

2.1.2.8 DO Statutory adjustments

No statutory adjustments have been made for the 2005/06 SRO Assessment.

2.1.2.9 AMP4-PR09 DO Changes

After the process of re-evaluation of the base year deployable outputs had been completed, the results were compared with what was produced for AMP4. It was found that there had been many changes and these varied from insignificant to very large. There were many reasons for these changes, and detailed tracking and supporting evidence has been produced on a source by source basis. These are displayed in summary form below:

Table 2.1.2.9 : Summary Table

Water Resource Zone	Equivalent PR04 DO position (Ml/d)		Current PR09 DO position (Ml/d)		Difference (Ml/d)	
	Average	Peak	Average	Peak	Average	Peak
Northern Zone	294.1	346.1	312.2	358.6	18.1	12.4
Central Zone	519.5	610.0	552.3	645.8	32.9	35.8
Southern Zone	184.7	237.3	191.7	222.8	6.9	-14.5
Company Level	**998.3**	**1193.5**	**1056.2**	**1227.2**	**57.9**	**33.7**

2.2 Reductions in deployable output

The Company has a requirement under the Water Industry Act 1991 to;
(a) '…to further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological or physiographical features of special interest;'

(b) a requirement to have regard to the desirability of protecting and conserving buildings, sites and objects of archaeological, architectural or historic interest; and

(c) a requirement to take into account any effect which the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects.

As such the Company in being seen as the 'water company of choice' should be excelling in environmental matters and leading in achieving its environmental objectives.

Low flows in many of the rivers within our supply area are a legacy of post war development to meet the demand for water in the new town developments and general housing growth in the Home Counties; Welwyn Garden City, Stevenage, Hemel Hempstead, Harlow and Luton. Many of these post War resource developments recognised the potential for an impact on local river flows but at the time this was not deemed a substantive reason to prevent the licensing of abstraction. Often local concern was raised about the impact of abstraction on river flows but it has not been until 1990 that low rivers flows have been seen as a priority.

The conflict between the provision of public water supply and the environmental requirements of nationally rare habitats, like chalk streams, continue to be a challenge. The challenge of managing a balance between the development of future resources and addressing the challenges of inherited environmental impacts where there is the potential for over riding public interest of public water supply is fundamental to our water resources planning into the future.

2.2.1 Sustainability Reductions

We have been engaged in eight studies in partnership with the Environment Agency during AMP4. The Environment Agency identified two Sustainability Reductions (SR) in their letter dated 11th June 2007. These are for two existing schemes; the Hiz (an AMP2 ALF scheme) and support to Ashwell Springs (an existing provision on the SLIP licence). A third was also identified, the Lee Valley SPA, but this has a zero reduction. These have Local and SSSI drivers respectively. In August 2008, we were advised of two other sustainability reductions, as described in 2.2.1.4. A programme of a further 6 investigations and options appraisals has also been notified to us by the Environment Agency identified for inclusion in PR09 which may result in other sustainability reductions.

Table 2.2.1 : Sustainability Reductions

Site Name	Driver	Priority	Current Status	Licences	Definite SR (Ml/d)	Indicative SR (Ml/d)
Lee Valley Special Protection Area	Habitats Directive	Medium	Investigation		0	
Hiz	Local	Medium	Licensing Solution ex AMP2	WYMO (06/33/13/07) TEMP (06/33/13/08) OFFS (06/33/13/09) WELL (06/33/13/10) OUGH (06/33/13/11)	0.84	
Ashwell Springs	SSSI	Medium	Options identification & appraisal	SLIP (06/33/14/36)		0.5
DIGS/ FULL and WHIH	Sustainability Reductions	High		29/38/2/89	-14.83	

2.2.1.1 Lea Valley SPA

The Lee Valley SPA scheme was a Medium Priority Habitats (Birds) Directive investigation, led by the EA. The investigations concluded that there would be no SR associated with this site, as the investigation under the RSA Programme for the Habitats Review of Consents showed that no abstractions were to be taken forward to Stage 4 for reductions.

2.2.1.2 River Hiz

The River Hiz scheme, a 1994 Alleviation of Low Flows (ALF) scheme, resulted in the provision of river support to the River Hiz at Charlton Mill Pond and the Spring Head of the River Oughton, from OUGH and/or OFFS to mitigate the impact of abstraction in the area. The 0.84 Ml/d reduction identified in the EA's letter of June 2007 is already accounted for in the base Opex calculations from AMP3 onwards and therefore there is no change to DO from these sources. Support has been provided to Charlton Mill Pond fairly continuously since the implementation of the scheme in 1996, with the exception of the very wet winter of 2000-01. However the EA expect us to formalise an Operating Agreement during AMP5 and we are currently working with them on this issue.

2.2.1.3 Ashwell Springs

There is a provision on the SLIP licence that requires us to provide support to Ashwell Springs SSSI from our SLIP source by discharging water into a nearby disused borehole so that it emerges from the spring in dry weather. The Environment Agency also supports the Spring from a borehole at Redlands Farm and this is the first point of augmentation. The EA have indicated that they would like to formalise the operation of the licence provision under an Operating Agreement. It is this volume that is referred to in this sustainability reduction and is therefore no change to DO. Work is in hand to produce an Operating Agreement.

2.2.1.4 River Mimram and Beane

In a letter of the 29th May 2008, the EA have notified us that they will not renew a recently granted group licence variation (29/38/2/89) relating to our sources at FULL and DIGS beyond 31/3/2015. This is due to impacts on flows in the River Mimram as assessed through the CAMS process. This will cause an average DO reduction of 3.48Ml/d.

This letter has been superseded by the EA letter of 29th August 2008 confirming a firm sustainability reduction of 9.09Ml/d at the FULL, by a cessation of the licence. This will result in a decrease in DO of 9.09 Ml/d at average and peak. The reduction of 3.48Ml/d mentioned above is included in the 9.09Ml/d. The sustainability reduction might be imposed later than the expiration of the licence variation, in which case the DO loss will occur in two steps. In addition, another licence at WHIH will be reduced to 15Ml/d at both peak and average, resulting in a 5.74Ml/d DO reduction at both average and peak. No date of these reductions was given, but for the purposes of this Plan, a date of 01/04/2015 has been used as a basis for our modelling, therefore we account for the full 9.09Ml/d reduction for FULL at that time. The sustainability reduction at FULL will also restrict annual operational volumes available during non drought years by a higher volume of up to 2.28 Ml/d, resulting in additional imports of water to meet demand in the zone, thus resulting in higher operational costs.

Such reductions will have a significant impact on our Company and customers. In addition to the impact on DO, normal year operation and costs will be affected, and the impact on the current AMP4 re-location schemes is unclear. In terms of cost, the impacts fall into four categories:

(1) Capital investment to replace the capacity at the current locations
(2) Increases in operating costs, and carbon emissions, as the water lost from low cost sources has to be replaced from the next available higher cost source
(3) Abandonment of assets that have been paid for by customers and otherwise may have many years of operational life
(4) Brings forward investment that would otherwise not be required to meet the growth in demand

Taken together, we would need to spend over £1m on the network simply to get water to customers, and additional operating costs of at least £800k per annum immediately the licence changes came into effect, before taking into account the loss of assets valued at over £12m and further costs of decommissioning and making safe. In both cases, the resulting loss of water from the supply demand balance would require an earlier replacement of this water than would otherwise be the case, thus further increasing costs to customers.

We have allowed for these DO losses in our final Business Plan, and have included the capital cost consequences, insisting that they are included in prices or fully compensated by the EA as this is the only basis upon which they could proceed. We are concerned that these proposals may not be in the interests of customers, particularly in the current economic climate and we are of the view that there is unlikely to be a sufficient positive cost-benefit.

2.2.1.5 Other Sites

It is possible that other time limited licences and variations may also not be renewed in the future. This could result in further reductions of up to 33.84 Ml/d at average and 32.61 Ml/d at peak. We have no indication from the EA on which, if any, of these time limitations may or may not be renewed, nevertheless the potential impact of the reductions has been assessed. The impact of the above losses in licence at our critical demand period and at average demand is shown in the graphs on Figures 2.2.1a and 1b below. There may be additional reductions required by the Water Framework Directive River Basin Management Plan activities mentioned above. Such reductions would not come into effect until at least AMP6, but collectively have a significant potential to reduce our resource base as indicated in the Water Resources Management Plan. The extent of such reductions and their timing are currently unknown.

Figure 2.2.1a : Consequence of Loss of Time Limited Licence at Critical Period

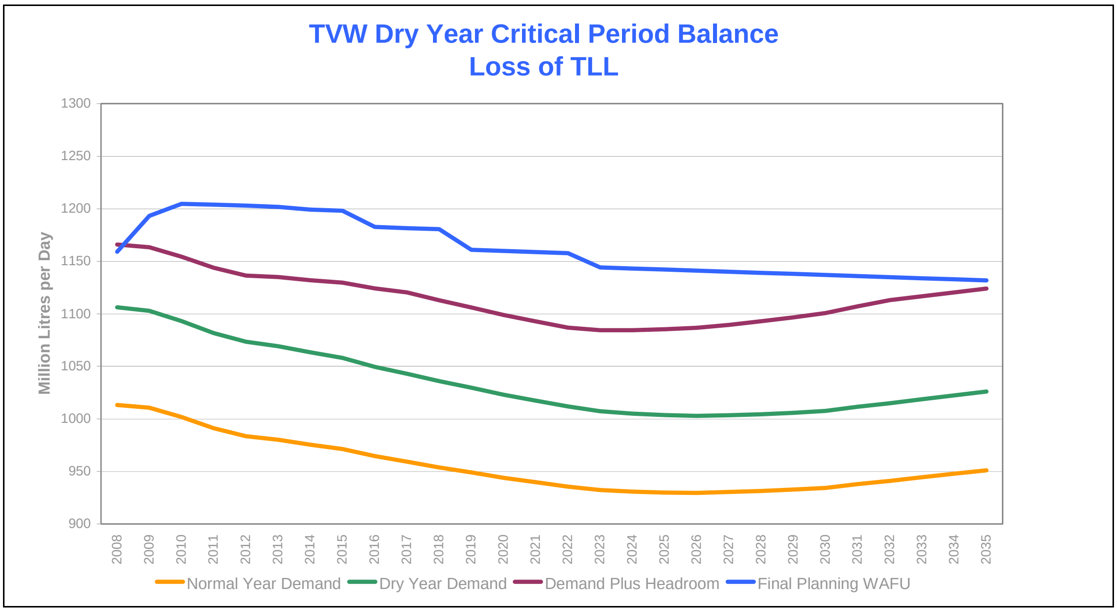
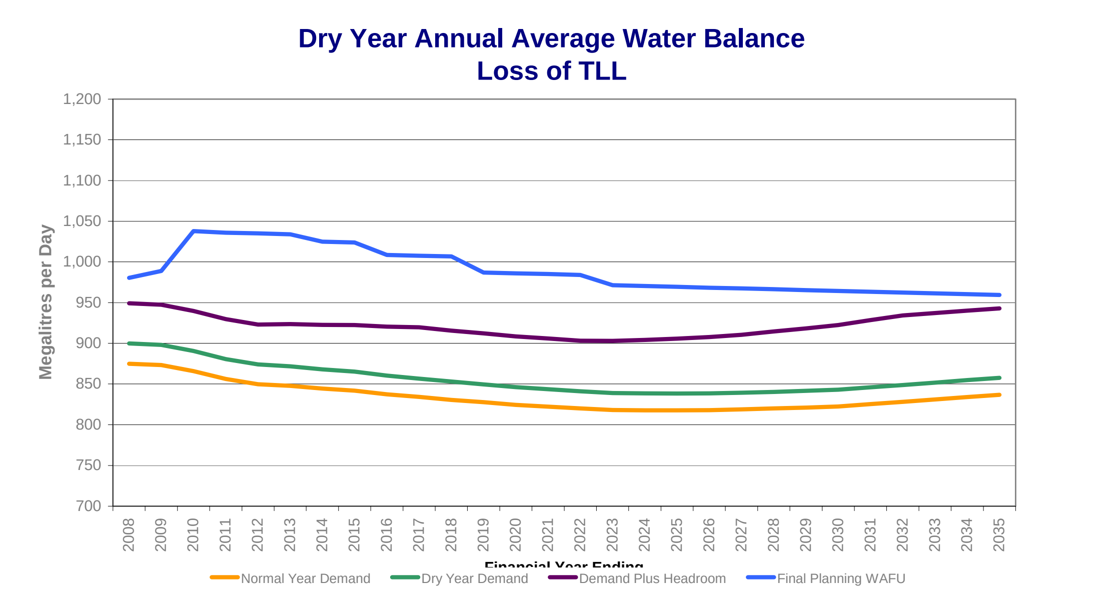


Figure 2.2.1b : Consequence of Loss of Time Limited Licence at Annual Average



2.2.2 AMP4 National Environment Programme - Update

2.2.2.1 Lee Valley SPA

This scheme was a Medium Priority Habitats (Birds) Directive investigation, led by the EA. The investigations have concluded that there will be no SR associated with this site, as the investigation under the RSA Programme for the Habitats Review of Consents showed that no abstractions were to be taken forward to Stage 4 for reductions.

2.2.2.2 South West London Waterbodies SPA

The EA investigations on this site, for which we have provided details of data that we have on water levels in the company owned lakes and local groundwater levels, have concluded that no significant impact on either the surface water or groundwater was found, and that these lakes are not being negatively impacted by abstraction licences. Therefore no licences will be taken through to a Stage 4 investigation or reductions.

2.2.2.3 River Mimram

Following the AMP3 investigation by the EA into low flows in the River Mimram, it was concluded that the Company's abstraction at FULL was having a detrimental effect on flows in the River, a series of further investigation including trial drilling and testing was funded in 2004. Investigations to date have identified that there are few locations to which the FULL source could be relocated due to active quarrying, historic landfilling and other land access issues. A site has been identified on the northern side of the valley near Tewin where land negotiations are nearing completion and it is hoped that trial drilling and testing will commence in Spring 2009.

Additional monitoring points have been identified with monitoring commenced at a number of these in Summer 2007. A further two observation boreholes are to be drilled to monitor the impact of abstraction from the trial borehole on chalk groundwater levels near Tewinbury SSSI.

Tewinbury SSSI is designated for its series of alluvial meadows and marshes bordering the Mimram and a small piece of Alder woodland. The site provides a habitat for a variety of wetland birds and the tall fen provides a roost for flocks of birds in winter. The site is considered to be unfavourable recovering and there has recently been a lot of work by Herts. and Middlesex Wildlife Trust and the EA to develop a water level management plan for the site.

2.2.2.4 River Beane

Following 1994 investigations a recommendation was made that WHIH Pumping Station should be relocation to the lower catchment. However, due to concerns over this proposal on low flow in the Lower Rib and Mimram implementation was postponed whilst investigation on the Mimram and Upper Lee groundwater model were undertaken.

The Company were funded in AMP4 for further investigations including trial drilling and testing of relocation sites for 50% of the WHIH abstraction as there was concern that relocating the full WHIH abstraction could have detrimental impact on flows in the Lower Beane.

Investigations to date have identified limited suitable locations with many areas away from the valley floor, on the interfluve between the Bean and Mimran and Beane and Rib, having historically been landfilled making them unsuitable for public water supply abstraction. This has meant that land negotiations have been restricted to areas close to the River. Two sites have been identified, and land negotiations are nearing completion and it is hoped that trial drilling and testing will commence in Spring 2009.

2.2.2.5 Upper River Gade

AMP3 investigations were undertaken by the EA on the Upper Gade in conjunction with developing a groundwater model of the Upper Colne. This work concluded that the relocation of the PICC end abstraction whilst thought to impact low flows was not cost effective and therefore alternatives to this should be investigated.

The Upper River Gade has been historically heavily modified, through the creation of mill leats and the construction of a flow diversion channel as flood defence as part of the development of the new town of Hemel Hempstead.

Through AMP4, we have undertaken various studies, investigations and workshops to identify what issues exist and how they may be mitigated. Suggestions have been made for modification of structures on the upper part of the river, and fencing to prevent animal damage to the river banks and these suggestions are being considered by local landowners and action groups, including angling societies for local implementation. On the reach just above and through Hemel Hempstead, the recommendations are to be adopted by the EA and the Borough Council and funded through both the RSA programme and the town centre re-development scheme.

2.2.2.6 Hughenden Stream

AMP3 investigations were inconclusive as to the impact of HUGH Pumping Station on flows in the Hughenden Stream. It was therefore agreed that as Thames Water were to decommission their pumping station at MILL on the neighbouring River Wye that we should monitor any benefit of this closure on flows in the Hughenden Stream first. Groundwater level monitoring has continued throughout the period 2005 to 2009, but as yet, Thames Water have not been able to close MILL for operational reasons. This has meant that there has not yet been an extended period of no abstraction on the Wye at Wycombe to enable us to assess whether this will also benefit flows in Hughenden Stream. It has been agreed with the EA that monitoring should continue until such time that this is possible.

Groundwater level monitoring to date has shown a typical chalk groundwater trend, being predominantly influenced by winter rainfall. The impact of the low groundwater levels associated with the low rainfall winters of 2004/05 and 2005/06 can clearly be seen, but they have recovered following good rainfall in 2006/07 and the subsequent period.

2.2.2.7 Lower River Rib

Investigations commenced in 2005 into low flows in the Lower River Rib and the potential impact of THUN and WADE Pumping Stations on flows. Concern was raised by the EA that this could be adversely affecting the ecology of the lower river. A combination of field work and desk studies has been undertaken and information on the accretion of flows and groundwater levels in the lower catchment. Two new observation boreholes have been drilled to provide additional information on groundwater levels between the Ash and the Lee. Signal tests have been undertaken and all data is currently being written up in a final report.

2.2.2.8 Thames Surface Water Intakes

Investigations into the entrainment of fish in the Lower River Thames Intakes, including our four surface water intakes and six of Thames Waters intakes, have been undertaken throughout 2006 and 2007 and the results published in March 2008. This monitoring was to assess the extent of fish entrainment in the intakes and calculate the impact on the equivalent adult fish population of this loss in fry and juvenile fish. In additional to the baseline monitoring, trials into the effectiveness of different types of passive screening have been undertake at the Company's EGHS intake. The conclusions were that screens were effective in reducing the impact on fry and they should be installed on each of the intakes. This has already been achieved at the WALS site and proposals for the remaining three sites have been included in the PR09 submission under the Cost of Quality section.

2.2.2.9 Environmental Monitoring

In addition to monitoring required through the Environment Programme we carry out routine hydrological monitoring of rivers, lakes and groundwater within our supply area. This is for a variety of purposes including time limited licence monitoring, baseline monitoring or in conjunction with particular pumping tests. Raw water quality monitoring is also undertaken on sites where there is concern about potential degradation of groundwater from for example landfill sites neighbouring one of our sources.

It is considered that this monitoring is a fundamental role of water resource planning, in order to understand the potential impact of our abstraction on the environment and the impact of other's activities, both historic and present, on the operation of our sources.

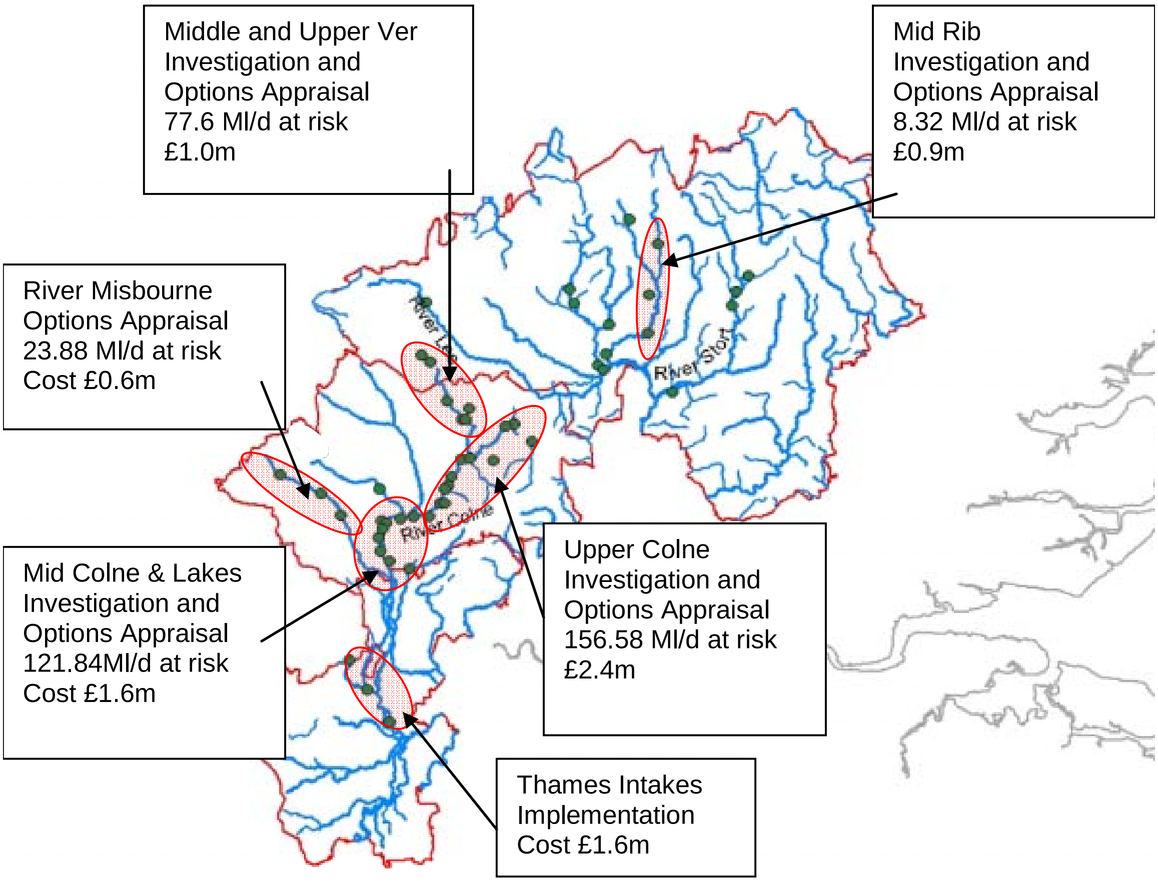
2.2.3 AMP5 National Environment Programme

For the AMP5 period, a programme of 7 investigations and 9 options appraisals and 1 implementation scheme have been identified by the EA in their letter of 28th November 2008 for inclusion in our FBP at PR09. The 17 schemes include 388Ml/d of our current DO (593Ml/d peak Licence) that is to be investigated in the AMP5 period; this is 30% of our total DO. The general locations of these investigations are shown in the Figure 2.2.3 below. The potential impact of these investigations are substantial and may indicate a requirement for future sustainability reductions, however we are concerned that scale of costs associated with this volume of water should be taken fully into account as this could be disproportionate to the benefits gained and may be unaffordable by our customers bearing in mind water is locally abstracted to meet local demands. We have evaluated the costs of undertaking these schemes as £7.4 million for our Final Business Plan (Table 2.2.3.8).

In AMP4, we undertook investigations on 66.4Ml/d (5%) of our total DO, with a resulting sustainability loss of 14.83Ml/d. If the same ratio were to be reflected in future outcomes from the AMP5 programme of studies this might suggest a future impact in the order of 87Ml/d. Such volumes of water will be very difficult to replace and costly, not only in the cost of the replacement water infrastructure, but in increased operational costs and carbon footprint, as this volume of water might require large scale imports, wholesale renewal of distribution mains or high impact demand reduction measures. The requirement for large replacement volumes may well require inter-basin transfers and/or desalination from a location remote from our operating area. Increased activities from water efficiency projects and demand management are unlikely to reduce demand to the extent required and would be both costly and unpopular with our customers. Nevertheless options will be considered in the options appraisals to be undertaken in AMP5 for specific sources and groups of sources. The cumulative effect will be critical.

Any future sustainability reductions will be enacted through the statutory process, taking into account the impact on the security of supply to customers and would only be enacted once this had been secured. The funding mechanism for future reductions remains unclear, but we assume these are to be met by compensation from the EA under sections 52 and 61 of the Water Resources Act (1991) as modified by the Water Act (2003) and derived from the EIUC charges that are now part of the abstraction licence charge. There are a number of areas for which funding will be required to overcome the impact of costs associated with reductions in deployable output and not all of these will be required at the same time. They include the cost of capital works to allow replacement water to reach the affected area to maintain local security of supply and increases in future operational costs (including the effect on carbon emissions). There will also be impacts of the change in asset value due to abandonment or lower utilisation as we will be left with stranded assets, for which our customers have already paid, and the bringing forward of investment to meet the growth in demand that would otherwise not be required.

Figure 2.2.3 : Environmental Investigations



The 17 schemes and one implementation are shown in Table 2.2.3a. These have a combination of Biodiversity (BAPw1) drivers, Sites of Special Scientific Interest (Iw3) drivers and Water Framework Directive (WFD) drivers. There are some differences between the final NEP schemes and those notified and detailed in our draft business plan. Some of the initial schemes have been excluded, some components of the initial ones have been classified as 'uncertain' and one new scheme (Upper Ver investigation) has been added. In addition, the scope and requirements of some of the projects has been expanded and clarified from those available for the draft plan. A comparison of these is given in Table 2.2.3a for clarification.

The output from this programme of work will predominantly be in the form of environmental impact assessment reports which will be signed off by the EA as complete. They have also requested that we undertake one implementation project, the installation of fish screens on our river intakes at EGHS, CHERS and SUNN, again based on the work undertaken during AMP4.

Table 2.2.3a : Quality Enhancement schemes for water abstraction

		Draft Business Plan	Final Business Plan	
Site Unique ID / Water Body ID	**Driver**	**Scheme / River Basin District - Waterbody Name**	**Scheme / River Basin District - Waterbody Name**	**Scopes**
RSA-THNE-28/03	BAPw1	Upper Colne Investigation	Upper Colne Investigation	Combined as one investigation (Upper Colne) and Options Appraisal (classified as uncertain)
RSA-THNE-28/15	BAPw1	Upper Colne Investigation	Upper Colne Investigation	
RSA-THNE-28/14	BAPw1	Upper Colne Investigation	Upper Colne Investigation	
RSA-THNE-51/13	BAPw1	R. Stort Invest	~~Out~~	
RSA-THNE-28/11	BAPw1	Misbourne Post ALF investigation	Misbourne Post ALF investigation	Misbourne Option Appraisal (Misbourne)
RSA-THNE-28/16	BAPw1	Mid Ver Investigation	Mid Ver Investigation	Combined as one Options Appraisal (Ver)
RSA-THNE-28/17	BAPw1	Upper Ver Investigation	Upper Ver Investigation	
RSA-THNE-49/07	BAPw1	Mid Rib Investigation	Mid Rib Investigation	Mid Rib investigation (Rib - Buntingford to Latchford) and Options Appraisal (classified as uncertain)
THEN 38/06/01	Iw3	Roydon Investigation 1	~~Out~~	
RSA-THNE-28/19	Iw3, BAPw1	Mid Colne Lakes Investigation	Mid Colne Lakes Investigation	Combined as one Options Appraisal (Mid Colne) and Options Appraisal (classified as uncertain)
RSA-THNE-28/02	Iw3, BAPw1	Mid Colne Investigation	Mid Colne Investigation	
RSA-THNE-28/08	BAPw1	River Chess Investigation	~~Out~~	
WFD Water Bodies				
AP13, Lee to Luton Hoo	WFw3	Thames - Lee to Luton Hoo	~~Out~~	
AP3, Upper Colne	WFw3	Thames - Upper Colne	Thames - Upper Colne	Combined with (Upper Colne) Investigation above
AP6, Lower Rib	WFw3	Thames - Lower Rib	Mid Rib	Combined with (Rib - Buntingford to Latchford) Investigation above
GB106038033300	WFw3	Thames - The Old Bourne	~~Out~~	
GB106038033310	WFw3	Thames - River Beane	Thames - River Beane	Solved through AMP4 therefore no invest / Options App
GB106038040110	WFw3	Thames - River Beane	Thames - River Beane	Solved through AMP4 therefore no invest / Options App
GB106039029820	WFw3	Thames - River Colne	Thames - River Colne	Combined with (Upper Colne) Investigation above
GB106039029840	WFw3	Thames - River Colne	Thames - River Colne	
GB106039029850	WFw3	Thames - River Colne	Thames - River Colne	
GB106039029870	WFw3	Thames - River Chess	~~Out~~	
GB106039029920	WFw3	Not included	Thames - Upper Ver	New Investigation (Upper Ver)
	BAPw1	Fish Screens	Fish Screens	Implementation

The projects shown in Table 2.2.3a include both the ‘certain’ schemes and those classified as ‘uncertain’ as the options appraisal will depend on the outcome of the investigations. We have also included the uncertain schemes in our Final Business Plan as we anticipate they will be required to be carried out in AMP5. The EA have indicated that options appraisals are undertaken, within the AMP5 period. We have reservations about whether this is realistic, particularly for the Colne Valley schemes as they potentially involve such large volumes of water. However we have used the same costing methodology to assess these, which accounts for an additional £1m, and included them in the final business plan.

For the purpose of our Final Water Resources Management Plan and the Final Business Plan we have amalgamated these 17 schemes into catchment projects which are summarised in Table 2.2.3b. The deadlines for these projects are also indicated. This gives six projects in total, plus the fish screens implementation project following on from studies in AMP4.

Table 2.2.3b : New NEP projects with deadlines

Project Name	Project name	Deadline
Upper Colne	Investigation	31 March 2014
	Options Appraisal	31 March 2015
Misbourne	Options Appraisal	31 March 2012
Upper Ver	Investigation	31 March 2013
Upper and Mid Ver	Options Appraisal	31 December 2013
Mid Rib	Investigation	31 March 2013
	Options Appraisal	31 March 2014
Mid Colne River & Lakes	Investigation	31 March 2014
	Options Appraisal	31 March 2015
Fish Screens	Implementation	31 March 2013

The rearrangement of the completion dates, using experience gained from the evolution of AMP4 projects between the draft and the final Plan, and new provisions added in the stage plans by the EA has resulted in the reassessment of the costing of the individual components of the scope. The changes have been applied uniformly to all the projects, according to the EA stage plans specifications and have been detailed in Section 10.5.

2.2.3.1 Upper Colne investigation

This is an investigation into the impact of our groundwater abstractions in the Upper River Colne on river flows, under a biodiversity (BAPw1) driver. The Colne receives a significant proportion of flow from chalk groundwater and is defined as a chalk river, which is listed as a priority habitat under the UK Biodiversity Action Plan. A total of 13 sources have been identified for investigation with a total peak licensed capacity of 316.64Ml/d and a drought peak Deployable Output (DO) of 156.58Ml/d and a normal peak DO of 168.58Ml/d. The findings from this investigation will therefore have the potential to significantly influence availability of our water resources into the future.

The investigation will include a hydro-ecological assessment of the current conditions, reviewing historic studies and collecting new environmental monitoring data to establish current conditions. It is anticipated that the work will require groundwater modelling, pumping tests at our sources and land use assessments. This work has been costed based on our experience of undertaking similar AMP3 and AMP4 investigations of other catchments. This new investigation includes a much greater number of sources, including those of strategic importance and will therefore be a much larger piece of work than those investigations undertaken to date. There are also three WFD investigations identified for the Upper Colne. This has been included in the Upper Colne investigation with costs limited at present to the assessment of the abstractions on meeting Good Ecological Status (GES), as we have been provided no specific details by the EA.

2.2.3.2 Misbourne options appraisal

The River Misbourne is a chalk river that rises at the village of Great Missenden and flows to the southeast to meet the River Colne at Denham, a distance of 28km. It's general location is shown in Figure 10. This scheme has been identified under a biodiversity (BAPw1) driver as it is defined as a chalk river which is listed as a priority habitat under the UK Biodiversity Action Plan. Three of our sources at GREM, AMER and CHAL will be included in these investigations. They have a peak licensed volume of 28.41Ml/d and a peak DO of 23.88Ml/d (normal and drought).

Low flows in the Misbourne were investigated by us during AMP1 and also by Thames Water and the EA. An implementation scheme followed, including infrastructure work and an 8Ml/d reduction in Public Water Supply (PWS) abstraction from our sources at Amersham, Great Missenden and Chalfont. A further reduction in abstraction was implemented by Thames Water at the head of the Misbourne. A licence variation and operating agreement was completed in AMP3 for our Misbourne Group of sources with a time limited licence variation also secured for an equivalent 8Ml/d increase in the BLAF Group of sources in the Mid-Colne. Whilst it is accepted that the reduction in abstraction in the Misbourne Valley has been a success and has improved low flows, the River is considered to still suffer from low flows and a further reduction in abstraction maybe required.

A scheme has been put forward by the EA for options appraisal. This scheme will therefore involve reviewing all the studies to date and looking at options and the cost benefits of implementing a further reduction in abstraction. This work has been costed based on the AMP4 options appraisal work on the River Gade.

2.2.3.3 Ver options appraisal

The River Ver is a chalk river that has its ephemeral source near Kensworth Lynch (south of Luton) and flows in a south easterly direction for approximately 25km to its confluence with the River Colne at Bricketwood, just to the north of Watford. The scheme has been included under a biodiversity (BAPw1) driver as it is defined as a chalk river which is listed as a priority habitat under the UK Biodiversity Action Plan. We have 7 sources in this catchment that have a cumulative DO of 52.49Ml/d and a peak licence of 62.5Ml/d.

Studies undertaken in the 1980's concluded that low flows were attributable to an increase in groundwater abstraction within the catchment. Groundwater abstraction was reduced at FRIA Pumping Station (28/39/28/0130) from 15.9M/d to emergency use only in 1993. Current investigations have concluded that the Ver continues to suffer from low flows.

This scheme put forward by the EA requires options appraisal of both the Upper and Middle Ver, covering a reach of the river 13.2km in length. The objective of the project is the identification of an appropriate scheme to improve the flow regime within the River Ver from its Source to Verulam Park (St. Albans) to enable the enhancement and establishment of the characteristic habitats, plants and animals of chalk streams, and to establish a sustainable abstraction regime within the catchment to support the above objective. The new abstraction regime needs to be designed to redress the impact on the local environment resulting from the present abstraction regime. This work has been costed based on the AMP4 options appraisal work on the Gade.

For the Final Business Plan, the EA added another investigation on the Upper Ver (see GB106039029920 Upper Ver), which was requested to be dealt with as a separate scheme. However, results from this investigation will be especially valuable for the evaluation of the different options along the whole length of the river. It is, therefore, prudent that we undertake the Ver investigation before we proceed to the options appraisal, always within timeframes set by the EA.

2.2.3.4 Mid Rib investigation

The River Rib has been classified as a chalk river, despite exhibiting flow characteristics of a flashy boulder clay catchment. The scheme has been included under a biodiversity (BAPw1) driver as it is defined as a chalk river and as such listed as a priority habitat under the UK Biodiversity Action Plan. The Rib upstream of the hamlet of Latchford has been identified as potentially being affected by abstraction.

This investigation will look at the impact of our CHIP, STAD and HARS Pumping Stations, with a total peak licensed volume of 11.82Ml/d and drought and normal peak DO of 8.32Ml/d on flows in the Upper/Mid Rib. The EA have identified a reach of 12.3km to be investigated. The investigation will require us to undertake hydro-ecological monitoring, which we have costed based on experience gained in similar projects undertaken during AMP3 and AMP4.

2.2.3.5 Mid Colne River and Lakes investigation

The Mid Colne River for the purpose of this scheme is defined as the River Colne from the confluence with the Gade to confluence with the Misbourne, a length of approximately 8km. This reach of the Colne is linked with the water of the Grand Union Canal and also the Middle Colne Lakes. The Middle Colne Lakes are a series of 18 water bodies formed from historic gravel extraction along the valley floor. The Colne is classified as a chalk stream and has therefore been allocated a BAPw1 driver.

The EA have undertaken an initial Restoring Sustainable Abstraction programme (RSAp) investigation on the this area and have identified that there is a potential impact from our abstraction at CHOR, BATC, MILE, STOC, SPRW, WESY, NORO, BLAF and ICKE on both river flows and lake levels. These abstractions have a total peak licensed volume of 146.14Ml/d and a peak DO of 121.84Ml/d (drought and normal) and include the 8Ml/d transferred from the Misbourne catchment as part of the earlier implementation of the Misbourne ALF scheme.

The lakes are used for a variety of recreational purposes including angling and sailing, as well as having local and national importance in terms of their biological interest. There is one Site of Special Scientific Interest (SSSI) in the reach to be investigated, the Mid Colne Valley SSSI which includes Allen Lake and Broadwater and covers an area of 2.3km^2. This scheme is therefore also allocated an Iw3 driver due to the SSSI designation.

The ICKE source has been out of service for a number of years due to contamination from the adjacent New Years Green Landfill site. The designation of this site through Part IIA would allow the installation of suitable treatment, under the polluter pays principle. To date, neither the Local Authority (who operate the site) or the EA have classified this land as contaminated. We have long believed that the EA should use its powers to designate the site and break the current stalemate and move towards resolving this problem. Due to its location away from the valley floor, this source is considered to have limited impact on the area of interest (River Colne and Lakes), and would thus benefit flows in the Middle Colne if it could be returned to service by changing the pattern of abstraction.

The EA's RSAp investigations concluded that a relationship exists between abstractions to the north of the SSSI site and upstream lakes and the River Colne. The report however concluded that for the River Colne there was insignificant data to determine the impact of groundwater abstractions on flows between Batchworth and Denham. Further investigations undertaken by the Environment Agency in 2007 as part of an annual review of abstraction licences in the area have concluded that there is a potential relationship between, or a potential for abstractions to negatively influence lake levels and river flows. The investigations have concluded that a further monitoring programme needs to be developed to gain to gain a better understanding of the hydrology / hydrogeology and the requirements of the lakes and the River Colne and to assess any potential improvement measures.

2.2.3.6 Upper Ver Investigation

The EA have added a new investigation to the original list that was given to us for the draft business plan. This requires an investigation on the Upper Ver. The driver for this scheme is the WFD for Water Resources Investigations to help deliver Good Ecological Status.

The objective of the investigation is to quantify the impact of our abstractions at REDB, FRIA and KENS on the upper reaches of the river. The abstractions associated with this part of the river are, which operate under an emergency operation agreement, as mentioned in Ver Options Appraisal description (2.2.3.3). The total peak licensed volume of theses sources is 27.27Ml/d and the drought and normal peak DO is 25.11Ml/d. These volumes are included in the totals given in 2.2.3.3. The impact assessment will include desk study, hydro-ecological monitoring and review of the Vale of St Albans Groundwater Model. The costing of the components of the investigation was completed using our AMP3 and AMP4 experience of similar studies.

This investigation focuses on the upper reaches of the river and it should precede the options appraisal, which focuses on the upper and lower reaches. Thus the results of the investigation can be taken into account when assessing the different options for achieving Good Ecological status.

2.2.3.7 Surface water intake fish screens

We have also included a scheme for the installation of fish screens on our surface water intakes. This follows on from a programme of detailed investigation and options appraisal carried out in conjunction with Thames Water under the AMP4 NEP. This scheme required us to investigate the extent of fish entrainment in the public water supply surface water intakes of the Lower Thames.

The conclusions of the project were that it was desirable to screen all river intakes on the Thames to minimise the entrainment of fish fry. A series of different screen types were tested to determine the most effective at keeping entrance velocities below that which would harm juvenile fish, whilst maintaining maximum operational flexibility. Hydrolox travelling screens were determined to be the most suitable and were recommended for installation at SUNN, EGHS and CHERS.

The consultants who undertook the studies have costed the civils works involved with purchase and installation of these screens and made allowances for post installation monitoring to demonstrate their effectiveness (Jacobs 2008). These costs total £1.56m.

2.2.3.8 Financial implications

The costs of undertaking this new programme have been derived using a unit cost basis. The projects have been broken down into a standard series of work activities following discussions on details of the scope with the Thames Region, North East Area office of the EA. Each activity was then costed, based on our experience of undertaking the National Environment Programme in AMP3 and AMP4 and then divided by the relevant driver (eg per km length of river or Ml/d in flow terms, or number of man days to complete a task) to produce a unit cost. The work activity associated with each scheme was then identified and the relevant unit cost and driver applied to derive new schemes totals. A summary of these are shown in Table 2.2.3.8 below. As noted above, costs were taken from the AMP4 consultants report for the implementation of the fish screens project.

Table 2.2.3.8 : Cost of NEP Programme

Scheme Name	Driver	Peak DO Value (Ml/d)	Peak Licensed Volume (Ml/d)	Investigation Costs (£k)	'Certain' Options Appraisal Costs (£k)	'Uncertain' Options Appraisal Costs (£k)	Implementation Costs (£k)	Linked Scheme
Upper Colne	BAPw1	156.58	316.64	1887		503		WFD Upper Colne
Misbourne	BAPw1	23.88	28.41		597			
Upper Ver and Ver Options Appraisal	WFw3 BAPw1	52.49	62.5	669	365			
Mid Rib	BAPw1	8.32	11.82	617		248		WFD Lower Rib, River Rib
Mid Colne River & Lakes	Iw3 BAPw1	121.84	146.14	704		231		WFD Upper Colne
WFD Upper Colne	WFD							Upper Colne
WFD Lower Rib, River Rib	WFD							Mid Rib
Thames Fish Screens	BAPw1						1562	
Total		**388.2**	**592.8**	**3876**	**961**	**982**	**1562**	**7381**

This scope and cost is significantly higher than our current NEP programme and many of the schemes require us to undertake signal tests at each source to identify any impact on adjacent river flows. This will need to be undertaken at particular times of the year and will result in significant periods of additional outage. The deadlines given in Table 2.2.3b make this a very challenging issue. A programme of work has been produced, but will be dependant on the ability to remove specific sources from supply, which may not be possible for a variety of operational reasons. Should funding for these schemes not be approved, then clearly they will not be undertaken.

2.3 Deployable Output: Issues going forward

The requirement for environmental monitoring and impact assessment work in to the future is seen to be rudimentary in water resources planning. The implementation of the Water Framework Directive (WFD) is likely to increase the scope and frequency of environmental monitoring into the future. However without dedicated funding to meet any new requirements there will be a conflict between the requirements of this European Directive and the recovery of costs through the Business Planning Process.

The Agency's Catchment Abstraction Management Strategy (CAMS) sets out the new licensing policy for catchments throughout England and Wales. The majority of catchments within our supply area have been designated as either Over Abstracted or Over Licensed or both, meaning that there are no further water resources available for exploiting without detrimental impact on the environment. Time limiting of licences and additional requirements stipulated on such licences for environmental monitoring mean that there will be an increasing requirement on the business to undertake and fund monitoring to maintain our licence base.

We have carried out an assessment of the potential impact of CAMS and WFD and the conclusions are shown graphically in figures 2.3a and 2.3b. Further detail on the CAMS and River Basin Management Plans can be found in section 10.3 and 10.4.

Figure 2.3a : CAMS Groundwater Management Units for the Veolia Water Central Supply Area (Source: Environment Agency)

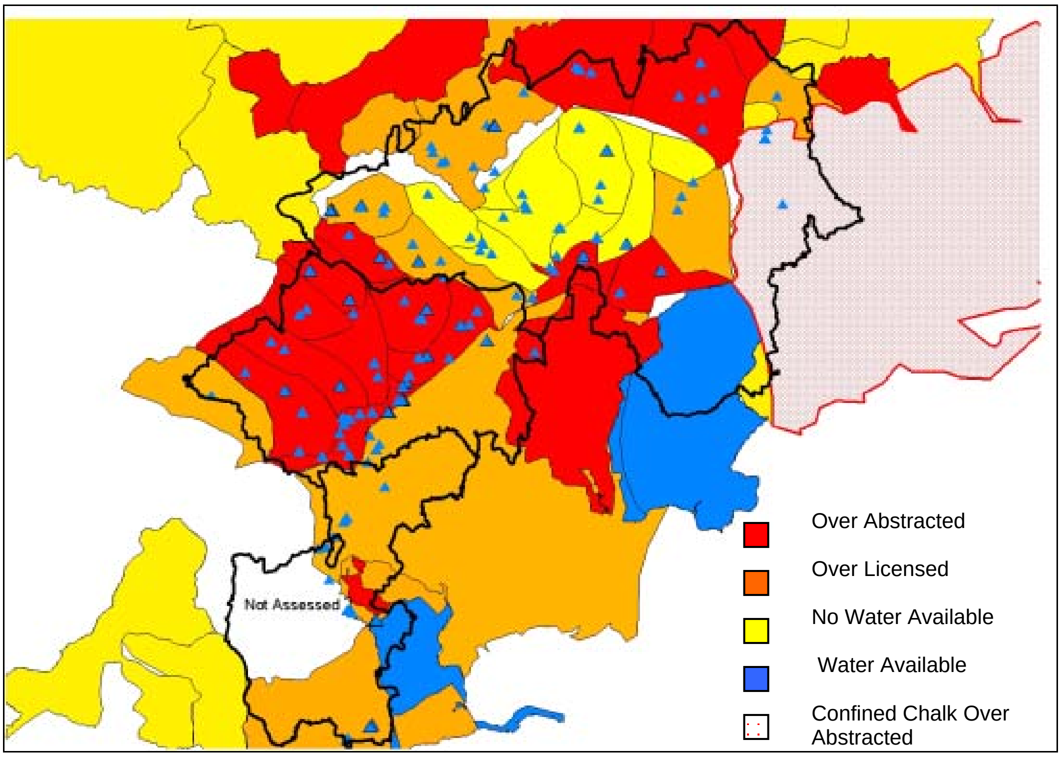
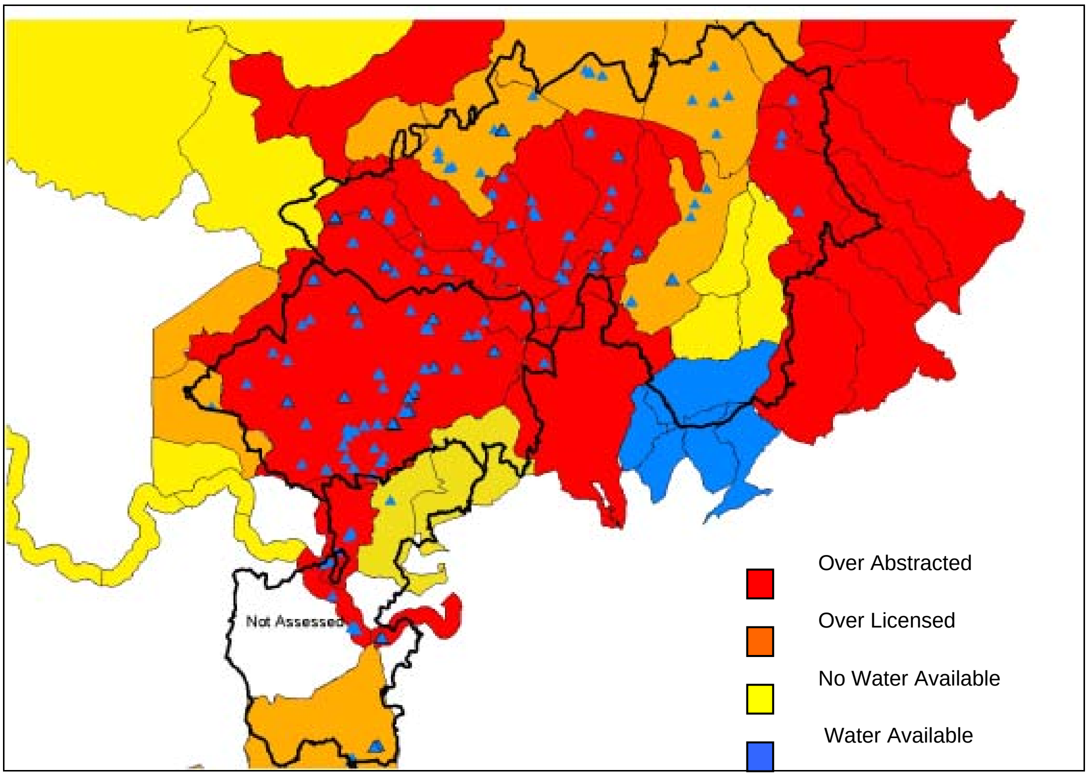


Figure 2.3b : CAMS Integrated Water Resources Management Units for Veolia Water Central Supply Area (Source: Environment Agency)



2.3.1 Measures to protect the resource base, pollution risk and performance assessment

There are a number of challenges to our resource base which we have taken account of in our analyses. These include:

- the threat of pollution from the industrial legacy of the past and urbanisation
- water stress and the loss of licences to meet environmental objectives
- climate change

Historically, as an industrial society we tolerated the pollution of our water catchment areas from urban, industrial and agricultural pollution, used poorly protected landfill sites and failed to clean up toxic sites. Land and groundwater pollution is therefore a long-term challenge in our area. Nevertheless, working with the Environment Agency and potential polluters, we have been able to improve the protection of catchments and reduce the threat to existing resources.

The risk from pollution threats is assessed based on the pattern of incidents that have occurred in recent years. Incidents have been caused by diffuse pollution (nitrate and pesticides), various hydrocarbons from run-off, ammonia, cryptosporidium, bromate, and PFOS from certain fire-fighting techniques[20]. This

[20] PFOS : Per Fluoro Octane Sulphonate

pollution has meant we have had to take some of our sources out of supply and the frequency and duration of supplies lost whilst treatment is installed (at a cost) are used to derive an estimate of loss of resource over time. The associated risk is included in the overall safety margin known as Headroom[21].

However, while we can treat water to ensure a high-quality supply or, if necessary find alternative sources of supply, the cost represents a cross-subsidy from our customers to those who are benefiting from polluting. This is contrary to the 'polluter pays' principle and makes water unnecessarily costly. We do what we can to protect our water sources. But we regret that, as yet, not enough is done through legislation and in other ways to reduce pollution of water sources, particularly from urban run-off and agricultural activities.

We will continue to manage the risks of pollution from point and diffuse sources. We will take what action we can, should a threat appear. Implementation of the WFD means that we have an opportunity to increase the protection of public water supplies. We are working with the EA and other water companies to set qualitative and quantitative targets for the water environment.

2.3.1.1 Pollution risk assessments

We depend on a large number of groundwater sources for our water resources and most of these abstract from the unconfined Chalk aquifer which is highly vulnerable to pollution and land use impacts. Our supply area is also marked by an extensive transport infrastructure, intensive agriculture, residential housing, waste disposal and industrial activity. These have historically led to frequent point source pollution events such as surface fuel spills, landfill leachate migration and diffuse source pollution trends such as increased nitrate and pesticide concentrations in the raw water.
Pollution of sources or potentially polluting incidents are a frequent occurrence within our operating area. These vary in magnitude and impact, but recently have been occurring with increasing frequency. In addition to the Bromate incident that emerged in 2000, several petrol and diesel spills have posed threats to sources, which in a few cases, has resulted in a temporary lowering of baseline deployable output. The impacts of the Buncefield incident in December 2005 on the local groundwater are still being assessed and a strategic groundwater source remains out of supply.

At the end of AMP3, 82Ml/d of licensed resource was estimated to be unavailable for supply following pollution in the previous thirty years. In AMP4, the following losses were experienced;

- The bromate pollution of both HATF and ESSE continues, and a replacement source at NOMA has been developed to replace HATF. The pump and treat operation at HATF, with disposal to sewer, and installation and management of GAC treatment at ESSE has allowed us to manage bromate levels at the NORM WTW to acceptable levels but AMP4 solutions are still in hand to recover the remaining losses and will deliver by the end of the AMP period. We participated in a Public Enquiry concerning the liability for the bromate pollution, under Part IIa of the Environmental Protection Act (the first appeal that has been heard under this act) and are awaiting the decision of the Secretary of State on both liability and the contents of the Remediation Notice that may be served on the

[21] UKWIR : New Headroom Assessment Methodology 2004

Appropriate Person(s). Meanwhile, continued monitoring and other actions are being undertaken by the Company.

- The Buncefield Oil Depot explosion in December 2005 may have resulted in the contamination of local groundwater by both hydrocarbon products and fire-fighting foam and associated by-products. BOWB was removed from supply as a precautionary measure until prevailing groundwater conditions and hydrochemistry are better understood. The source has remained out of supply since the incident and is part of an on-going, detailed, multi-agency investigation. This has not been removed from Deployable Output as it is anticipated that it will be returned to service in 2009.
- The NORM source was removed from supply during May 2005 due to extremely high levels of the pesticide Mecoprop in the raw water. The source was out of supply for over a month while pesticide concentrations returned to treatable levels. The incident gave rise to communication with the Environment Agency in an attempt to locate the pollution source and to reinforce best practice for agrichemical handling and application. We undertook a catchment survey and a draft Water Safety Plan was submitted to the Drinking Water Inspectorate (DWI) for comment.
- Output from the CRES source was cut back for several months during 2002 following a large petrol spill at an adjacent petrol station. Output was restored once mitigation strategies were implemented by the petrol company, but the threat still remains as little active remediation has been undertaken to date.
- A large spill of diesel fuel occurred in 2003 adjacent to the WESY and NORO sources, and whist contained, still poses a threat to these sources although no reduction in output has occurred as a result of this to date.
- At AMER MTBE was detected in the raw water during July / August 2006. The deployable output was not reduced as there was sufficient blending in the reservoir. Investigations were undertaken with the EA and the various holders of fuel in the local catchment. No confirmed source of the pollution was found.
- We remain concerned that underground storage of hydrocarbons continues to be allowed so close to public supply boreholes, particularly with new entrants to the fuel retail sector. We anticipate that pollution incidents such as those detailed above will continue despite recent changes in regulation.
- Water quality schemes have been implemented at our SLIP and CHIP sources to reduce the impact of diffuse nitrate pollution. Diffuse pollution from agricultural and urban nitrate, pesticides and other compounds is evident in many sources but generally increases slowly so treatment can be put in place before output is affected (e.g. AMP4 GAC scheme to treat pesticides at KENS). However, there is little evidence of improving water quality in the groundwater environment and we anticipate further requirements for increased treatment and for sources to be taken temporarily out of supply.
- We are monitoring the current activities by local authorities and the Environment Agency as part of the Contaminated Sites legislation. We have yet to be informed of any issues arising from this work other than for some of those sites where a pollution link had been previously identified. In the case of New Years Lane Landfill and the pollution of groundwater abstracted from ICKE, we have been unable to make any progress as the landfill site owner is also the competent authority and the landfill has not been designated as contaminated land.

- Historic pollution of groundwater at the GE Healthcare site in Amersham area was notified to the EA in 2005. There was no impact on the deployable output of the abstraction boreholes however proactive monitoring at VWC sites and EA observation boreholes was undertaken.

A schedule of our sources currently affected by pollution is shown in Table 2.3.1.1a below. In light of the considerable length of time it takes from detection through monitoring, modelling analysis and eventually designing and implementing system or treatment changes to tackle the pollution issues, the affect of pollution is often cumulative and this is taken account of in our DO and headroom assessments.

Table 2.3.1.1a : Sources Affected by Pollution

Site	Peak Licence (Ml/d)	Date Lost	Date Recovered	Cause	Mitigation / Comments
BERK	7.96	1999	1999	arsenic / VOC / pesticides	Site remediation
ESSE	9.09	2000	2009	bromate	GAC installation and pump and treat from HATF, as a temporary measure whilst AMP4 solution implemented
HATF	9.09	2000	2009	bromate	Replaced by NOMA solution
BULS	3.41	1997	2006	coliforms	Now borehole and upgraded treatment
PERI	5	1998	1999	coliforms	Improved local sewerage systems and membrane plant
TEMP	5.68	2001	2001	coliforms	Audit local septic systems
WAFI	8.5	1970's	n/a	coliforms	Site still not in service
WILR FULR	7.96	1998	1999	coliforms	
EAST	68.19	1997	1997	cryptosporidium	Increased treatment
SPRW	18.18	1991	2005	cryptosporidium	Increased treatment
STOC	9.09	1990's	2005	Iron	Increased treatment
RUNL	9.55	1998	1999	hydrocarbons	
BRIC	27.28	1970's	1970's	NH4	Blending
ICKE	12.5	1995	2020	NH4	Site still not in service
WATE	1.36	1990's	1990's	NH4	Blending
SLIP	6.82	2001	2001	nitrate	Blending
CHIP	3.5	2001	2001	nitrate	Increased treatment
ALBE	5	1980's	n/a	nitrate	Site still not in service
NEWB	1	1980's	n/a	odour	Site still not in service
EASB	1	1970's	n/a	oil	Site still not in service
CRES	29.3	2002	2003	petrol/diesel	Site remediation
STEV	2.73	1989	2009	solvent	Increased treatment
BALD	4.55	1989	2007	solvents	Increased treatment
DUNM	2.18	1995	2002	solvents	Increased treatment
BOWB	6.81	2005	2008	hydrocarbons & PFOS	Buncefield incident

Clearly the above suggests more needs to be done to manage risks from pollution and our Plan includes a range of activities in order to minimise those risks.

In light of our concern over pollution we have carried out desk study land use surveys of all company groundwater catchments as part of the Water Watch programme. These surveys capture current land use and have been augmented and updated using commercial databases and other published data. All Water Watch catchment surveys have been transcribed to GIS to facilitate a greater degree of data manipulation and interpretation.

To gain a better understanding of what potential risks are present in the different groundwater catchments, we have undertaken a number of visual catchment surveys and subsequent pollution risk assessments (PRA's). The PRA utilises a source – pathway - receptor approach and draws on a range of data including land use, hydrogeological conditions and both headworks assessments and downhole inspections to calculate the relative risk of a pollutant occurring in the raw water at a public water supply borehole. These PRA's have been incorporated into Drinking Water Safety Plans (DWSP) to provide a rigorous, quantifiable risk based assessment on which monitoring requirements, risk mitigation, treatment methods and future investment can be based. The most "at risk" sources, a number of which will have DWSP's developed, are detailed in Table 2.3.1.1b.

Table 2.3.1.1b : Proposed Pollution Risk Catchment Studies for DWSP Studies

	Catchment	Risk	History
1	BLAF	Manganese	Rising Trend
2	BERK	VOC's	Rising Trend
3	CHOR	Microbiological	Rising Trend
4	CLAN	Microbiological	Rising Trend
5	KINW	Nitrate	Rising Trend
6	RUNL	Boron	Rising Trend
7	ROYD	Manganese	Rising Trend
8	HUNT	Iron	Rising Trend
9	BOWB	PFOS	Pollution incident
10	HOLY	PFOS	Pollution incident
11	CRES	Hydrocarbons	Hydrocarbon leak
12	TYTT	Nitrate & Exotics	Landfill studies
13	ROES	Nitrate & Exotics	Landfill studies
14	CHAL	Microbiological & Turbidity	Flooding
15	NORM	Pesticides	Pollution incident
16	CAUS	Turbidity	Commercial development
17	PERI	Residential Development	Residential development
18	STOC	Iron	Bio-fouling
19	BUSA	Microbiological	Sewer surcharges
20	WALL	Microbiological	Sewer surcharges

We will maintain our efforts to influence other organisations to reduce the threat of pollution from their activities. We have also been working with Water UK and the EA to show how the requirements of the Water Framework Directive may be implemented to reduce the threat of pollution and have supported work to implement Article 7 in particular. We hope this work will result in improved planning controls and monitoring of the environment to improve protection of sources used for drinking water.

We have also commenced in engaging a number of catchment stakeholders which is in-line with working practices resulting from the Water Framework Directive. This body of work includes agreeing an operating protocol and pollution incident response procedure with a mineral extraction company, restricting livestock use on Company land close to abstraction boreholes, advising developers on best practice and environmental management systems and objecting to planning applications that would potentially derogate the local groundwater.

It was anticipated that the location and identification of hazards from former industrial and waste disposal sites would result from local area authority Contaminated Land Strategies. However this remains a difficult task pending completion and publication of Contaminated Land Registers and the commercially sensitive nature of contaminated land investigations.

2.3.1.2 Catchment Management

We have agreed with Ofwat on the need for greater focus on preventative management of pollution. To this end we will be appointing 2 catchment management officers to add to our water resources function. These officers will take responsibility for catchment monitoring and pollution prevention for both point source and diffuse pollution risks.

2.4 Outage

Outage is the quantum of resources and asset capacity that is ‘not available for use’ at any point in time due to plant breakdowns, essential maintenance and unexpected operational events such as pollution. Our plans must include an allowance to accommodate these events. The allowance may be influenced to a degree through our capital maintenance programme which is used to maintain the capability and readiness of our assets.

The increase in deployable output is enhanced by improvements in asset reliability relating to a reduction in outage for the base year of 19 and 33 Ml/d average and peak respectively. Accordingly the net amount of water available for use increases significantly for the 2006/7 base year of our Water Resources Management Plan. This situation is expected to remain relatively stable for the duration of the Plan. The uncertainty of these assessments relate to the accuracy of the method of assessment and the robustness of the data relating to plant failure. This data is a combination of telemetry records coupled with experience and judgement from senior operating staff relating to the frequency, severity and impact of plant failure events. The data for plant failure is used to develop a statistical relationship and a confidence level of 95% is used for our Plan that ensures that the safety margin will be exceeded for 5% of time or in the proportion of only one year in 20 years.

Our outage assessment used the UKWIR 1995 methodology described in *Outage Allowances for Water Resource Planning.* Assessments were completed for each source works within the three resource zones that comprise the supply area. Three standard pro-formas were developed for the assessments:

- **Groundwater sources**
- **Surface water abstractions**
- **External transfers and imports**

Assessments were mainly based on interviews with operational staff experienced with each source and historical data was used as an aid to assessing outage. The data obtained from these assessments was then applied to a Monte-Carlo based simulation using Crystal Ball® software, which was created specifically for the outage assessment. Monte Carlo simulation is a statistical evaluation technique which obtains a probabilistic approximation to the solution of a problem by using statistical sampling techniques. These models were created for each of the old six resource zones, with source outages being summed to give a total outage value for the resource zone, with specified levels of certainty.

In response to comments made by the Environment Agency and the reporter on the Draft Water Resource Management Plan, we decided to reconstruct the outage model at the three water resource zone level, instead of at the old six zones. In addition, model runs were carried out for three specific planning periods, namely:

- Base year AMP4 - Base year (2007-08) to 2010
- AMP5 - Post 2010 to 2015 – This reflects the additional Deployable Output resulting from the AMP4 schemes
- AMP6 to 2035 - Post 2015 – This reflects the Sustainability Reductions that the EA informed us of at the end of August 2008.

The outage, for the base year, in periods of average water demand was recalculated as 52.4 Ml/d (a decrease of 9.1 Ml/d from the draft submission), whilst at critical periods of water demand (assumed to be a one month period from mid-July to mid-August) the outage was 44.7 Ml/d (a decrease of 6.1 Ml/d from the draft submission). This is considered to be a representative value of current conditions and reflects the quality scheme improvements gained during the AMP4 period.

2.4.1 Outage Analysis Results

The results of the Crystal Ball Monte-Carlo modelling process produce a number of different percentiles of certainty for each of the three resource zones. These are then summed to total outage for a chosen level of certainty. The results for each of the planning periods at 95% certainty, are shown in the table below.

Table 2.4.1a : Outage results for each of the planning periods at 95% certainty

	Outage (Ml/d) 95%ile					
	Base Year AMP4		AMP5		AMP6 to 2035	
Zone	**Average**	**Peak**	**Average**	**Peak**	**Average**	**Peak**
Central	20.46	21.39	21.03	20.73	21.03	20.73
Northern	6.93	12.09	6.90	12.45	6.29	12.12
Southern	25.05	11.18	25.24	11.18	25.24	11.18
Total	**52.43**	**44.65**	**53.17**	**44.36**	**52.56**	**44.03**

The outage results for the base year compared to the deployable output are shown in the table below.

Table 2.4.1b : Outage results for each resource zone compared with the deployable output for each zone

Resource Zone	Average DO (Ml/d)	Average Outage (Ml/d)	Peak DO (Ml/d)	Peak Outage (Ml/d)
1 Northern	312.2	6.9	358.6	12.1
2 Central	552.3	20.5	645.8	21.4
3 Southern	191.7	25.0	222.8	11.2
Total	1056.2	52.4	1227.2	44.6
% of DO		5.0		3.6

2.5 Potable Water Transfers and Bulk Supplies

2.5.1 Anglian Water: ANGL Water

The existing 91 Ml/d (av.) and 109 Ml/d (peak) supply from ANGL is included in the figures of Deployable Output.

The 1961 Great Ouse Water Authority (GOWA) Act of Parliament and the 1971 GOWA Statutory Water Order indicates that we can increase its current entitlement to Grafham water from 91 Ml/day (109 Ml/day on peak) up to 136 Ml/day (163 Ml/day on peak).

This issue was subject to Judicial Review with the outcome was that the average (91Ml/d) and peak (109Ml/d) are not variable or at risk. Anglian Water takes the view that there is shared misery in a drought although they do not challenge the above capacities. The following text was agreed with Anglian Water in 2004.

"Anglian Water and Veolia Water Central jointly contribute to the cost and utilisation of Grafham Water, treatment works and supply system. ANGL is part of the Anglian Water RUTHS pipeline system. Three Valleys supply from ANGL continues to be governed by Great Ouse Water Act 1961 as amended and the arrangements were confirmed in a Judicial Review in 1999. Anglian Water's water resources plan does not currently include provision for an additional supply of water to Three Valleys in

the future over and above the existing supply arrangements, however, the companies have agreed to explore the feasibility, cost and implications of an additional supply from the RUTHS in the future. In addition the Companies have agreed to explore changes in the current operational arrangements which may enable greater flexibility and optimisation of the existing supplies from ANGL."

In 2006 we asked Anglian Water to consider the feasibility of an additional supply from ANGL and this option has been included in our option appraisal. Latest discussions and information however suggest that Anglian do not have surplus capacity in their current systems and an additional supply would trigger the need for a new regional storage reservoir. We propose to continue to explore future resource development options with Anglian between 2010 and 2015.

2.5.2 South East Water

We provide a bulk supply to South East water from our Southern Resource Zone. The supply has a maximum capacity of 36 Ml/d and this capacity is often taken. We are discuss South East Water's future requirements regularly. The current agreement is reflected in our export volume assessment.

2.5.3 Thames Water: FORT

We have the right to water from Thames Water, through FORT pumping station. This right was established in 1927: We "may from time to time require a supply of water but not exceeding on any one day of twenty four hours the quantity of six million gallons (27 Ml/d)", "unless prevented by frost unusual drought or other unavailable cause or accident" (Metropolitan Water Board Act , 1927, ch lxxi. Second schedule, p.27). The connection is operational but does not currently have capacity to provide more than 10 Ml/day, because of hydraulic constraints. It is used primarily as an emergency and security link. Import from Thames at FORT was enhanced in 2009 following implementation of a new emergency supply of 17 Ml/d. Under the scheme protocol, the Company will have access to 27Ml/d in an emergency on a 'best endeavours' basis. The marginal cost is high (40p/m^3) so not cost effective compared with alternative supplies. Our plan is based on a DO of only 10Ml/d but there is a scheme, included in our options appraisal to evaluate raising deployable output by 17Ml/d average and 27Ml/d peak.

2.5.4 Thames Water: KEMP

Import from Thames at KEMP is a "best endeavours" agreement for emergencies and the deployable output is deemed to be zero.

2.5.5 Thames Water: LADY

The existing supply has a capacity of 2Ml/d. Additional import from Thames at LADY has not yet been discussed in detail with Thames, however we have modelled the connection in-house to gauge the impact. The scheme raises average DO by 2Ml/d and peak by 4Ml/d and has been included in our options appraisal.

2.5.6 Cambridge Water

There are three small connections from Cambridge Water.. There is an emergency connection at LOWE, installed in 1997 during the drought, with a capacity of 4 to 8Ml/d depending which boreholes supply the connection. The connection is no longer essential because we have developed strategic mains in the area and these are fully utilised. However an emergency interruptible supply arrangement (DO zero) is currently being investigated for operational flexibility.

2.5.7 Other Cross-Border Connections

We have some other small bulk imports, representing approx. 1 Ml/d in total (average and peak), from Thames Water (HAMP) and Essex and Suffolk Water. These together represent less than 1% of supply.

3 DEMAND FORECASTING

3.1 Different types of demand forecasts

The approach taken to demand forecasts follows the recommendations outlined in the UKWIR/NRA R&D reports[22] .

Independent forecasts have been prepared for each component of the water balance. Changes to distribution input are controlled by a number of external factors (population and housing growth, changes in the regional economy and customer water using behaviour) and other factors over which we have some control or influence (leakage policy and practice, metering targets and rate of penetration and water efficiency publicity).

Baseline and final planning demand forecasts have been prepared for:

- Normal year annual average,
- Normal year critical period,
- Dry year annual average,
- Dry year critical period.

3.1.1 Normal year and dry year forecasting

We have prepared forecasts of normal and dry year for both annual average and critical period scenarios. The normal year is used as the base and is adjusted for a dry year. Critical period scenarios are produced by applying demand factors to each customer type. Assumptions are made for non domestic properties. Domestic measured properties are assumed to have a 15% lower response to dry year and critical period conditions than unmeasured domestic. Unmeasured domestic are adjusted to reconcile to an overall peak factor for the zone, which is derived from analysis of historic demands.

3.1.2 Peak forecasting

We have examined a range of periods to assess our ‘critical period’, that is the period of time in the year where demand is greatest. In operational terms the most significant events have occurred in 1995 when a long hot dry summer generated high demands over an eight-week period. The resource situation at that time was satisfactory. This demand period has been used hitherto as our benchmark for the dry year demand forecast with average day peak week taken as the critical period occurring at any point within an eight-week window (56 days). Daily peak conditions are not used for water resource planning purposes as extreme peaks in demand and short-term extreme outages are accommodated using service reservoir storage.

A similar period of hot dry weather occurred in 2003 recording record temperatures in the South East, and a detailed comparison of operational performance has been carried out. In determining normal and dry year peak factors for each zone we have looked at the years 2002 to 2007. We are limited to these years by the extent of

[22] UK Water Industry Research Limited – Demand forecasting methodology (1995) and Forecasting water demand components (1997).

reliable zonal demand data. As a result our peak factors correlate well with the 2003 year.

3.2 Base year population and properties

3.2.1 Base year population

Population has been allocated to customer categories. Measured non household population has been allocated from the 2001 census data at output area level summed up to resource zone. This update increases the population in measured non household significantly from our previous estimates.

We have around 10,000 unmeasured non households. These are generally small businesses with complex supply arrangements that make them difficult and expensive to meter. In some cases these may be a mixture of commercial and domestic uses. We have no specific information on the occupancy rate in these properties however we have included a nominal value for population in this category recognising that there will be some domestic population.

For measured households a measured occupancy survey was conducted in order to baseline the measured population and assist in the determination of the population of unmeasured households.

The content of the survey was specifically designed to obtain the occupancy of each measured household as well as identify the means by which the property came to be measured and if the presence of the meter affected water use. Water Resource Zones (WRZ's) and socio-economic indicators (Acorn values) were also incorporated into the results database to extrapolate additional information and trends from customer responses.

The principal objective of this survey was to determine the average occupancy of measured households in our supply area and the initial determination was 2.17. The average occupancy for each Water Resource Zone was calculated from the data and is presented in Figure 3.2.1a below. Table 3.2.1 lists the average occupancy values by measured household category. It is apparent that the majority of respondents were optants.

Figure 3.2.1a : Average occupancy of measured households by water resource zone.

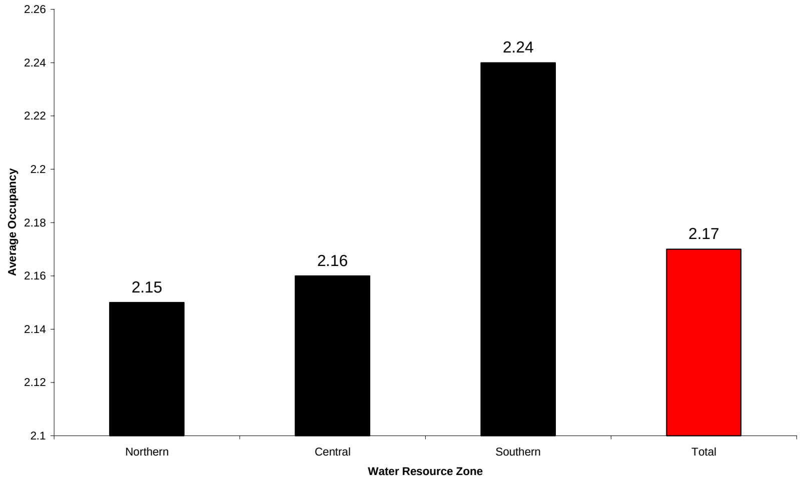
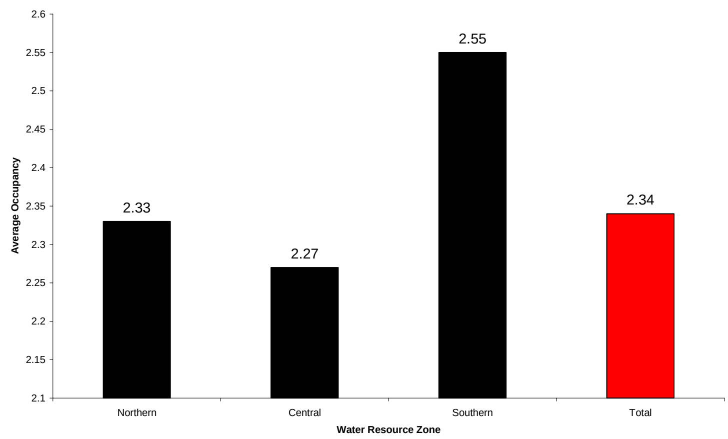


Table 3.2.1 : Average occupancy determinations per category of measured households.

	How did the property come to have a water meter?				
	Newly built	**Water meter installed before moved in**	**Asked for meter to be installed**	**Installed after moved in**	**Total**
Average occupancy	2.52	2.51	1.86	2.69	
% of total responses	12.7	21.7	54	10.1	100
Number of responses	1228	2089	5202	976	9495

As Table 3.2.1 indicates, optants formed the majority of responses (54%) in the survey. However, we do not consider that optants properties represent 54% of our measured properties as a whole. Therefore the survey results were reviewed by assessing the proportion of properties which are still being lived in by occupiers who requested a meter as a percentage of our measured properties base. Similarly we made assumption about new properties and properties that became metered on change of occupier. In doing this we are able to make an assessment of the representativeness of the survey respondent. Measured occupancy rises on the basis of this assessment from 2.17 to 2.34

Figure 3.2.1b : Average occupancy of measured households by water resource zone after recalibration.



Unmeasured domestic population is calculated as the residual population of the total population (see above) minus the measured domestic and non household populations for each resource zone.

3.2.2 Base year properties

Base year properties have been derived from our Hi-Affinity billing database for all of the June Return reported categories. Historic June Return figures have been analysed to provide a split of measured customers into customer types. Where no figures exist simple assumptions have been used to back cast to estimate total numbers. The measured property base is split as shown in Table 3.2.2.

Table 3.2.2 : Distribution of properties with type of metering

Category	Percentage
New	33%
Optant	46%
CoH	19%
Selective	2%

3.3 Forecasting the potable water customer base

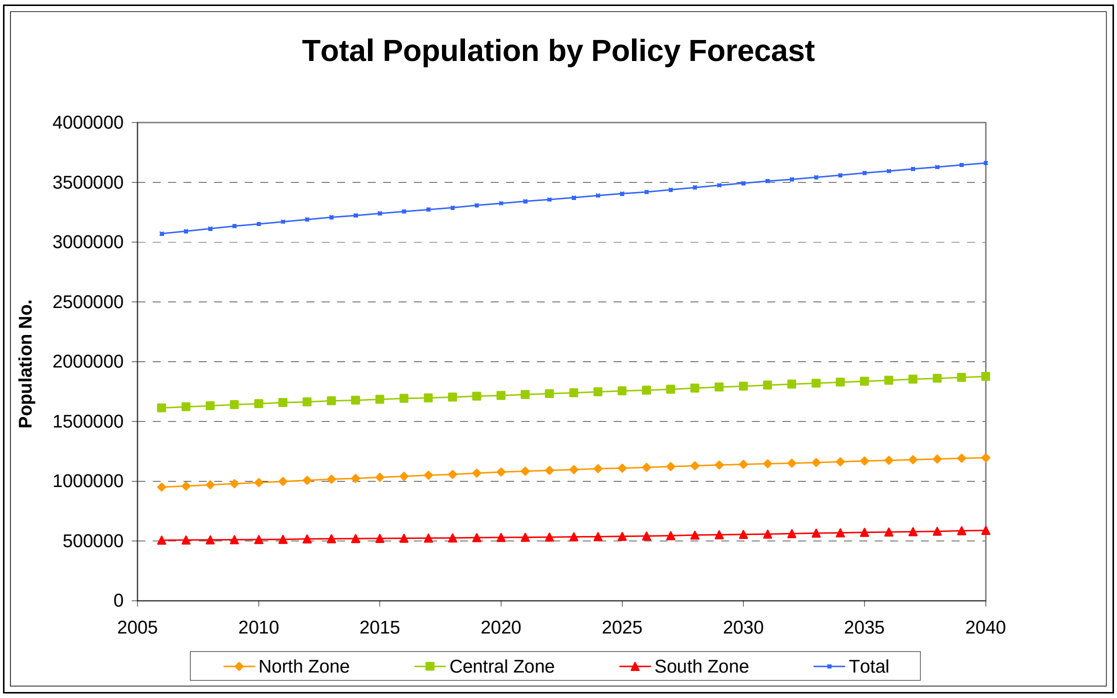
3.3.1 Population forecast

The population we serve is set to increase considerably over the next 25 years. We produce company specific population forecasts to inform the supply demand balance and maintain continued security of supply.

To ensure a consistent methodological approach when determining a company specific forecast, Experian were commissioned to undertake a joint housing and population study for the South East on behalf of a number of water utility companies, including TVW. This multi-client study was jointly commissioned by participating water companies in the South East region to produce a range of demographic data to inform the water resource planning process. From this a policy-based forecast was produced as required by the Environment Agency.

The policy-based population forecast for the Veolia Water Central supply area forecasts a population increase of 591,020 (19%), from 3,070,939 in 2006 to 3,661,959 in 2040. It also forecasts average yearly growth across the region to be between 15 – 20,000 extra individuals a year from 2006 - 2040.

Figure 3.3.1 : Veolia Water Central total population forecast



There is an element of the population we serve that is omitted by the methodology used by conventional estimates. This comprises a hidden and transient population not fully reflected in the mid-year estimates or National Census. To ensure that this population was recorded we commissioned Leeds University to produce a review to evaluate this issue[23]. The results of this study produced a low (46,635), medium (88,919) and high (132,418) estimate for the un-accounted population. There is considerable uncertainty surrounding the estimates for hidden populations as data on a national scale is fragmented and difficult to quantify. We therefore propose to use the central estimate of 88,919 people, rather than using the lower or upper range figure. This figure is fixed and reapportioned across each resource zone based the population served in that zone compared to the total number supplied for any given year.

The Environment Agency recommends that a policy-based forecast be used to project future population. This policy based forecast is felt to be a robust estimate of growth given all the current available data.

[23] Leeds University : Geography Department led by Professor McDonald.

3.3.2 Housing forecast

The demand for new housing has been severely reduced through the current economic downturn in the short term. However, much like the population of our area, the demand for housing over the longer term, shows little or no sign of abating. The growing population and present housing stock shortfall is resulting in strong 'top-down' targets for new dwellings in order to meet this demand, in the period beyond 2015.

We produce company specific housing growth forecasts in order to ensure a continued level of supply now and in the future. These forecasts utilise best available information from a national, regional and local scale.

Often site specific knowledge is also important, for example where planned developments occur close to a supply boundary. In these circumstances closer inspection is required to assess the precise housing numbers that fall within a supply area.

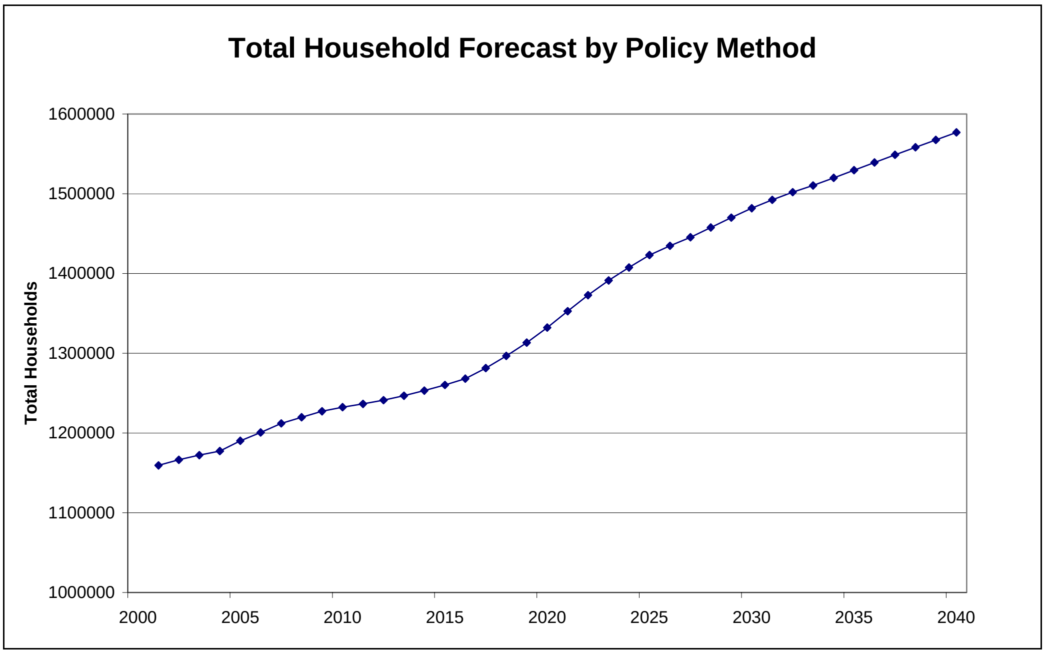
To ensure a consistent methodological approach when calculating our housing forecast Experian were commissioned to undertake a joint housing and population study for the South East. This study was carried out on behalf of a number of water utility companies, including Veolia Water Central. From this work a company specific forecast were produced based on government policy. We also undertook an internal review of housing growth which further supports an understanding of expected growth.

The Experian study was used as a baseline forecast of housing growth between 2006 and 2040. The effects of the economic downturn have been closely monitored and been used to refine the forecasts downwards to correlate with predicted and observed reductions in new house completions. This has resulted in a short term fall in the expected volume of new completions within the next five years. After this point, new completions will rise rapidly in number before returning back to policy predictions in the longer term.

The following points outline the housing forecast that was produced and the subsequent main results. These results are illustrated in Figure 3.3.2.

- **Experian's Policy-Based Household Projection:** This method aligns the trend-based estimates with the housing allocations, promulgated in the draft regional plans. The effects of the economic downturn have been considered and integrated into the forecast. The housing growth resulting from this methodology shows an increase in housing stock from 1,159,337 in 2001 to 1,566,035 in 2040, an increase of 406,698 dwellings (35%).

Figure 3.3.2 : Veolia Water Central total housing forecast



The Environment Agency recommends that a policy-based forecast be used to project future housing growth. The forecast utilises the Experian policy based property forecasts, and the effects of the current economic downturn have been monitored and accurately modelled using the latest trends and data from relevant and reputed sources. This policy based forecast is felt to be a robust estimate of growth given all the current available data.

3.4 Base year household demand

3.4.1 Per capita consumption

The total volume of water each person uses per day is known as their Per Capita Consumption or PCC. The PCC value varies across the country due to factors including socio-economic breakdown, climate, metering penetration and occupancy.

3.4.1.1 Unmeasured PCC

We use data from an internal water consumption monitor study, called Watcom[24], to derive the base year unmeasured PCC. These PCC's are used in conjunction with company research data to calibrate the micro-component model in the base year.

3.4.1.2 Measured PCC

The measured base-year PCC is calculated by dividing the domestic measured billed volume (minus supply pipe leakage) by the measured domestic population. The measured customer PCC projection is then forecast forward from this figure.

[24] Watcom (WatCoM) is our study of 1800 unmeasured properties to assess consumption of water for this group of customers.

3.4.2 Baseline micro-component per capita consumption

We undertake customer surveys to better understand how water use relates specifically to our customers. Historic surveys have included questionnaires sent out with the company's billing booklet and online water audits located on our website. These questionnaires have however often been light in content, focussing more on promoting water efficiency rather than producing robust information suitable for a microcomponent model.

The most recent survey however was a comprehensive questionnaire of unmeasured customers that returned over 10,000 responses. This questionnaire sought to strengthen our specific understanding of base-year water use that was in turn benchmarked against the existing consumption monitor study. The number of replies received makes the results both representative and statistically significant for the company as a whole. Each respondent was asked to provide their postcode, which enables us to obtain which water resource zone that respondent would fall within and what their socio-economic 'ACORN' background is.

3.4.2.1 Base year components:

The basis of indoor and outdoor water use by component for the base year is shown in Tables 3.4.2.1a and 3.4.2.1b respectively.

Table 3.4.2.1a : Base data for indoor water use

Base year assumptions: Indoor appliances	
Standard toilet	The ownership of a standard WC was derived from a customer survey of 10,000 households. The results were obtained by water resource zone and a weighted average determined for the company as a whole. The results showed that measured ownership was 75%, with un-measured ownership at 78%. Where a standard toilet and low flush toilet were both owned, a weighted average of the two was produced to ensure that the combined ownership did not exceed 100%. The results of the survey identified that flush frequencies, whether the toilet was low flush or otherwise, were 3.1 per person per day for measured customers and 3.4 per person per day for un-measured customers. The frequencies varied slightly across each water resource zone, although centred around a figure of approximately 3.25.
Low flush toilet	The ownership of low flush toilets is approximately 25% across our supply area. Where both dual flush and standard toilets are owned, so as to ensure ownership does not exceed 100%, the figures are reapportioned accordingly. The frequency of low flush toilet flushing was as per the standard WC.
Bath	Bath ownership in the base year was calculated as being 90% for both measured and un-measured customers with the base year frequency of use approximately 0.3 uses/person/day. These results were derived from the survey undertaken by our customers.
Showers	Power shower ownership was surveyed at being approximately 24% with the frequency of use approximately 0.6 uses/person/day. This frequency of use is the same for standard and power showers. Ownership of standard showers was forecast as being approximately 73%. Where it is observed that the ownership exceeded 100% (that is to say individuals owned both a power shower and standard shower) the ownership was reapportioned so as not to exceed 100%, otherwise figures were taken directly from

	the survey results.
Hand basin	Hand basin ownership in the base year is 100%. The survey results indicate that frequency of use varies slightly by region, although average measured personal daily use was 3.1 with un-measured use slightly higher at 3.6 uses/person/day.
Kitchen tap	The kitchen tap ownership is considered to be 100% in the base year with a frequency of use for both measured and un-measured households of 2 uses/person/day. This reflects an estimated morning and evening use.
Washing machine	Base year ownership of washing machines was high in our area with an approximate ownership of 90% for measured and un-measured customers. The frequency of use per person per day was also calculated at being 0.3 for measured and un-measured customers.
Hand washing clothes	The 'ownership' of being able to wash ones clothes by hand was set at 100% in the base year as everyone has the ability to wash their items in this manner. There is little evidence to suggest a frequency for this occurrence although the MTP suggest it might be as high as 0.07 uses/person/day. When calibrating this model to the base year it was determined that the average base year frequency is more appropriately 0.015 and 0.008 for measured and un-measured individuals respectively.
Dishwasher	The survey undertaken showed that base year dishwasher ownership was a little over 20% for both measured and un-measured customers. The frequency was approximately 0.28 uses/person/day for measured customers and 0.23 uses/person/day for un-measured customers.
Dish washing by hand	Dishwashing by hand has been set at 100% in the base year as all have the ability to wash dishes in this fashion. Survey evidence has also suggested that the frequency of this washing is approximately 1.3 uses/person/day.
Water softener	An internal review of water softener penetration indicated that ownership in our supply area ranged from between 5% to 10%. A frequency of use is assumed to be automatic and with modern appliances dependant of volume of water used through the softener. An estimate based on an average PCC forecast a recharge rate of once a week.

Table 3.4.2.1b : Base data for outdoor water use

Base year: Outdoor appliances	
Car washing (hosepipe)	The ability to wash a car using a hosepipe varies by geographical area and as such is largely a function of affluence. The average company ownership for un-measured customer is considered to be 20%, with measured customers at 8% ownership. This is considered a reflection of the tendency of measured customers to be more cautious of how they use water than those who are un-measured. The frequency of use is reflected in this difference with 0.03 uses/person/day for un-measured customers and 0.01 uses/person/day for measured customers
Car washing (bucket)	As with the hosepipe means of washing a car it has been assumed that washing a car using a bucket is available to approximately 50% of un-measured customers with 10% of measured customers electing this as an option. The frequency of use is low with 0.007 uses/person/day from measured customers and 0.031 uses/person/day from un-measured customers.
Sprinkler	Sprinkler ownership in the base year is considered to be 13% and 10% for un-measured and measured customers respectively. The frequency of use is considered small with between 0.008 and 0.001 uses/person/day for measured and un-measured customers respectively.
Hosepipe	Base year hosepipe ownership is considered to be 14% & 51% for measured and un-measured households respectively. Base year frequency of use is considered to be 0.01 & 0.03 uses/person/day for measured and un-measured customers.
Watering can	Watering can ownership in the base year is estimated as being 21% for measured and 51% for un-measured households. Frequency of use for measured and un-measured customers is considered to be 0.02 & 0.03 uses/person/day.
Miscellaneous	A miscellaneous use is simply one that has not been sufficiently classified for in the modelling. That is to say the difference between what the model forecasts in the base year and what the actual recorded PCC's are. In this instance there is a 90% miscellaneous 'ownership' for measured and un-measured customers in the base year with a 0.89 occurrences/day and 1.07 occurrences/day for measured and un-measured households respectively.

3.4.2.2 Base year micro-component results

The breakdown of water use by micro-component for measured and unmeasured households by resource zone is illustrated in Tables 3.4.2.2a and 3.4.2.2b below.

Table 3.4.2.2a : Base year measured households by resource zone.

Water Resource Zone	Component	2007	Percentage of total
Metered Northern	**Toilet Use**	26.1	18%
	Personal Washing	66.6	45%
	Clothes Washing	13.3	9%
	Dish washing	19.2	13%
	Outdoor Use	0.6	0%
	Other	16.6	11%
	Miscellaneous	6.0	4%
	Total	**148.4**	
Metered Central	**Toilet Use**	24.7	15%
	Personal Washing	72.5	45%
	Clothes Washing	14.1	9%
	Dish washing	22.8	14%
	Outdoor Use	2.8	2%
	Other	17.0	11%
	Miscellaneous	6.0	4%
	Total	**159.8**	
Metered Southern	**Toilet Use**	25.9	17%
	Personal Washing	76.9	49%
	Clothes Washing	13.3	9%
	Dish washing	18.9	12%
	Outdoor Use	2.1	1%
	Other	18.1	12%
	Miscellaneous	1.0	1%
	Total	**156.2**	

Table 3.4.2.2b : Base year unmeasured household by resource zone.

Water Resource Zone	Metered PCC	2007	Percentage of total
Un-Metered Northern	**Toilet Use**	30.8	18%
	Personal Washing	77.3	44%
	Clothes Washing	14.6	8%
	Dish washing	21.6	12%
	Outdoor Use	7.4	4%
	Other	18.6	11%
	Miscellaneous	5.7	3%
	Total	**176.0**	
Un-metered Central	**Toilet Use**	27.2	15%
	Personal Washing	79.9	46%
	Clothes Washing	15.0	9%
	Dish washing	22.9	13%
	Outdoor Use	7.4	4%
	Other	18.6	11%
	Miscellaneous	4.6	3%
	Total	**175.6**	
Un-Metered Southern	**Toilet Use**	28.8	16%
	Personal Washing	77.4	44%
	Clothes Washing	14.8	8%
	Dish washing	20.2	11%
	Outdoor Use	7.1	4%
	Other	18.1	10%
	Miscellaneous	10.8	6%
	Total	**177.2**	

3.5 Forecast household demand

3.5.1 Forecast micro-component per capita consumption

The micro-component model provides an understanding of how domestic customers use water and how this use is forecasted to change in the future. The model identifies the main components of water use for a typical household.

The following equation shows how the consumption figure for each component is calculated.

Ownership (O) * Frequency (F) * Volume (V) = Consumption (litres/person/day)

The washing machine component could be used to describe this relationship: an assumption is made as to how many homes own a washing machine and how many times a day that machine is used. An understanding of the market penetration of certain models and using best available national data gives an average volume of water each machine consumes per use.

The specific equation may read as follows:

O (90% or 0.9) * F (0.3 uses/person/day) * V (50 litres/use) = 13.5 litres/person/day

Or ***0.9 * 0.3 * 50 = 13.5 l/p/d***

The full model is developed within Microsoft Excel and is based on a simple concept, as seen in the consumption equation above. In its most basic form, the model is a series of O, F and V equations, summed to give a total PCC. This calculation is repeated year on year to produce a forecast, taking into consideration projected changes in the O, F and V estimates.

The model is calibrated in the base-year (2005/6) to the PCC's calculated from the Watcom monitor and the known billed measured consumptions.

The model is built around a series of spreadsheets including:

- Ownership of appliances by Water Resource Zone (measured & unmeasured),
- Frequency of use of the appliances by Water Resource Zone (measured & unmeasured),
- Volume of use for each appliance,
- Consumption of water (measured & unmeasured).

3.5.1.1 Forecast assumptions

To account for the uncertainty around a central forecast, a low and high set of forecast assumptions were also produced. These used the same base year assumptions as the central forecast but serve to highlight the uncertainties behind the potential future behavioural changes assumed.

3.5.1.2 Micro-component categories assumptions

The assumptions made for each component and forecast type for indoor and outdoor usage are shown in Tables 3.5.1.2a and 3.5.1.2b respectively. There is less reliable information on ownership and forecast assumptions for outdoor appliances than there is for internal uses. The Code for Sustainable Homes makes little attempt to quantify external use and as such PCC calculated by this fails to take into account this usage. The following categories were modelled on the best available data for external use and consumption. Ownership levels have been set not to change for each of the forecasts for all of the external components.

Table 3.5.1.2a : Forecast for indoor use by component

Forecast assumptions: Indoor appliances	
Standard toilet	The ownership of a 'standard' 9L toilet will decrease. Evidence suggests that the replacement rate of any given WC is in excess of 15 years. To allow for uncertainty surrounding this figure we forecast a standard toilet ownership reduction over a 20 year period from the base year position, each standard toilet being replaced by a dual flush toilet. For the Low, Central and High forecast estimates this change in ownership equated to an annual average decrease of 4.3% for both measured and un-measured customers. This decrease in standard WC ownership was off-set by an increase in the ownership of low flush toilets. The frequency of use forecast for the standard WC modelled no change for each forecast type as it is considered that WC use will continue unchanged.
Low flush toilet	Low flush WC ownership was forecast to directly replace standard toilet stock. This ensured that ownership of WC's remained at 100% but simply the WC model available for use changed. The frequency forecast remained un-changed as so was set at zero.
Bath	For the low estimate of future use bath ownership was forecast to decrease at 0.2% p.a. This brought bath ownership down from 88% in the base year to approximately 84% in 2035. It was not considered that a decrease in ownership beyond this rate was justified given the available data. The frequency was also forecast to decrease in the low forecast by 0.004 uses/person/day which takes into account an increasing preference for showers. The central estimate for bath ownership also forecast a slight decrease in bath ownership due to the evidence to suggest that showers are often being fitted in preference to baths with little evidence to suggest that bath ownership will increase. This forecast was also used for the High forecast. In the Central estimate bath use is forecast a decreasing at 0.003 uses/person/day as showers are forecast to become more popular, however the High forecast projects an increase in bathing as there is evidence to suggest that as baths tend toward being a means of relaxation rather than simply functional an increase in use may be observed. For this reason the High forecast estimates a personal daily increase in bathing of 0.003. The MTP forecasts the frequency of bath use to decrease by 0.5% between now and 2010 and 1% thereafter. Over the plan period this equates to a weighted decrease of 0.3% p.a, which as a decimal = 0.003.pa.
Standard and power showers	When forecasting the ownership of showers there is evidence to suggest that power shower ownership will reach 50% by 2021. For this reason an annual increase in power shower ownership was applied so that this assumption was achieved. In order not to double count shower ownership the standard shower ownership forecast was set to decrease at a third of this rate, simulating that one in three newly fitted showers will be standard. So that forecast does not double count ownership at any point a function was added to the calculations so that power showers were the drivers of future

	demand and that standard showers occupied the remaining ownership but at no point exceeded a combined shower value of 100%. For the frequency of use power showers were set to continue at the same rate of use in the Low forecast. The central and high forecasts project a mild increase in shower use (0.003/person/day increase) for both shower types as personal standards of hygiene and shower availability continue to increase.
Hand basin	Ownership is forecast to remain the same at 100%. Frequency of use in the Low estimate is projected to decrease marginally by 0.001 uses/person/day to reflect and increasing consciousness of water use. The Central and High models however forecast no change in the frequency of use.
Kitchen tap	None of the forecast assumptions model the ownership of kitchen taps to decrease below 100% nor do they model an increase in use in the future.
Washing machine	The MTP forecast that washing machine ownership is likely to reach 95% by 2015. Given this prediction an annualised growth was calculated that enabled the washing machine ownership level to reach this. A function was written into the report so as to ensure ownership did not exceed 100%. The frequency of use forecast was set at zero for the Low and Central forecasts although a yearly projection of 0.001 uses/person/day was built into the High forecast to simulate a marginal increase in used based on a greater ownership and subsequent availability.
Hand clothes washing	The forecasts assumptions maintain a 100% ownership for this Microcomponent across each forecast level. The Low and Central models forecast a yearly decrease of 0.001 uses/person/day to reflect the increasing functionality of modern automatic machines. The 'High' model frequency is forecast to continue unchanged at the current rate.
Dishwasher	Dishwasher ownership is forecast to be 40% by 2015 given current rates in growth. To meet this predicted market penetration an annual average growth rate of 2.1% have been projected across our supply area. This linear growth was forecast forward with an amendment in the formulae to ensure that the ownership did not exceed 100%. At this forecast rate dishwasher ownership would be approximately 85% by the year 2035. No varying rates of frequency were set into the Low, Central or High forecasts.
Dishwashing by hand	The ownership for dish-washing by hand has been set at 100% for each forecast method. Each forecast assumption forecasts a reduction in the dish-washing frequency as a greater number of appliances are now made to be dishwasher proof and increased dishwasher ownership and technology will increase the use of machine. The annual reduction assumptions currently modelled are Low forecast = 0.04 uses/person/day decrease, Central forecast = 0.037 uses/person/day and High forecast = 0.018 uses/person/day.
Water softener	In the absence of reliable data there has not been a forecast change in softener ownership or frequency in any of the models

Table 3.5.1.2b : Forecast for outdoor use by component

Forecast assumptions: Outdoor appliances	
Car washing (hosepipe)	The Low forecast assumes frequency of use of this component to decrease annually by 0.001 uses/person/day. This considers the increased use of automatic car washers. The Central forecast forecasts no change on the current frequency of use and the High forecast assumes a very moderate increase of 0.0001 uses/person/day.
Car wash (bucket)	As with the car washing using a hosepipe the frequency is set to remain unchanged on the Central forecast with a 0.0001 uses/person/day decrease in the Low forecast and a 0.0001 uses/person/day increase in the High forecast.
Sprinkler	Frequency forecasts as per the car washing shows no change in the Central forecast with a moderate increase/decrease of 0.0001 for the High/Low models respectively.
Hosepipe	As with previous external assumptions the hosepipe frequency of use is forecast to decrease by 0.001 uses/day per annum in the Low forecast, is unchanged in the Central forecast and is forecast to show a moderate increase of 0.001 for the High forecast.
Watering can	As with hosepipe use the frequency of use for a watering can is assumed to un-changed for the Central forecast but experience a 0.0001 use/day per annum fall for the Low forecast and a 0.0001 use/day per annum increase for the high forecast.
Miscellaneous	The frequency of miscellaneous occurrences are forecast to be unchanged in the Low and Central models with a slight increase scenario of 0.001 occurrences/day per annum in the High forecast.

3.5.1.3 Volume assumptions

A decision was made to keep the volume assumptions for internal micro-components constant over the forecast period. Table 3.5.1.3 summarises the micro-component categories used in the model and the evidence based used to derive the assumptions.

Table 3.5.1.3 : Volume assumptions and evidence base for components

Micro-component	Volume (Litres per use/event)	Evidence Base
Standard WC	9	The range in WC volumes range to >13L. MTP[25] evidence suggests 9L WC's have the greatest market penetration at the current time.
Low Flush WC	6	Low flush WC's also vary in volume. Since 2001 guidance has been that 6L is the maximum cistern volume permitted and is used as the assumed volume.
Bath	80	There are a range of bath volumes in the market place. With an increasing prevalence toward much larger than standard luxury baths. However, the MTP report that a standard bath volume is 88L. In 'Water Use in new dwellings', WRc reports a volume of 68.55 litres/use. We have used a value of 80 litres.
Power Shower	96	The volume a shower uses is a function of time spent and flow rate, both of which vary considerably. Evidence from the Code for Sustainable Homes and MTP suggest that a flow rate of 12L/min is standard, and although the EA suggest that average shower times are toward 10 minutes – the traditional view is that this is too on the high side, for this reason and based on supporting literature research We have chosen a 8min shower time. This equates to 96L/use.
Standard Shower	48	As per the power shower although flow rate has been reduced to 6L which equates to a volume figure of 48L/use.
Hand Basin	6	Assumes a 6 litre volume per operation which correlates given standard water pressures across our supply area to 30-60 seconds run time per use. This figure is supported by Waterwise[26] evidence.
Kitchen Tap	9	This figure is derived from average flow rates as per the hand basin with marginally longer run times. This figure is again supported by Waterwise evidence.
Washing Machine	50	Volume per use of washing machines is a factor of their age and model type. The range is varied although an agreed figure of circa 50L is broadly agreed as standard.
Clothes Washing (by hand)	32	This figure assumes that each time clothes are washed by hand it takes one full sink of water (16L) to soap them and another full sink to rinse them. Evidence to support this further is light.
Dishwasher	18	MTP reports an average of 15.15L per use. We chose an average of 18L/use
Dish washing (by hand)	16	Assumes that on average a washing-up bowl of water (circa 8L) and approx. 1 minute 'rinse time' circa 8L per washing event.
Water Softener	12.5	An internal review of the current market penetration of washer softeners, each with varying rates of regeneration, provided an average figure of 16L per person per regeneration.
Car Washing (Hosepipe)	300	Data varies widely. A Waterwise figure of 300L per event correlated closely with an internal monitoring trial and so has been used.

[25] Market Transformation Programme, www.mtprog.com
[26] Waterwise - UK NGO focused on decreasing water consumption in the UK

Car Washing (Bucket)	35	Assumes 3-4 buckets per wash at circa 10L/bucket supported by both an internal trial and Waterwise data.
Sprinkler	1000	Waterwise data suggesting that when used a sprinkler is used for approximately 60 minutes. At 10L per minute flow rate this correlated to circa 1000L per use.
Hosepipe (watering)	300	At a flow rate of 10L per minute an average 'plant watering event' of 30 minutes would consume circa 300L of water.
Watering Can	8	Assumes average volume of a watering can is 8L and that the watering can is filled and the water contained is used completely.
Miscellaneous	6	Assumes a 30 second -1 minute unaccounted for daily tap run at circa 6-8L/min.

3.5.1.4 Results

Modelling the domestic demand for water using a micro-component approach provides a useful guide to demand over the plan period. Table 3.5.1.4 shows the forecast PCC values for measured and unmeasured customers by resource zone. The forecast PCC values are represented at company level in Figure 3.5.1.4.

Table 3.5.1.4 : PCC forecasts resulting from the micro-component analysis

	Metered Households			Unmetered Households		
WRZ	**Northern**	**Central**	**Southern**	**Northern**	**Central**	**Southern**
2007	148.4	159.8	156.2	176.0	175.6	177.2
2008	148.1	159.4	156.1	175.8	175.5	176.6
2009	147.8	159.0	155.8	175.7	175.3	176.0
2010	147.5	158.5	155.4	175.6	174.9	175.4
2011	147.2	158.0	155.1	175.5	174.4	174.9
2012	146.9	157.5	154.7	175.1	174.0	174.3
2013	146.3	157.1	154.4	174.6	173.6	173.8
2014	145.8	156.6	154.0	174.1	173.2	173.2
2015	145.3	156.2	153.7	173.6	172.8	172.7
2016	144.8	155.7	153.4	173.1	172.4	172.2
2017	144.3	155.3	153.1	172.6	172.0	171.6
2018	143.8	154.9	152.8	172.1	171.6	171.1
2019	143.3	154.4	152.5	171.6	171.3	170.6
2020	142.8	154.0	152.1	171.0	170.9	170.1
2021	142.3	153.6	151.9	170.4	170.5	169.6
2022	141.7	153.2	151.6	169.9	169.9	169.1
2023	141.2	152.8	151.4	168.7	169.4	168.7
2024	141.1	152.4	151.6	168.7	169.5	168.6
2025	141.0	152.3	151.7	168.7	169.6	168.5
2026	140.8	152.3	151.8	168.7	169.6	168.4
2027	140.7	152.3	151.8	168.6	169.7	168.3
2028	140.6	152.2	151.9	168.6	169.8	168.2
2029	140.5	152.2	152.0	168.6	169.9	168.1
2030	140.4	152.2	152.1	168.6	170.0	168.1

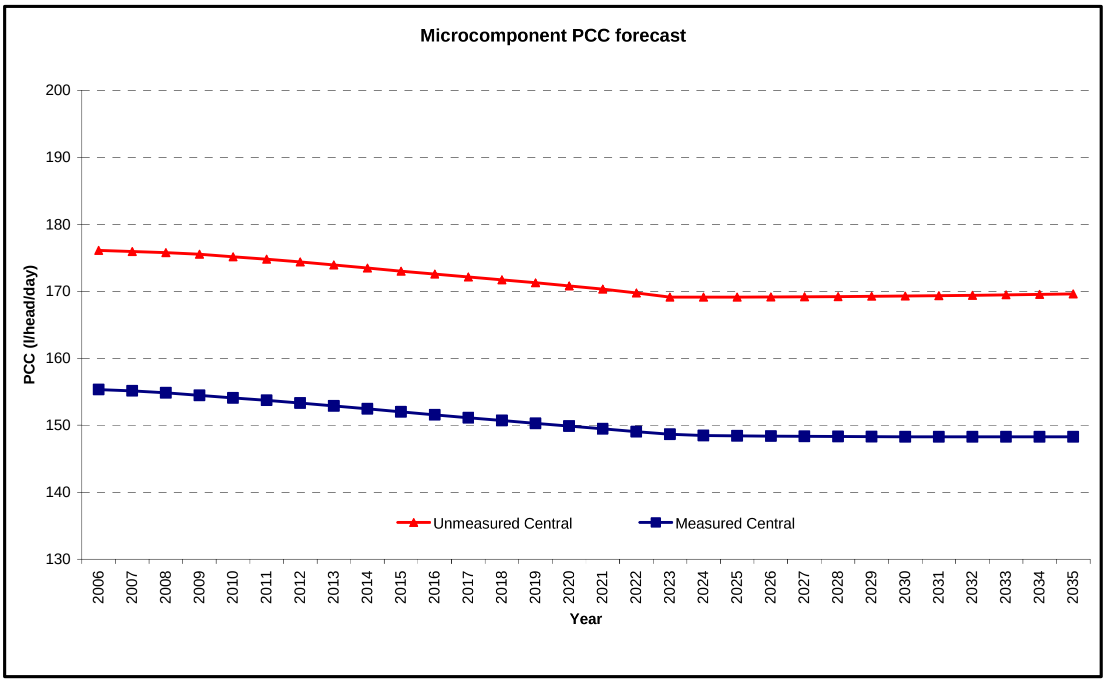
	Metered Households			Unmetered Households		
WRZ	**Northern**	**Central**	**Southern**	**Northern**	**Central**	**Southern**
2031	140.3	152.2	152.2	168.6	170.1	168.0
2032	140.3	152.2	152.3	168.7	170.2	167.9
2033	140.2	152.2	152.4	168.7	170.3	167.9
2034	140.2	152.2	152.5	168.7	170.5	167.8
2035	140.1	152.2	152.6	168.7	170.6	167.7

The central forecast is the most robust at this time. A measured PCC in the base year of 155 l/p/d falling to circa 148 l/p/d by 2035 with an unmeasured PCC in the base year of 176 l/p/d falling but then rising again to 170 l/p/d (Table 3.5.1.4).

The model assumptions created to inform this report have been based on a comprehensive customer survey, of sufficient size to ensure that it was fully representative of the company. This provided detailed base year assumptions on water use that were then added to, based on best available data to benchmark the base year to the calculated unmeasured and measured PCC.

We consider that given the accuracy of the data used to benchmark the base year this central forecast projects a sound basis from which to consider future demand. The Low and High forecasts are also considered solid outliers from which to base the considerable uncertainty about a forecast of this type.

Figure 3.5.1.4 : Central forecasts of PCC for measured and unmeasured customers



3.6 Government 130 l/p/d Per Capita Consumption

In its publication Future Water[27] DEFRA announced an aspiration to achieve an average PCC consumption of 130 l/p/d national average normal year PCC in 2030 for metered population.

We have reviewed how it may be possible to achieve this goal together with the ballpark costs of attaining it utilising an assessment of the impact of tariffs and the measures required to reduce the volumes of micro components contributing to PCC.

The target figure set out in Future Water assumes full metering, tariffs (seasonal tariffs) and innovation (AMR and Smart metering). Smart metering with real time information relating to water usage is not widely available for water meters at the current rime although we understand that the Government endorses a similar 10 year programme to install digital meters in every home for gas and electricity to allow customers to monitor their energy consumption is to be completed by 2020. Our compulsory metering policy will lead to achievement of 90% meter penetration with “dumb” meters by 2030 which we assume to be “full” metering since there will remain a rump of meters where it is difficult or impossible to fit a water meter to properties either internally or externally. We are fitting AMR meters to all internal and multiple unit new developments from April 2009 and we will work with our customers during AMP5 to determine what information has most benefits.

To get to the target, one of the solutions is to assess possible reductions in PCC associated with the introduction of seasonal tariffs. For the 2030 year, our micro-component model forecasts a 148 l/p/d measured PCC as a normal year average. AMR technology is expected will have an impact on the measured PCC and reduce the decay in consumption savings as this allows more frequent billing and improved consumption data to be provided to customers thus raising awareness of lifestyle decisions as well as identifying supply pipe leakage. We also consider that AMR and smart metering will both facilitate the introduction of seasonal tariffs and raise customer awareness of water consumption in the home and therefore that a combination of tariffs and smart metering will have a significant impact on water consumption.

Our estimate is for a 19.7 Ml/d reduction at average in a dry year by the introduction of seasonal tariffs and smart metering however the costs of installing AMR will require meter replacement with the more advanced units when these become available.

A reduction in PCC of approximately 6 l/p/d in a normal year is forecast for measured PCC and therefore this will reduce to 142 l/p/d by 2030 with the introduction of seasonal tariffs. The cost of installing AMR for all of our measured properties and for the introduction of tariff schemes is estimated to £105 million.

Once tariffs are introduced, the 130 l/p/d target could possibly be reached by improving appliance efficiency by facilitating the introduction of new, more efficient appliances for each household in the following ways.

- The volume of a bath can be reduced by 10 litres (70 litres per use) by replacing existing, larger baths smaller more water efficient fittings.

[27] Future Water – The Government’s water strategy for England. Published February 2008

- The volume of a power shower can decrease to 80 litres per use by installing aerated showerheads.
- The volume of a normal shower could be reduced to 42 litres by fitting flow restrictions and/or shower timers.
- A modern water efficient washing machine and a dishwashing machine use only 45 litres and 15.5 litres, according to the manufacturers. Therefore the introduction of a subsidy to encourage all consumers to replace their old machine with a more water efficient one will yield benefits in terms of PCC.
- Reducing toilet flush volumes from 6 litres to 4.5 litres would make measured PCC lower but will require replacement of toilet and bathroom fittings and suitable incentives to encourage such measures.

Table 3.6 summarises the reductions in volumes and the costs associated to each item.

Table 3.6 : Costs of reductions in PCC

Micro Component	New volume (l/use)	New PCC	Change in PCC (l/p/d)	How to get new volumes?	Costs millions
Bath	70	146.5	1.8	Subsidy to replace bath with smaller more water efficient fittings. Allow £300 per bath to include liaison with bathroom supplies and fitters.	195
Power shower	80	140.4	6.1	Distributing and fitting aerated showerheads. Fitting service and test to verify reductions in flow rate at £80 per showerhead.	20
Normal Shower	42	138.9	1.5	Fit flow restrictions, shower timers, increased publicity, flow shut off devices.	65
Washing Machine	45	137.5	1.4	Trade in and subsidies for all washing machine replacement. £150 per machine plus admin and overheads.	110
Dishwasher	15.5	137.0	0.5	Trade in and subsidies for all washing machine replacement. £80 per machine plus admin and overheads at 10%	13
Dual Flush Toilet	4.5	132.3	4.7	Replace older toilets for free plus plumbing services including for fitting.	55

Our estimate of the total cost to reduce measured PCC from 148.3 l/p/d to 132.3 l/p/d is £460 million. Installation of AMR and introduction of seasonal tariffs would cost £105 million and would decrease the PCC to 126.3 l/p/d. Therefore bringing the total cost to £565 million.

3.6.1 Uncertanties in the range in PCC

There is considerable uncertainty over the reliability, sustainability and repeatability of demand management schemes at the current time. For schemes available post 2025 it is likely this uncertainty will be lessened. Should this prove to be so then larger, multiple or longer duration demand management schemes may be available for use in the future and the least cost solution may include a greater proportion of demand management schemes including those shown in 10.7. In that the case the maximum volume that may be satisfied within a cost-effective solution could be 100% of the 44 Ml/d supply deficit at critical period. This magnitude of demand savings at critical period is equivalent to around.7 Ml/d at annual average or approximately.2

l/h/d. Accordingly our forecast of baseline average pcc in 2035 could be reduced from 162 to 160 l/h/d within a least cost range of options.

We have also considered the effect of the range of uncertainty of micro-component (MCC) forecasts with the supply/demand balance. Our work on micro-components of demand assessed the confidence range of baseline average PCC was -23 to +12 l/h/d at 2035. Applying this range to the adjusted forecast of average PCC for 100% demand management schemes to satisfy the critical period supply deficit means a possible range of average PCC from 137 l/h/d to 172 l/h/d by 2035.

3.7 Non-household demand

We commissioned consultants to work with us to compile a commercial demand forecast. The proposed methodology follows industry best practice guidance[28]. The forecasts are based on relationships that have been established between actual commercial consumption and Real Gross Value Added (GVA) over a period of 8 years from 1998/99 to 2005/06 inclusive, which have then been extrapolated forward to 2036/37 based on long-term forecasts of regional GVA growth for the East, London and South East regions of the UK.

The forecasting methodology that has been used is a two stage process. Firstly, regression analyses have been carried out to establish relationships between commercial demand and the relevant economic explanatory variables based on historic data for a period of 8 years from 1998/99 to 2005/06 inclusive. Secondly, these relationships have been extrapolated forward to forecast future demand over a 30-year period to 2036/37 based on long-term forecasts of economic growth.

Regression analyses have been carried out to explain our commercial consumption as a function of UK regional data for both Real Gross Value Added (GVA) and Employment for the East, London and South East regions. This work has been carried out separately for each of 12 different categories of demand, split by supply area and SIC category as follows:

Supply areas: All Zones, Northern Zone, Central Zone, Southern Zone;

SIC categories: All Categories, Services, Industry & Manufacturing.

The best relationships that have been established (based on the R-squared regression values) have then been used to forecast future demand through to 2036/37 based on forecasts for the underlying economic factors.

Forecasts for the Northern, Central and Southern zones have been scaled so that they always sum to the relevant forecast for All Zones.

For each supply area, the two best regression equations have been chosen as the basis for the demand forecasts (e.g. for Total Consumption and for Services Consumption). Starting from the actual consumption for 2006/07, these regression equations are used to forecast future demand through to 2036/37 on the basis of the relevant regional GVA forecasts. The remaining consumption forecast is then calculated from the first two forecasts (e.g. Industry & Manufacturing Consumption =

[28] UK Water Industry Research Limited – Demand forecasting methodology (1995) and Forecasting water demand components (1997).

Total Consumption minus Services Consumption). It should be noted that given the uncertainty associated with the forecast economic growth, bearing in mind the volatility in actual consumption in recent years (Figure 3.7a), the regional GVA forecasts have been approximated to an annual growth of 3% per annum every year for the purposes of the demand forecasts.

Forecasts for the Northern, Central and Southern zones have also been scaled so that they always sum to the relevant forecast for All Zones. The forecasts for All Zones have been left unchanged as these are based on the regression equations with the best R-squared values.

The resulting demand forecasts all reflect Pre-MLE June Return consumption figures. The forecasts for the Company as a whole are shown in Figures 3.7b, 3.7c, 3.7d and 3.7e.

Since preparation of our commercial demand forecast the UK has entered a recessionary period which we believe will impact upon non-household demand for water. During the recession we anticipate that small companies and enterprises that cease to become viable will close or be located elsewhere in the UK or abroad. It is therefore probable that the loss of demand will not be recovered post recession. Whilst the full scale of the recession is yet to become apparent we cannot begin to assess the impact or duration of the reduction in demand that we can expect. However we have used latest economic assessments to adjust the demand and represent the impact in Figure 3.7f.

The principal impact of the recession forecast is to increase the steepness of regression analysis curves leading to an accelerated decline in our manufacturing sector forecast and reducing forecasted increase in services sector commercial demand for water.

Figure 3.7a : Forecast growth in GVA and Employment by region

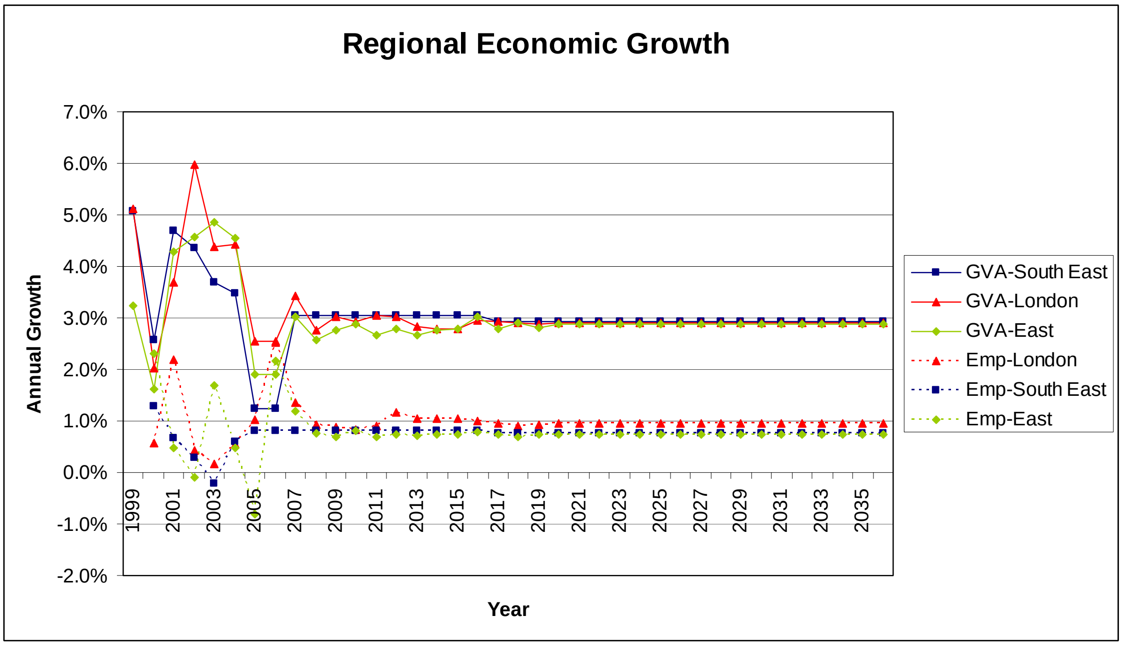
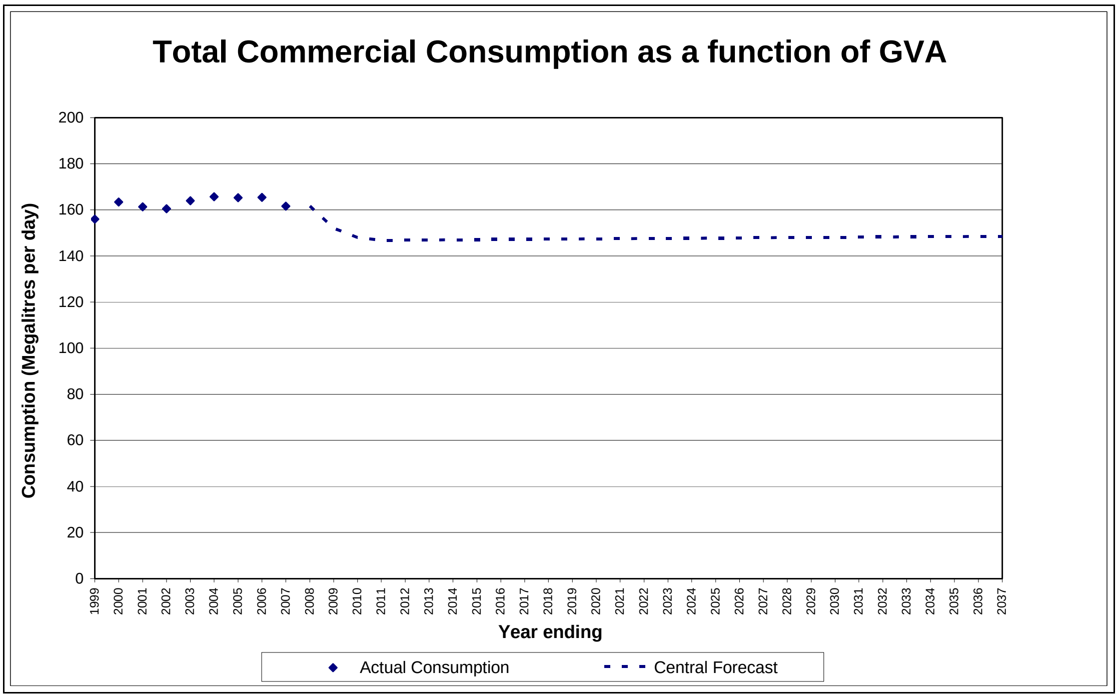


Figure 3.7b : Veolia Water Central Commercial Demand Forecast (All Sectors)



Our revised, recession impacted commercial forecast is shown in Figure 3.7.f below.

Figure 3.7c : Veolia Water Central Commercial Demand Forecast (Services)

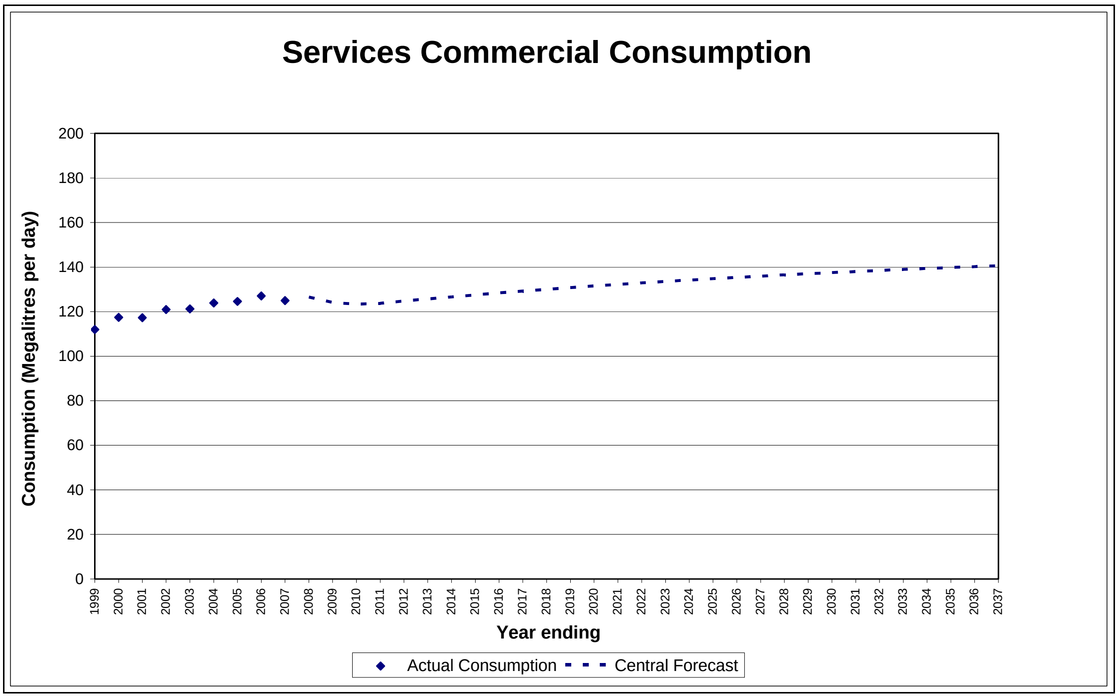


Figure 3.7d : Veolia Water Central Commercial Demand Forecast (Industry & Manufacturing)

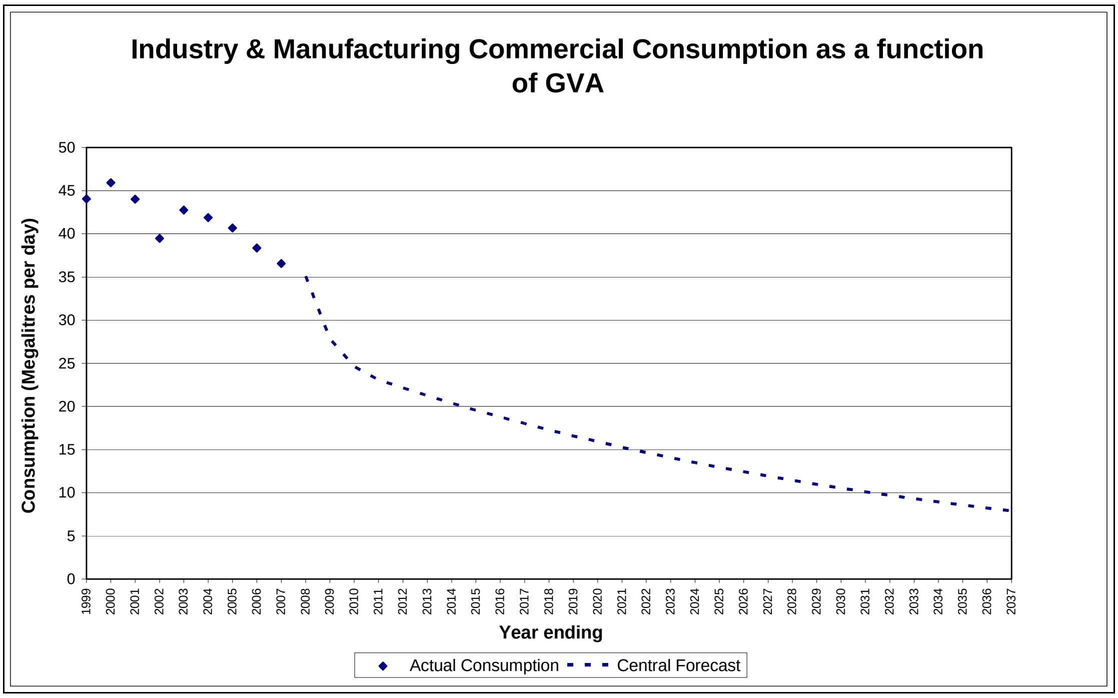
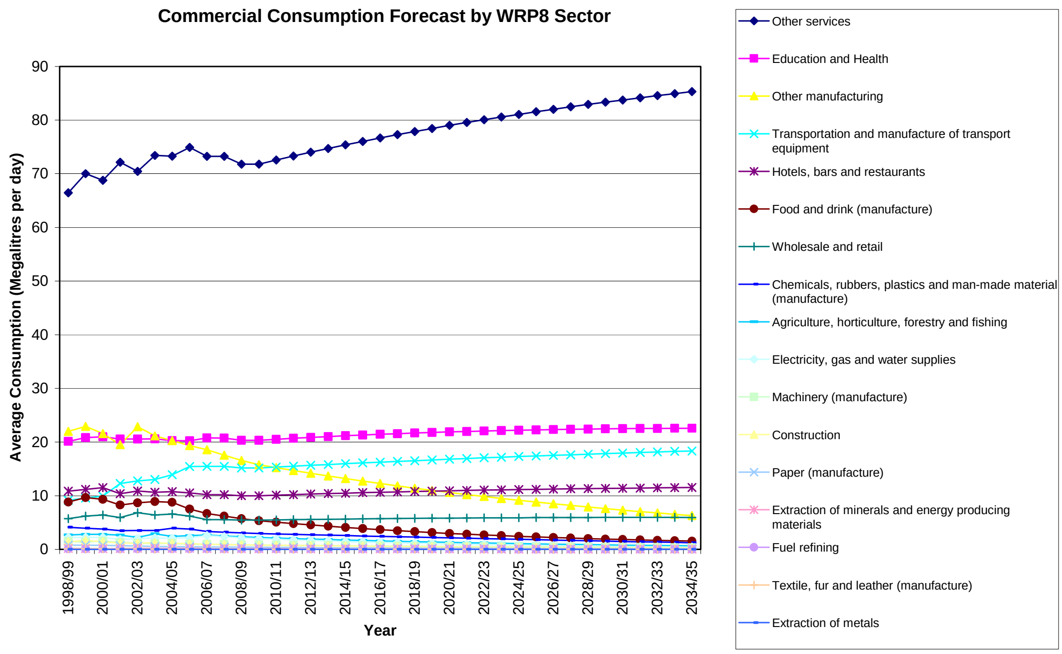
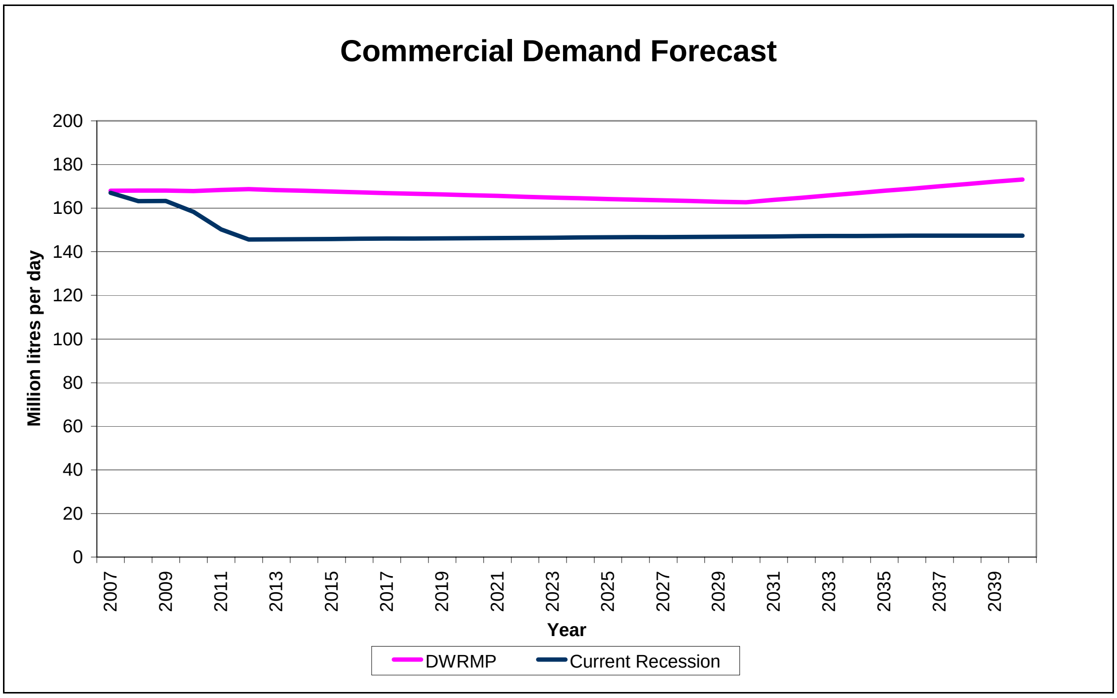


Figure 3.7e : Veolia Water Central Commercial Demand Forecast by WRP8 Sector



In light of the deteriorating economic conditions we have re-examined our non-household forecast and now predict a significant reduction in consumption as a result of business failures in the next few years. Our revised forecast is shown below.

Figure 3.7f : Veolia Water Central Revised Commercial Demand Forecast (All Sectors)



3.8 Water efficiency and metering

3.8.1 Water efficiency

We have demonstrated a strong commitment to the promotion of water efficiency (WE) with many initiatives to both promote and distribute water saving devices. The current WE strategy within the business plan is based upon the premise that the successful growth of water efficiency to domestic customers requires the economic incentive provided by metering.

Overall, these have had limited success with regard to the volumetric savings claimed and have proved relatively costly to complete. Notwithstanding this the Company remains committed to a pro-active water efficiency strategy to discharge our statutory duty, while supporting the overall supply/demand balance.

The company has a proven track record having won 5 independent awards for its water efficiency activities. Promotional projects and projects used to assess emerging technology such as the ongoing use of remote meter reading technology together with customer advice, building to a list of achievements to date.

Table 3.8a outlines the water efficiency schemes which form part of the feasible list of schemes, and the area of the water efficiency strategy with which they are associated. Details of our Water Efficiency Strategy are included in section 1.12.4.

Table 3.8a : Water efficiency schemes

Stream	Scheme Title	Comments	Estimated Savings
M	Water Audits - Commercials	Increase Number	0.58 Ml/d
M	Water saving devices - Voucher Scheme	New scheme proposed	0.31 Ml/d
M	Customer subsidy for purchasing water saving devices	New scheme proposed	10.5 Ml/d
M	Re-washering taps	New scheme proposed	0.99 Ml/d
M	WE Project for SME's	New scheme proposed	1.62 Ml/d
M	Retro fit dual flush mechanism	New scheme proposed	0.31 Ml/d
M/R&D	New cistern displacement devices	New scheme proposed	3.38 Ml/d
M	Community water efficiency scheme.	New scheme proposed	2Ml/d
M	Housing Associations - Targeted water efficiency promotion	New scheme proposed	0.18 Ml/d
R&D	Dual flush valve failures - Investigation	New scheme proposed	(0.03 Ml/d)
M	Aerated shower retrofit	New scheme proposed	0.13 Ml/d
M	Hose gun trigger - Targeted DMA	New scheme proposed	0.33 Ml/d

Water efficiency activity strands included in the strategy are:

- Promotion (P)
- Measurement (M)
- Supply/demand balance (S/D)
- Operational use of water (O)
- Industry and Company R & D (R&D)

Promotional and educational schemes are considered Company policy. All the schemes which fall into the 'Company Policy' category were excluded in the phase one screening process. The schemes which are considered company policies are listed below.

Table 3.8b : Company policy schemes

Scheme Title	Comments
Targeted water conservation - Industrial customers / bodies	Company Policy
Targeted water conservation - Commercial customers	Company Policy
Targeted water conservation - Public Sector - see scheme 334	Company Policy
Targeted water conservation - Designers of hot water systems, taps and water using appliances	Company Policy
Targeted water conservation - Labelling water consumption appliances	Company Policy
Water saving devices - Encouraging Water Efficient appliances in manufacture	Company Policy
Water saving devices - R&D into WE technology	Company Policy
Tighter water regulations	Company Policy
Water Regulation Audits	Company Policy
Water Butt promotion	Company Policy
Local Press and Poster Campaign (see 346)	Company Policy
Local Press and Poster campaign combined with high demand enhanced media campaign	Company Policy
Joint water efficiency promotions partnership with Local Authorities	Company Policy
Development of Re-use Techniques and applications	Company Policy

A number of the company policies are discharged by joint industry activities, such as those conducted through UKWIR, Water UK and WRc. Many of the promotional activities for example the promotion of Water butts now form part of the company's everyday approach to the promotion of water conservation.

We contribute to and support industry and academic R&D groups in order to understand the issues involved in promoting water efficiency nationally. The Company continues to participate in groups such as the WE Network, Anglian Regional Water Efficiency Group, National Water Conservation Group, and the Water UK/Ofwat/Defra/Environment Agency Quadripartite.

It is assumed that the schemes which are undertaken to reduce consumer consumption would not result in permanent consistent water savings, with any project it is highly likely that over time water saving devices will be replaced or not maintained in a number of cases, resulting in an net reduction in the volumes of water saved over time. For example if a cistern displacement device fails it is quite likely it will be removed and not replaced.

Ofwat has confirmed it will set water efficiency targets for the period from April 2010 until March 2015. Our correspondence with Defra has confirmed that the targets are not yet a legal requirement. When the targets are set under s.93B of the Water Industry Act and hence become mandatory we will take action to meet them. This will create a new obligation and we will change our Plan accordingly to include additional activities needed to meet the target. The £671k cost of the additional activity should then be included in price limits although this will be less if Ofwat recognise our current programme of education activities

3.8.2 Metering

If all (or at least 90%) of our customers were to have water meters, we could measure usage and patterns of usage more accurately, allowing us to manage demand more effectively. More than a third of our customers have a meter. From the industry's experience with metering[29], we know that customers tend to use, on average, 10% to 15% less water than if they stayed unmeasured. Meters also allow us to charge on a pay-as-you-take basis, which the majority of customers believe is a fairer basis for charging.

Meters also open the way for new ways of charging for water which vary with the scale of demand by individual customers and which relate to the differing costs that particular types of demand impose on the system. Variable tariffs will mean that customers pay according to their usage, be it essential, discretionary, seasonal, daily or nightly. Seasonal tariffs, for example, will help us manage demand in the peak summer months, and shift the burden of water charges to those who use most at periods of peak demand. However, the true potential of more effective tariff structures will not be unlocked until we can access reliable household occupancy data as demand for water most closely correlates with the number of people living in a house.

Whilst our customers, regulators and environmental stakeholders are generally in favour of metering and of promoting the reduction of abstraction of water for public supply through water efficiency measures, they are also concerned about the impact of accelerated programmes of metering on customer bills and ability to pay.

Our assessment of our supply demand position is that we have a surplus of supply over demand in until 2026 and therefore metering is not cost effective however we have investigated a range of metering programmes to determine if they have a positive cost benefit.

We have considered the impact of our proposed metering programme on customer bills and estimated the effect on price increases because of the capital investment required and the additional operating costs of metering. Installations in new homes are expected to be paid for by the developer.

---

[29] UKWIR 2006 Report on Review of Demand Impacts of Metering

In order to understand the best way of introducing new ways of charging for water pilot trials are being carried out. This will evaluate the cost-effectiveness and influence on consumption of new tariffs. A water efficiency (WE) programme is also being devised to supplement the effect of metering and tariffs on demand. This programme will be based on the latest evidence of cost-effectiveness of WE measures and Ofwat benchmarks in order to improve the reliability of outcomes

We will also be investigating the use of new devices for reading meters automatically (AMR[30]) in a tariff trial so that we can draw conclusions on the cost effectiveness of AMR and of tariffs in drawing up programmes of accelerated street by street metering should the need arise in the future.

Our economic assessment indicates that it is cost effective to install attachments to new meters that are installed inside houses so that these can be read without having to gain access to the property and we are already installing these devices where our compulsory metering teams encounter properties where it is uneconomic to install an external meter. These devices will not be cost effective in terms of gathering meter readings but they will facilitate our ability to ensure that all meters are read at least once a year. When there are sufficient numbers installed, the introduction of new ways of charging for water in the future.

Our assessment of a range of metering strategies suggests that further compulsory metering is not beneficial without the inclusion of significant quantities of wider intangible benefits. At the recent price determination by Ofwat we were unable to justify a continuation of our compulsory metering policies over the period 2010-2015. It remains our intention to continue our existing compulsory 'change of occupier' metering policy after 2014 which will achieve 90% measured properties by 2030. Our cost benefit analysis for metering is included in section 8.4 of this plan.

3.9 Leakage control

3.9.1 Leakage management

Over the past three years we have significantly increased our active leakage control activities and the associated expenditure in order to meet our mandatory leakage target of 145 Ml/d for 2006-07 and 140 Ml/d by 2009/10. This has been achieved mainly through increased targeted leakage activity on the network.

Following extensive research into different techniques and equipment available for leak detection we improved our approach to leak detection in 2007. This placed more emphasis on value led techniques as opposed to simple sounding.

We have maintained our leakage detection organisation at the recent high levels of about 80 Full Time Equivalent (FTE) personnel. To support this level of resource we employ around 35 contractors who are regionally based and have shared skills allowing us increased flexibility to respond to leakage outbreaks. We use a number of contracting organisations to ensure we have the right experience and skills available.

About 70% of the workforce is employed using detection techniques such as step testing, leak noise correlating and deployment, and analysis of noise logging

30 Advanced Meter Reading devices AMR

equipment. There is still a role for simple sounding to rapidly locate small incremental increases in leakage. Outputs are measured on the value of leak found from a baseline amount (on an assessed basis) and contractor payments relate to this.

We have implemented a change in our Leakage Reporter software system which will allow us to move towards better performance measurement using actual nightline measurements and using leakage performance indicators to monitor and improve our efficiency. Benchmarking with others in the industry indicates that in the majority of cases we are performing efficiently. Examples of Leakage Performance Indicators (LPI's) being developed or used at present include:

- Number of properties per leakage technician
- Number and types of leaks found per technician
- Volumetric savings achieved per leakage technician
- Natural rate of rise of leakage
- Speed of repairs
- Percentage of dry holes
- Unit volume per leak located

A change in our reporting lines in 2008 now also means that the Leakage Operations Manager responsible for leak detection activities lies within the Asset Management organisation that are responsible for meeting the leakage target. This now brings aspects of leakage including pressure management, district meter area maintenance, reporting, infrastructure improvements into one accountable area

Table 3.9 illustrates the high level of active leakage control undertaken to meet our mandatory leakage targets.

Table 3.9 : Total number of repairs

	Total Leaks		
Year	Reported	Detected	Total
2004-05	13,277	9,704	22,981
2005-06	12,961	17,179	30,140
2006-07	13,420	19,408	32,828
2007-08	12,297	19,823	32,120

Contractor performance is focussed on ensuring we maintain a low work in progress (WIP) and repair leaks (especially mains bursts) without undue delay therefore reducing the volume lost and ensuring our leakage teams can return for further surveys if required. The effect of the new Traffic Management Act has still to be properly evaluated but we have systems in place that should minimise this impact.

3.9.2 Leakage infrastructure

District metering remains a cornerstone of our leakage strategy, with almost 82% of properties covered by district meters providing detailed information on night flows. In total, we operate almost 800 separate district meter areas, covering on average 1,400 properties. Data loggers are installed at all 1,200 district meter sites and daily downloads of information to our servers enable this flow data to be reviewed, analysed and archived. We utilise a combination of communication links including leased telephone lines and are able to link to the majority of data logger types available.

We are using this comprehensive and integrated leakage reporting and monitoring system to enable us to:

- Continue to report leakage based on the minimum night flow methodology with data extracted from the district metering systems
- Ensure that the reporting and monitoring systems are robust and flexible to enable us to react or change future requirement
- Report at various levels within the company
- Build on the integration links already established with other corporate systems such as our Geographical Information and work management systems
- Define the leakage detection priorities on a weekly basis

We have an extensive and mature pressure management system covering about 60% of our properties that is constantly being improved. A recent study shows that 40 of our 400 pressure reducing valves would benefit from increased control. Using new controllers now on the market we have improved control at these sites. We estimate benefits will vary greatly but between 14 and 40 m3/hour could be saved. We are also studying sites that would benefit from flow modulation. Using hydraulic modelling studies we are continually searching for new areas where pressure management could be introduced. A large project has commenced in North London which divides a hydraulic demand zone of approximately 200,000 properties into 8 separate sub zones. For security reasons, each zone with flow control will be regulated at night.

Our service reservoir inspection programme enables potential leakage to be identified on a site by site basis. The programme is designed such that each storage site is internally inspected at a frequency of at least once every 10 years and externally every 5 years. Wherever possible, as part of the internal inspection a drop test on the storage unit is undertaken prior to and after completion of the inspection. External inspections involve detailed observations of under drains and perimeter drains (about 40% of reservoirs) and signs of leakage in the embankments. In addition to the routine inspection programme all water levels in the storage units are constantly monitored through our telemetry system which reports data to a 24 hour manned operational control room. This enables trends in storage levels to be reviewed and the identification of any potential overflow incidents. In practice we notice very little leakage coming from our reservoirs and where found, it is acted on immediately as this has a potential to undermine the structure of the reservoir.

Losses from trunk mains are assessed from information gathered through a trunk mains inspection programme. Sections of trunk mains are walked by a dedicated team to verify if any visual signs of leakage are evident. In addition to the visual inspection, where possible, noise loggers are deployed on available fittings to confirm the integrity of the main and identify the existence of a leak. We also have the ability to compare distribution input at a zonal level with information collected from our district meter data base. This allows trends to be established at a zonal level and enables changes in the profiles to be detected and hence early investigation of appropriate trunk mains or service reservoirs within the zone. We have also conducted, as part of our infrastructure capital maintenance programme for AMP4, detailed condition and risk assessments of 50 trunk mains.

3.9.3 Economic Level of Leakage (ELL) Analysis

This section presents the findings of our investigation of leakage trends and the current Economic Level of Leakage (ELL) and Socially Efficient Level of Leakage (SELL).

A least cost plan approach has been used to minimise operating costs in the short term and defer capital investment in the future. We consider achieving an adequate supply/ demand balance as a key part of our overall business strategy.

Assessment of the ELL is an important factor in demonstrating to our regulators that we are operating efficiently. We have selected the Modelling of Economic Leakage Targets (MELT) equations and the SALT model (developed by RPS Water) for our economic leakage appraisal. This approach allows us to include the deterioration of our network through the concept of Natural Rate of Rise in leakage (NRR).

The SALT model estimates the cost of maintaining or reducing leakage assuming a NRR (method B in the Tripartite report) and calculate our ELL using a least cost plan approach, as recommended in the tripartite best practice report.

We have been carrying out a NRR study for the past two years based on leak repair and flow data (2005-2008) in accordance to the UKWIR best practice methodology. The robust NRR estimation provided by this study is used to populate the SALT model.

To define the optimum leakage level for customers, society and environment, we have calculated and included in the ELL the environmental and social costs and benefits as a result of external impacts of leakage related and leakage management externalities to define the Socially Efficient Level of Leakage (SELL).

The methodology adopted complies with the ‘best practice approach’ identified in the Tripartite Report. Two detailed reports prepared by RPS Water present the Economic Level of Leakage and Socially Efficient Level of Leakage analysis and specifically address the following points:

- **Methodology**: The methodology used to undertake the analysis conforms to industry best practice.
- **Data Quality**: We have used company specific data in the ELL analysis wherever possible and this data has been applied at the Resource Zone level. Audit trails for the data have been demonstrated back to source data and systems.
- **Water Balance:** Leakage data aligns closely with the water balance demonstrating the robust nature of the calculation.
- **Zone Appraisal:** The ELL analysis has been built up from the water resource zone level and is fully consistent with the supply demand balance appraisal.
- **Breadth of Analysis:** The report identifies a range of leakage control options that have been fully considered and costed.
- **Environmental and social costs:** A specific study has been undertaken to include the environmental and social costs and produce the SELL at

Water Resource Zone and at company level. The study has been carried out on our behalf by RPS Water.

- **Sensitivity Analysis:** The report presents the sensitivity analysis of the short-run ELL and of the short-run SELL estimate to the key input data.

3.9.3.1 Current leakage-cost relationships

The adopted approach is the same as the one we used in presenting our Draft Business Plan 2008 but the relationships have been updated using 2007/2008 data.

We have developed leakage-cost curves using the well-known MELT equation approach. The curves have been defined by regression analysis using Company specific data related for active leakage control cost and intensity of activity for the period 2007/2008. Two cost curves have been developed for each of our Water Resource Zones: a leakage-detection cost curve and a leakage-repair cost curve.

The key variables in the (ALC) cost curve are the natural rate of rise (NRR) and the background leakage (BL):

- The detectable element of the total NRR is the leakage that needs to be overcome through active leakage control or other means before any real reduction in leakage over a year is observed
- The background leakage is the lowest level of detectable leakage where the marginal cost of ALC is infinitely high.

3.9.3.2 Natural Rate of Rise in leakage

Total and detectable NRR have been calculated for a sample of about 400 district meter areas (DMAs) over the period 2006/2008 using the calibrated burst frequency approach in batches of DMAs by asset cohorts defined by mains material.

Regression analyses have been subsequently carried out on NRR calculated using four explanatory variables: mains length, number of properties, pressure and mains age.

The inclusion of the average mains age in the NRR relationships and the classification of the DMAs by cohorts based on the mains material allow us to take into consideration the impact of mains renewals that have been carried out during the last years on the NRR. Indeed the younger the network the lower the NRR and DMAs which contain a high proportion of plastic pipes such as PVC and MDPE have a lower NRR.

The defined relationships have been applied to every leakage zone (DMAs and passive areas) to estimate the total and detectable NRR for the whole company.

Table 3.9.3.2 is a summary of our detectable NRR by water resource zone and for the region as a whole.

Table 3.9.3.2 : Natural Rate of Rise at company and at resource zone levels

Zone	Detectable NRR (Ml/d/year)
Northern Zone	15.2
Central Zone	27.4
Southern Zone	10.6
Company	53.2

3.9.3.3 Policy minimum level of leakage or background leakage

We have estimated background leakage from Minimum Achieved Leakage (MAL) Level. We averaged the daily minimum night flows values in our region over the period April 2006-March 2008 and we used the lowest values found per DMA as the MAL value. Night allowances were then deducted and MAL levels were adjusted for pressure. DMAs were then ranked by Network Density, divided into property density bands and the 20^{th} Percentile was taken for each band as an estimation of background leakage.

A regression analysis was performed to provide a functional relationship at company level. Background Leakage was finally estimated for each DMA and each Water Resource Zone based on the defined relationship.

Table 3.9.3.3 is a summary of Background Leakage (Minimum Achieved Leakage) by water resource zone and for the region as a whole.

Table 3.9.3.3 : Background level of leakage at company and at resource zone levels

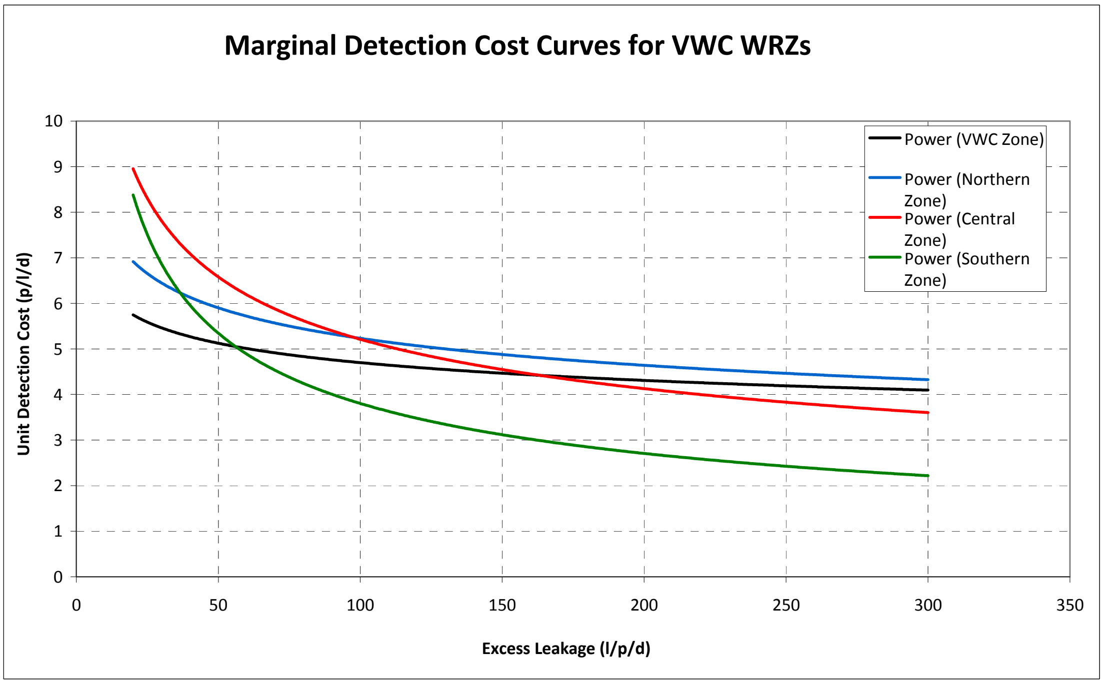
Zone	Background Leakage (Ml/d)
Northern Zone	16.7
Central Zone	24.9
Southern Zone	5.9
Company	47.5

3.9.3.4 Marginal and total leakage-cost relationships

We defined two marginal cost functions for active leakage control (ALC) for each Water Resource Zone through regression analysis of the observed costs and leakage savings data for the year 2006/2007: One function for detection and one for detected repair activities. The costs associated with reported repairs are regarded as fixed costs.

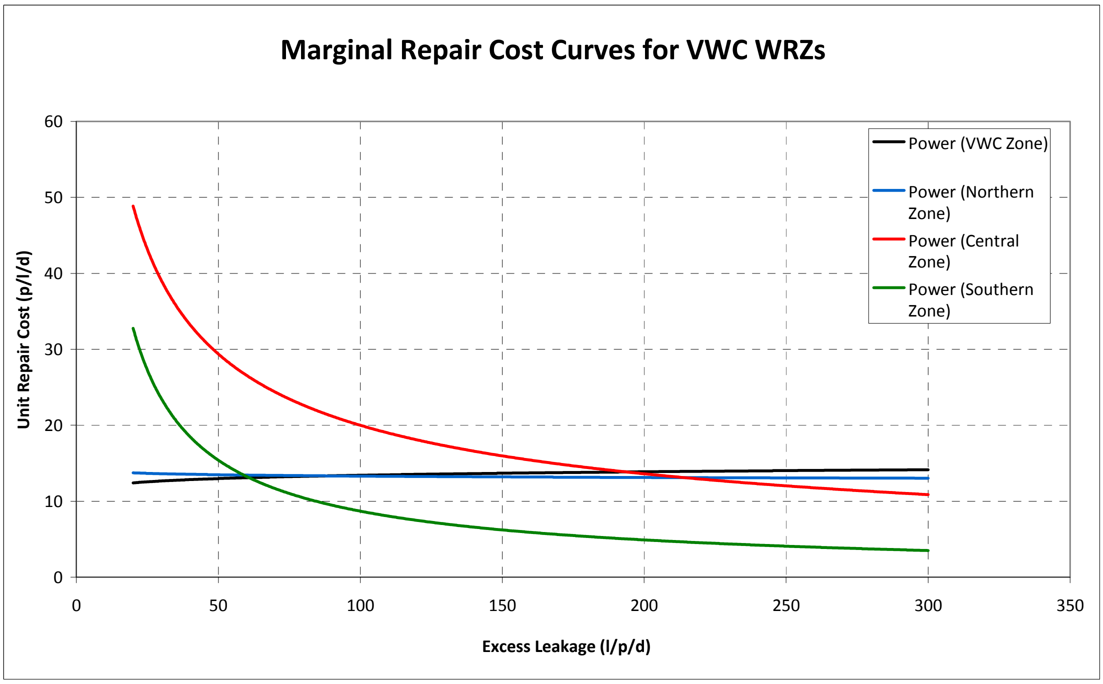
Detection costs: Detection costs include direct labour and contractors who both record time spent by activity. Total detection costs for the 2007/2008 amounted to £3.44m.

Figure 3.9.3.4a : VWC Marginal detection cost curves for the 3 resource zones



Repair costs: Unit repair costs defined by job category are applied to the number of detected leakage jobs. Total repair costs for 2007/2008 are £10.3m

Figure 3.9.3.4.b : VWC Marginal repair cost curves for 3 resource zones



We then derived the total cost function, from which the annual cost of moving from one level of leakage to another can be estimated, as the integral of the marginal cost functions between the start to the end of the year taking into account the detectable NRR.

3.9.3.5 Environmental and social costs and benefits

The 2002 tripartite report recognises that costs and benefits included in the ELL calculation should not be limited to those borne directly by the company. It therefore introduced the concept of social and environmental costs and benefits as a result of external impacts. By including both direct and external costs and benefits it is possible to set leakage targets that are optimal for customers, society and the environment.

The assessment of the leakage-related and leakage management externalities, and then the short-run SELL calculation has been carried out by RPS Water on our behalf. In line with the guidance the following externalities have been investigated for each water resource zone:

- ***Leakage related externalities:*** Environmental and carbon related externalities arising from the effects of leakage reduction (changes in level of abstraction, treatment and distribution as a result of changes in leakage levels)
- ***Leakage management externalities:*** Social disruption and carbon related externalities arising directly from the implementation of leakage management activities (detection activity, repair activity, pressure management)

The environmental, social and carbon cost/benefit analysis is based on company specific data for the period 2007/2008. When company specific data or assumptions were not available, default water industry data or assumptions recommended in the Ofwat guidance have been used.

3.9.3.6 Leakage related externalities

The sources of leakage externalities considered in the analysis are abstraction, distribution and treatment.

Environmental leakage related externalities

Using the abstraction data and local knowledge of zonal sources, we defined a list of individual sites in the 3 Water Resource Zones for detailed analysis of environmental externalities. The potential externalities investigated are angling, informal recreation, in-stream recreation, commercial fisheries and aquaculture, commercial navigation, non-use and biodiversity, agricultural use and other abstractions.

Our Northern and Central Water Resource Zones produce high marginal environmental costs for the following reasons:

- Low river flows at a number of sites affected by supply abstractions
- Significant costs associated with angling and biodiversity at river reaches affected by the abstraction sites

A summary of the marginal environmental costs of leakage at the 2007/2008 level of leakage is shown in table 3.9.3.5a.

Table 3.9.3.5a : Environmental leakage related externalities

Zone	Environmental costs (£/Ml)		
	Lower	Central	Upper
Northern Zone	659.57	1040.52	1421.48
Central Zone	190.46	297.43	404.41
Southern Zone	0.36	0.60	0.84

Carbon leakage related externalities

The externalities that we considered included the emissions from fuel use and energy use, from water treatment processes such as ozonation and from the disposal of treatment residues. The climate change levy has been deducted from the estimates.

We found that carbon leakage related externalities are dominated by energy consumption in all three Water Resource Zones. Carbon costs for the production and distribution of water supply are shown in table 3.9.3.5b.

Table 3.9.3.5b : Carbon leakage related externalities

Zone	Carbon costs (£/Ml)		
	Lower	Central	Upper
Northern Zone	£4.20	£4.58	£4.97
Central Zone	£4.53	£4.91	£5.30
Southern Zone	£6.36	£6.89	£7.43

3.9.3.7 Leakage management externalities

The leakage management activities causing externalities that we considered included leakage detection, leakage repair and pressure management.

Social leakage management externalities

We initially considered traffic delays, pedestrian delays, supply interruptions, flooding, noise pollution and low pressure. However, filtering of the externalities based on their significance allowed a reduction in the number of externalities to:

- Detected leaks: traffic and pedestrian delays in the 3 resource zones
- Reported leaks: traffic and pedestrian delays and flooding in the 3 resource zones
- Pressure management: low pressure in the Southern zone

We found that our social externalities are dominated by delays to vehicle traffic in the repair of detected and reported leaks.

Table 3.9.3.5c summarises the estimates of the marginal social costs of the leakage management externalities.

Table 3.9.3.5c : Social leakage management externalities

Zone	Marginal social costs of repair (£/repair)		
	Lower	Central	Upper
DETECTED LEAKS			
Northern zone	£20.76	£41.94	£114.32
Central zone	£36.10	£72.12	£195.24
Southern zone	£20.29	£41.03	£111.88
REPORTED LEAKS			
Northern zone	£63.81	£113.55	£278.06
Central zone	£97.07	£178.96	£453.31
Southern zone	£57.06	£98.76	£235.15
PRESSURE MANAGEMENT	Annual social costs (£)		
Southern Zone	£8,001.77	£9,208.38	£10,584.35

Carbon leakage management externalities

Carbon costs for the detection costs for the detection and repair of leaks are shown in table 3.9.3.5d.

Table 3.9.3.5d : Environmental leakage related externalities

Zone	Marginal carbon costs of repair (£/repair)		
	Lower	Central	Upper
DETECTED LEAKS			
Northern zone	£4.04	£4.25	£4.47
Central zone	£4.13	£4.35	£4.56
Southern zone	£3.25	£3.42	£3.59
REPORTED LEAKS			
Northern zone	£3.70	£3.90	£4.09
Central zone	£3.85	£4.06	£4.26
Southern zone	£2.95	£3.10	£3.26

3.9.4 Short Run Economic Level of Leakage

The approach that we have adopted for our short-run ELL and short-run SELL assessment complies with best practice and is based on a restricted form of the least-cost plan, in which only leakage management and value of water lost are considered.

The Short-Run ELL is defined as the level of leakage for which the total present value cost of active leakage control costs and of the water lost through leakage, is a minimum over a given planning period. The present value costs are calculated from the annual expenditure required to move from the average leakage level in one year to an average in the succeeding year.

Our calculation of the short-run ELL and short-run SELL uses the least-cost planning model SALT. The model balances the cost of active leakage control against the cost of water lost to find the optimum level of leakage and is able to optimise cost and leakage over 30 years taken from the base year 2007/08.

We calculate the value of the water lost as the annual average level of leakage in each year, multiplied by the current marginal cost of water produced and delivered.

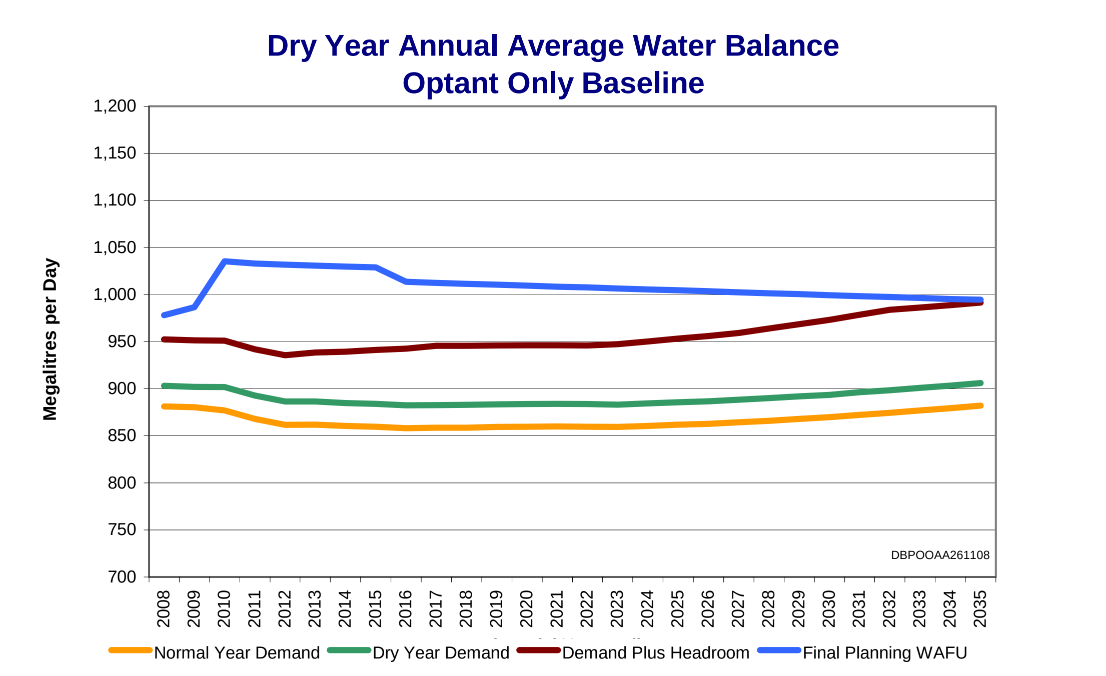
The marginal cost of water (MCoW) is defined as the additional cost of producing another unit volume of water.

The short-run ELL and the short-run SELL are defined annual ALC costs and using annual average leakage costs based on the cost of water saved through leakage reduction in any zone. In the context of water resources this means water saved through a mix of normal and dry years over the planning period.

In Veolia's case we have a supply surplus through AMP5 and therefore the ELL should be calculated compared with the most expensive source utilised as an alternative to leakage through the AMP.

In normal years which are the basis of our planning for nine years out of 10, the most expensive source used in any zone may be different to the dry year case. The graph below shows the baseline average year forecast for Three Valleys showing the difference between normal and dry years (24.6 Ml/d for AMP5) at company level, however source utilisation depends on the configuration of each Water Resource Zone.

Figure 3.9.4 : Annual Average Baseline Supply Demand Forecast



Zonal Operating Conditions

The company is divided into three Water Resource Zones. The definition of a Water Resource Zone is the largest zone within which the security of supply is equal. In each case supplies are maintained by a blend of groundwater and surface water supplies however in operational terms fluctuations in demand are accommodated by increasing/decreasing the most expensive supply in each case.

The forecast of leakage reduction over the next 5 years is 10 Ml/d which reflects a continuation of our current rate of leakage savings and this reduction is likely to be distributed across the company. A reasonable distribution of reductions per zone would be pro rata the existing proportion of total leakage per zone.

Northern	55 Ml/d
Central	122 Ml/d
Southern	23 Ml/d

Annual resource utilisation is shown in the table below. The table shows the distribution of resources used since 2003/4 and it should be noted that even during the drought year of 2006/7 resource conditions did not require the regular use of the FORT supply to maintain supplies.

Table 3.9.4a : Annual Utilisation of Resources

	HFWS Ml/d	ANGL Ml/d	Groundwater Ml/d	FORT Ml/d
2003-2004	195.56	59.08	542.75	0.35
2004-2005	174.55	41.90	554.43	0.09
2005-2006	179.09	47.28	554.78	0.15
2006-2007	169.45	43.10	528.72	0.25
2007-2008	177.65	31.57	559.29	0.03

During the AMP5 period we have a modest surplus of supply over demand even in a dry year and in all cases this surplus is greater than the deployable output capacity of the FORT supply in a dry year. Therefore FORT will only be used in emergency conditions other than a small intermittent regular import to maintain the operational state of readiness of the cross border pipework. Accordingly it would not be appropriate for us to use FORT for the marginal cost of water in our ELL calculation.

Zonal Marginal Cost of Water

In the case of our Southern Water Resources Zone the most expensive source of water is the EGHS source. The capacity of the source is 133.2 Ml/d and the variation in zonal demand between normal and dry years is accommodated by varying the output of EGHS. EGHS is therefore the marginal cost for southern zone in both normal and dry years.

Since the commissioning key link mains during AMP4 supplies from ANGL are largely contained within the Northern zone. Therefore this is the most expensive source used in Northern Zone (excepting small local cross border connections that are necessary to maintain security of supply in very small zones close to the boundary and therefore unaffected by changes in supplies to other parts of the zone).

The ANGL supply is used under the Ver Operating Agreement to replace part of the lost output from FRIA source with an equivalent annual volume of 10.96 Ml/d. Therefore the change in marginal cost of water utilised in the average day from reducing leakage would reflect the reduction in import from ANGL provided that import remains higher than 10.96 Ml/d.

In terms of the central zone the most expensive resource used is also ANGL. If leakage reductions are achieved a blend of HFWS water, and groundwater resources would be reduced. However any water ‘not used’ in the zone would be exported into Northern zone or to ARK Reservoir (and thus to Northern Zone) thereby reducing the support of the zone from ANGL.

The normal year benchmark of take from ANGL is currently approximately 32 Ml/d (see table above) and in a dry year this may increase up to its full average capacity of 91 Ml/d. This range embraces the forecast difference in demand between normal and dry year (35 Ml/d) accordingly the MCOW for northern zone in both normal and dry year conditions is the ANGL supply. This situation would prevail until such time as the ANGL supply is fully utilised in a dry year.

Critical period operating conditions

Looking to the future the dry year case used for water resources planning occurs with a frequency of approximately one year in 10. In the dry year case for our Central Water Resources Zone, we would expect that FORT imports would increase to their capacity during peak period which is the critical design case. Under annual average dry year demand conditions however there remains a supply surplus and therefore FORT imports are not required.

In practice additional imports would only arise should unexpected events also arise such that our full outage and full headroom allowances are utilised simultaneously and indeed provided alternative precautionary measures such as a hosepipe ban are not implemented as evidenced in 2006. Notwithstanding this, for the purposes of our ELL calculation, we have assumed that full outage and headroom margins are taken up. Accordingly the worst case for the marginal utilisation and therefore the marginal cost of water in our Central Water Resources Zone would reflect nine years of zero FORT water and one week out of 52 use of FORT at its capacity for the tenth year

The final marginal costs of water in the three Water Resource Zones are presented in the Table 3.9.4b.

Table 3.9.4b : Marginal costs of water in the three resource zones

Zone	Marginal cost of water (£/Ml)
Northern Zone	151.94
Central Zone	151.94
Southern zone	59.56

3.9.4.1 Short-Run Private Economic Level of Leakage

Based on the marginal operating costs of water defined above, we are currently working at a level of leakage which is 3.4 Ml/d below our current Short-Run ELL of 183.39 Ml/d. The results of this analysis are shown in Table 3.9.4.1. At company level and at resource zone level the company is operating below the ELL.

Table 3.9.4.1 : Short-Run ELL at company and at resource zone levels

WRZ	07/08 Pre-MLE Leakage	Short Run ELL	Reduction ELL
	Ml/d	Ml/d	Ml/d
Northern Zone ELL	48.47	30.67	17.8
Central Zone ELL	118.38	120.63	-2.25
Southern Zone ELL	19.91	38.87	-18.96
Company ELL	186.76	190.18	-3.4

3.9.4.2 Short-run Socially Efficient Level of Leakage (SELL)

The same approach as for our ELL is used to calculate the SELL using the SALT model but incorporating leakage related and leakage management externalities along with the ALC and water lost private.

Based on the cost/benefit estimation presented functional external cost/leakage relationships have been developed and then integrated with the private leakage/cost relationships in the ELL calculation process.

This calculation process has been applied to three resource zones and the total costs of private and external costs of detection, repair and water over a 30 years period have been minimized from the base year 2007/2008. The level of leakage defined is regarded as the Socially Efficient Level of Leakage or SELL.

The results of the SELL calculation are presented in table 3.9.4.2 for the three resource zones and the whole company.

It shows that we are currently operating 24.0 Ml/d below our SELL.

Table 3.9.4.2 : Short-Run SELL at company and resource zone levels

WRZ	07-08 Pre MLE Leakage	Short Run SELL	Reduction to SR SELL
	Ml/d	Ml/d	Ml/d
Northern Zone SELL	48.5	29.8	18.7
Central Zone SELL	118.4	131.9	-13.5
Southern Zone SELL	19.9	49	-29.1
Company SELL	186.8	210.8	-24.0

The results indicate to us that in our Northern Water Resource Zone the environmental impact of our operations (abstracting, treating and distributing water from mostly underground resources) has a proportionately higher impact than our active leakage control activities.

In our more urban Central and Southern Water Resource Zones which are dominated by large surface water resources the social disruption associated with active leakage control activities is proportionately more significant than the environmental impact of our abstractions from the Thames.

3.9.5 Long-run Economic Level of leakage

To assess our long run Economic Level of Leakage we utilise an economic model which determines the least cost of schemes required in the future to close any deficit between availability of water resources (supply) and predicted demand for water (demand).

In order to evaluate alternative supply schemes (schemes that increase the volume of water available to meet demand) and demand schemes (schemes that have the effect of moderating future demand for water) that can be used in the model we have carried out a wide range of studies to capture all possible options (combinations of supply and demand measures).

Over 300 'unconstrained'[31] schemes have been subjected to a multi-criterion assessment to separate out the most feasible set of schemes for further analysis in the economic models. 110 schemes have been selected including the range of schemes summarised in Table 3.9.5 below and included at Appendix 3.

Table 3.9.5 : Summary of Feasible Schemes and Groups

Scheme Category (total schemes in category)	Example schemes from each scheme in category	Scheme AISC p/m3	Total benefit for scheme category		Range AISC p/m3 within scheme category	
			Av. Ml/d	Pk Ml/d	Low	High
Transfers (10)	ANGL additional supply	40	102	149	2	245
	LOWE bulk supply	124				
	FORT utilisation	134				
	Thames regional reservoir	245				
Demand Mgt (12)	Community WE scheme	21	15	15	21	1174
	Retrofit aerated showers	228				
Leakage (25)	New technologies	3	25	25	3	1306
	Mains renewals	1306				
Metering (8)	Targeted plus AMR	32	65	65	32	277
	Difficult properties	227				
Resource Development (35)	Purchase licences	30	20	150	8	593
	Essex confined	235				
	HILF	238				
Water reuse (5)	Greywater in new communities	11	5	5	11	501
	Relocation of STW	502				
Tariffs (2)	Seasonal	5	51	51	4	16
	Rising block	16				
Treatment (7)	ICKE ammonia	65	20	65	21	271
	LANE 160 restoration	138				
Total feasible schemes 104			303	534	2	1306

3.9.5.1 Incremental Leakage Schemes

In addition to the schemes summarised above we have undertaken an analysis of the leakage cost relationship for each of our Water Resources Zones to derive costs for individual increments of leakage reduction of 1 Ml/d using active leakage control (ALC).

Sufficient schemes to achieve a total of 15 Ml/d in each resource zone have been derived and their costs have been broken down into

[31] 'Unconstrained' : Schemes assessed without regard to their feasibility or cost-effectiveness. This means we can ensure we have considered a wide range of possible options.

- Detection cost
- Detected repair cost
- Detection maintenance cost
- Detected repair maintenance cost
- Carbon cost
- Environmental cost
- Social cost

We have then included each of these incremental schemes in our supply/demand modelling so that in addition to discrete supply or demand schemes our model has the option to choose increments of leakage reduction where these are more cost effective than alternative supply or demand management options.

3.9.5.2 Supply Demand 'Least Cost' Modelling

In order to identify the least cost option and balance of schemes that will "close" our supply demand deficit was we use a Dynamic Programming model. The model selects an optimised least-cost development scenario at water resource zone level using the primary supply/demand balance inputs shown below:

- Deployable output;
- Outage allowance;
- Process losses;
- Water imports;
- Demand forecasts;
- Water exports;
- Target headroom.

From the above inputs the model can then evaluate a range of alternative development options that could be implemented to meet forecast deficits in the supply/demand balance at water resource zone level.

In order to evaluate the least-cost development plan the model utilises a Dynamic Programming algorithm to search for the optimum least-cost development programme for each water resource zone.

The Dynamic Programming algorithm works by treating the water resources plan as a sequence of staged developments, whereby each stage is optimized in sequence. This reduces considerably the number of permutations of options to be evaluated as each stage is optimised in order and searches for the optimum solution by computation of precise function values.

This represents the least cost combination of additional schemes to balance supply and demand in the longer term. The schemes selected by the model are set out in the table below and include metering, resource development, strategic transfers, pressure management, water audits, optimisations of licences and water efficiency and water audit schemes.

No options to incrementally reduce leakage are selected which indicates:

- active leakage control options are all more expensive than alternative supply or demand management options
- that our long run ELL is the same as our short term marginal cost of water ELL and that therefore
- We are currently operating at our long term ELL

3.9.6 Results Summary and Leakage Target

We are operating at the current economic level of leakage when assessed on a consistent basis and we are meeting our 2 Ml/d per annum glide path target to reduce leakage in the five years of AMP4. The glide path reductions include savings of supply pipe leakage arising from the compulsory 'change of occupier' policy.

For all our forecasts of the economic level of leakage (ELL and SELL) we have demonstrated that the Company is currently operating at around the economic level of leakage derived at Company level.

Our supply demand balance appraisal also indicates that no active leakage control methods are selected to close our future supply demand balance deficit in preference to alternative schemes that either increase resource or reduce demand for water. This demonstrates that our long term ELL is the same as our ELL.

Our leakage targets for AMP4 are set out in table 3.9.4 below. In 2007/8 our reported leakage figure was 141.78 Ml/d which is 2.22 Ml/d below our Ofwat 'glide path' target. We have assessed the equivalent best practice methodology reporting leakage figure as 187.2 Ml/d. We recognise that this re-calculation gives a very large apparent change in reported leakage and our performance will appear to deteriorate in comparative terms. However, the actual leakage from our network has not changed.

We have agreed with Ofwat that it is the relative change in leakage, not the absolute level of leakage, which continues to be the most important aspect of the leakage calculation demonstrating a contribution to improving the supply/demand balance. Accordingly we believe it is appropriate to adopt fully the best practice methodology for future planning. Therefore since our move to best practise methodology does not change the quantum of leakage or our achievements in reducing leakage and meeting our target, we propose the level of leakage reported under our new methodology is the same level below old target calculated under the old methodology.

Therefore our leakage target for 2007-08 is 182.59 Ml/d and further drops in leakage of 2Ml/d in 2008-09 and 2009-10 suggest that our best practice leakage target at the end of AMP4 is 184.98 Ml/d, rounded to 185 Ml/d.

Table 3.9.6a : Change in reported leakage and proposed equivalent Ofwat targets.

Leakage Targets	2005-06	2006-07	2007-08	2008-09	2009-10
Ofwat ‘rounded’ target	150	145	145	145	140
Ofwat ‘glide path’ target	148	146	144	142	140
Reported Leakage	148.7	144.8	141.78		
Difference from ‘glide path’ Target	+0.7	-1.2	-2.22		
Best Practice Leakage			186.76	184.76	182.76
Best Practice Target			188.98	186.98	184.98
End AMP4 Leakage Target					185

Since we have demonstrated that further leakage reductions are not cost effective or necessary to maintain the supply demand balance, a flat leakage target for AMP5 held stable at 185 Ml/d is indicated. In our draft WRMP and Final Business Plan we argued that our regulators and customers would not understand a temporary cessation in our activities to reduce leakage and proposed to continue reducing leakage for AMP5. However we were not able to satisfy Ofwat that further leakage reductions in leakage are cost beneficial and they have asked that we hold leakage steady for the AMP5 period.

Our analysis indicates that we are operating at our ELL. However taking into account the sources and robustness of the data methods used and the sensitivity of this calculation to the data and customer preference that we should continue to reduce leakage, we believe that it is prudent to resume leakage reduction at a steady rate after, 2014 . In addition the continuation of our metering policies following AMP5 and beyond will contribute to a reduction in total leakage through the discovery and repair of supply pipe leaks.

Our DWRMP proposal was to maintain our current glide path level in total leakage during AMP5 and AMP6. In their recent final determination of prices Ofwat have set our leakage target at 185Ml/d until 2015. Our long-term FWRM plan remains to continue to reduce leakage by a total of 20Ml/d by 2030. This compares with our previous proposal of a 30Ml/d reduction.

The economics of leakage reduction will be kept under regular review especially if our supply demand position changes. We will also re-visit our assessment in detail for our next WRPM and Business Plan.

4 CLIMATE CHANGE

4.1 Supply

From experience, our groundwater sources are robust to one dry winter (dry being 75-80% of long term average rainfall). The occurrence of two such dry winters in a row results in lower groundwater levels, reduced river flows, reduced outputs from vulnerable sources and the imposition of flow constraints/augmentation requirements. This is what the current drought Deployable Output (DO) scenario is based on. We have not experienced three dry winters within available groundwater records although this event has been recorded in rainfall terms in the 1890's.

We have four run of river licensed abstraction points on the River Thames. None of these are subject to flow constraints. Thames Water, under the Lower Thames Operating Agreement has the responsibility of maintaining flows over Teddington weir. Thus, unless current licence and operating agreement are changed, we are not constrained by any impact of climate change on river flows.

We also import water from ANGL. This is a treated bulk supply arrangement and has no restrictions imposed on it relating to climate change. Thus we are entitled to take up to our full allowance, and Anglian Water will manage the reservoir reserves to enable this.

This then leaves only the assessment of groundwater sources. To make this assessment we commissioned consultants Jacobs to work with us to create climatic sequences and run an existing groundwater model to predict the impact of climate change on groundwater levels in line with Environment Agency guidance. The groundwater model used is owned by the Environment Agency for the Upper Colne groundwater and was last updated in 2006. Results from this model were extrapolated for the remainder of our sources that lie outside the modelled area.

Overall there will be modest changes in groundwater levels during due to climate change impacts. In the areas of greatest recharge, in the northern area of the Company groundwater levels will fall by as much as 4-5 m, although a more typical value of between 3-4 m is anticipated. The comparative reduction in water levels reduces progressively southwards, with falls of between 0-1 m present in the south. Small rises of less than 1 m are simulated in the south and south east, where the Chalk becomes confined and the response to variations in recharge is delayed.

We forecast a decrease in Deployable Output due to Climate Change of 27.28Ml/d at average and 29.53Ml/d at peak conditions for the median case. This is a reduction of 2.5 % and 1.9 % respectively of our overall abstractions

Our evaluation does not take into account the impacts of maintaining such abstraction on the local hydrogeology. Low flow rivers are already impacted by droughts, and further declines in rainfall will result in even lower flows.

Where such low flows are compounded by abstractions, the Environment Agency may require a reduction in abstraction, or augmentation water to help maintain flow, reducing the amount available to meet customers demand. No allowance has been made in the figures below to reflect such volumes.

Table 4.1 : Effect of climate change on resource base assuming no loss of time limited licence

Deployable Output (Ml/d)	2009-10	2011-12	2016-17	2021-22	2026-27	2031-32
Dry Year Annual Average	1113.5	1111.5	1106.4	1101.4	1096.3	1091.3
Dry Year Critical Period	1272.7	1270.6	1265.4	1260.3	1255.1	1249.9
Dry Year Annual Average Change from 2006-07	-	-2.0	-7.0	-12.1	-17.2	-22.2
Dry Year Critical Period Change from 2006-07	-	-2.1	-7.3	-12.5	-17.7	-22.8

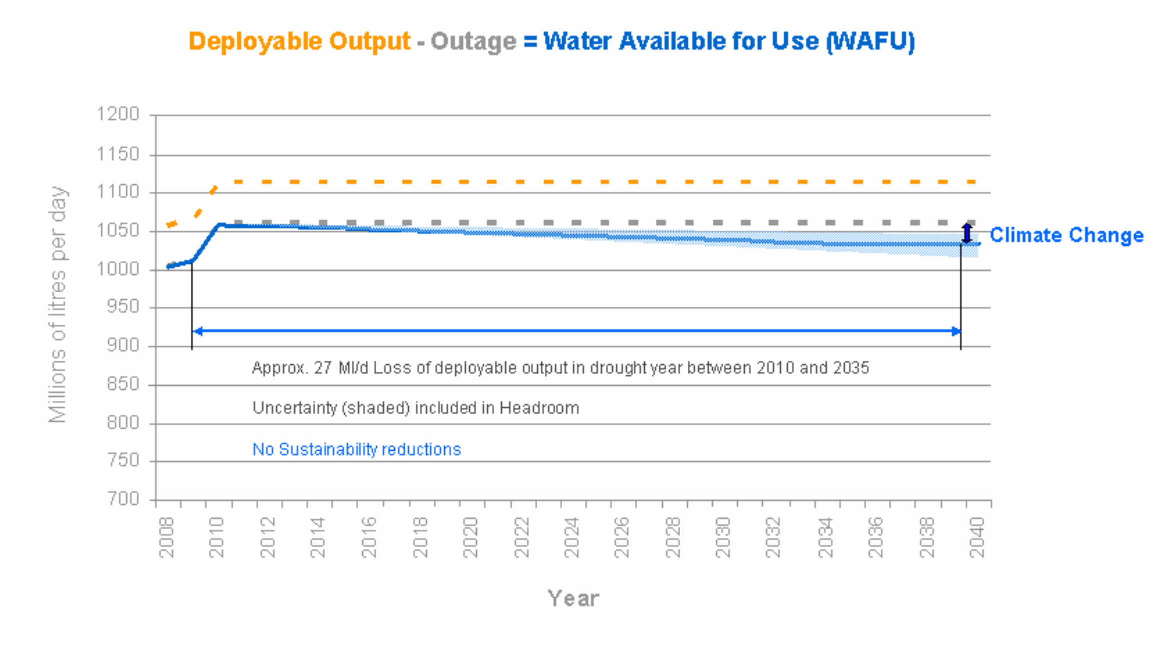
4.2 The effect of Climate Change on demand

Climate change impacts on demand have been modelled in accordance with the final CC:DEW Climate Change and Demand for Water report prepared by the Stockholm Environment Institute in 2002. Factors have been applied according to the medium high forecasts for the Alpha and Beta scenarios for the Thames Region for domestic demand. This is an increase in demand of 1.37% by 2020. For commercial demands the beta medium high scenario has been used for the Thames region of 2.5% increase. The resultant increase has been modelled in headroom.

4.3 Impact of climate change on supply-demand balance

Climate change has an impact of -27Ml/d and -30Ml/d on average and peak resource respectively. This represents approximately 2.5% of our available resources as indicated in Figure 4.3.

Figure 4.3 Supply Forecast including Climate Change

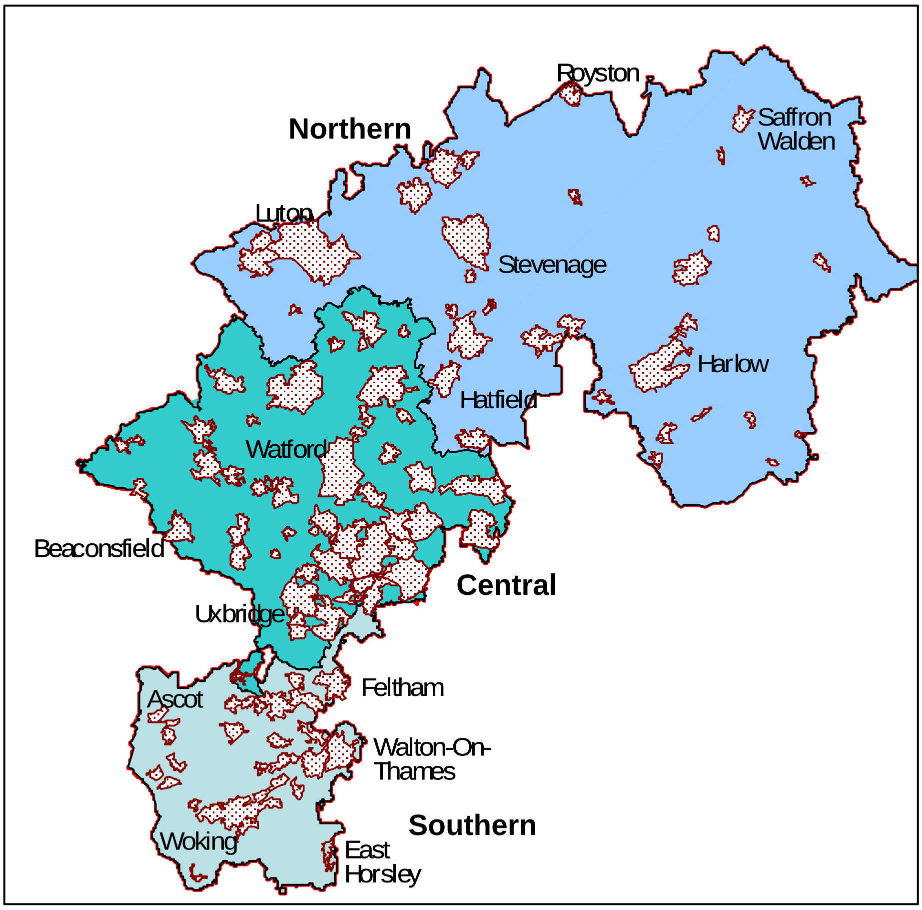


5 TARGET HEADROOM

This document outlines the methodologies employed in developing a complete review of our target headroom requirement, incorporating the way it is prepared and the assumptions which underlie each component and the way they interact. Assumptions and key forecast drivers will be described alongside the presentation of the headroom calculation.

At the time of the analysis our operating area is made up of 3 water resource zones. Our 2004 draft water resources plan submission was assessed on the basis of 6 water resource zones. The grouping of the Company into 3 zones was as a result of further integration of the supply system within the company. For this Plan the target headroom analysis has been undertaken on the basis of the 6 sub resource zones and summed to the level of the 3 zones.

Figure 5 : VWC Resource Zones



Our supply is comprised predominantly of groundwater from around 100 sources dispersed geographically throughout the company. 37% of the company's supply base is made up of water from the Thames and is located in the South East of our supply area. Around 5% is supplied from Anglian Water.

5.1 Choice of method

Headroom methodologies

Two documents outline accepted practice in the field of headroom estimation. These are:

- *WR/13 A Practical Method for Converting Uncertainty into Headroom* UKWIR 1998.
- *WR/13/2 An Improved Methodology for Assessing Headroom* UKWIR 2002

The two methodologies, although they cover broadly the same headroom components, are very different in approach. The 1998 methodology (the old methodology) is a simple points scoring system for calculating target headroom. The 2002 methodology (the new methodology) determines headroom through probabilistic simulation. The uncertainties of each headroom component are defined as probability distributions and then combined using monte-carlo techniques. The 1998 method is appropriate only where no supply demand deficit exists over the planning period. Where there is a supply demand issue the more comprehensive assessment as recommended in the 2002 methodology should be employed.

The key components of the headroom calculation in the 2002 method are :

- S1 Vulnerable surface water licences
- S2 Vulnerable groundwater licences
- S3 Time limited licences
- S4 Bulk transfers
- S5 Gradual pollution causing a reduction in abstraction
- S6 Accuracy of supply side data
- S7 Single source dominance and critical periods (old method only)
- S8 Uncertainty of climate change on yield
- S9 Uncertain output from new resource developments (new method only)
- D1 Accuracy of sub component data
- D2 Demand forecast variation
- D3 Uncertainty of climate change on demand
- D4 Uncertain outcome from demand management methods (new method only)

Of these categories S1, S2 and S3 are identified by the EA as being not required for the assessment of headroom uncertainty as these elements are taken care of in the NEP programme and covered under the presumption of renewal respectively.

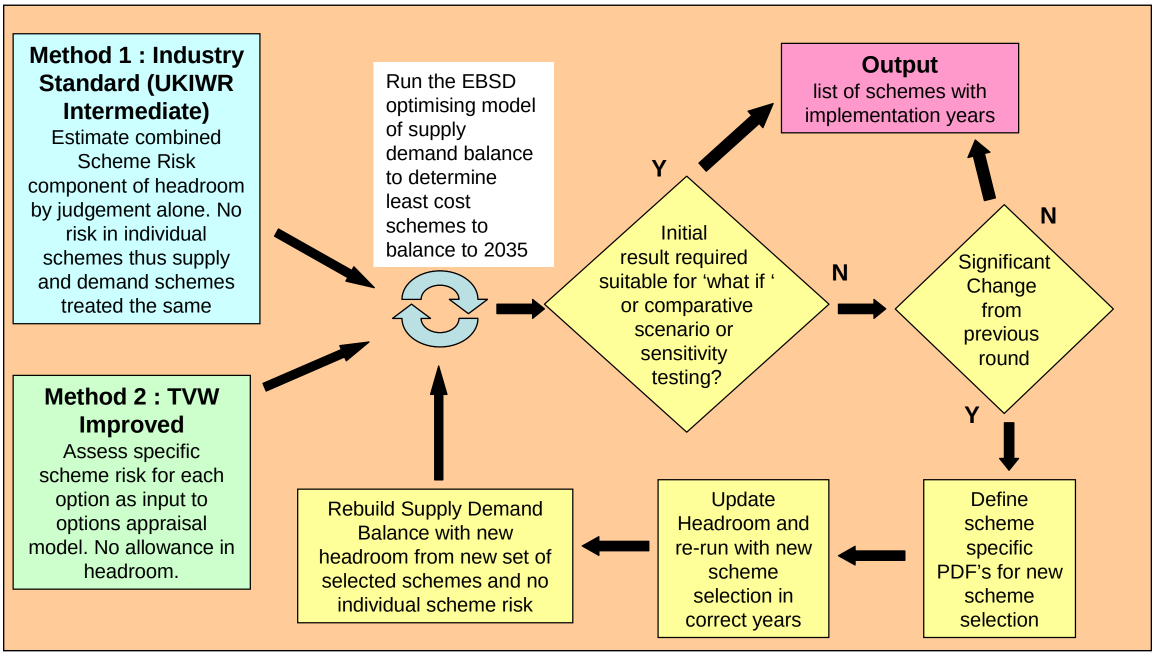
Approach

For the PR09 submission, the Company has undertaken a target headroom calculation using the new headroom methodology. In undertaking the headroom calculation, a review of the AMP4 headroom submission was carried out and used as a base position upon which changes could be evaluated.

The new headroom methodology requires a specific investigation of uncertainty at a component level. Some supply side uncertainty however could only be estimated at a higher level such as licence groups or even resource zones.

In order to begin the analysis we must begin with an initial estimate of headroom. For Veolia Water Central this involves calculating target headroom excluding S9 and D4 and applying the risk for these components directly in the economic modelling. The resulting capital programme can then be assessed for scheme risk and the headroom model re-run to determine headroom including risk of the selected schemes. See flowchart below:

Figure 5.1 : VWC EBSD Model Process



5.2 Supply side risks

The EA has provided guidance during 2007 relating to application of both methodologies. Instruction was given that no uncertainty should be applied to either vulnerable licences (S1 and S2) or time-limited licences (S3) unless specifically advised.

Risk factors were assessed by reference to previous work and, in the case of supply side categories to the company's Water Resources specialists. For each category of source component the following represents the data requirements.

S1 Vulnerable surface water licences

Vulnerable surface water licences are licences where Environment Agency and/or pressure groups have expressed concern about the environmental impact of a licensed abstraction.

In line with the guidance issues by the EA nothing has been included in the categories of vulnerable surface/groundwater licences. Any variations to licences that are affected by environmental concerns are assumed to be accounted for within the (NEP) national environment programme.

S2 Vulnerable groundwater licences

Vulnerable groundwater licences are licences where EA/pressure groups have expressed concern about the environmental impact of a licences abstraction. Reductions in volume could be applied as licence change or flow constraints. Data needed are:

- Magnitude of loss of DO (max, min, best estimate)
- Probability of loss
- Demand condition (average/peak)
- Duration of restriction if relevant
- Frequency of restriction (return period) if relevant

In line with the guidance issues by the EA nothing has been included in the categories of vulnerable surface/groundwater licences. Any variations to licences that are affected by environmental concerns are assumed to be accounted for within the (NEP) national environment programme.

S3 Time limited licences

These are licences that either are now or could at some time in the future be time limited. The EA can renew, revoke or modify a time limited licence and there is therefore inherent uncertainty in time limited licences. Data needed:

- Magnitude of loss of DO (max, min, best estimate)
- Probability of loss
- Demand condition (average/peak)
- Duration of restriction if relevant
- Frequency of restriction (return period) if relevant

In line with the guidance issues by the EA nothing has been included in the categories of vulnerable surface/groundwater licences. Any variations to licences that are affected by environmental concerns are assumed to be accounted for within the (NEP) national environment programme.

S4 Bulk imports

This category relates to the reliability of bulk imports. Data needed:

- Magnitude of loss of DO
- Probability of loss
- Demand condition (average/peak)
- Duration of restriction if relevant
- Frequency of restriction (return period) if relevant

No uncertainty has been applied to bulk imports. No long-term issues have been identified with respect to bulk supplies.

S5 Gradual pollution

It is most likely that pollution, if it occurs, will result in the complete loss of the source, except in the unusual situation that blending is available as an option. Even where blending can be used this will generally require capital investment accordingly a headroom allowance should be made. Sources of information are PR04 Headroom, assessment for pollution risk.

Gradual pollution has been dealt with at sub resource zone level. There are a number of sources that are situated in an urban environment. An exponential function has been applied representing the most likely position of no pollution events.

The following table lists the history of pollution in our supply area.

Table 5.2a : History of Pollution

	Bow Bridge	Berkhamstead	Essendon	Hatfield	Bulstrode	Northwood	Periwinkle Lane	Poorsfield	Ruislip Common	Temple End	Watford Fields	Willian Road Fuller	Eastbury	Springwell	Dunmow
Peak Licence		7.96	9.09	9.09	3.41	3.41	5	11.37	7.96	5.68	8.5	7.96	68.19	18.18	2.18
Avg. Licence			9.09	9.09	3.41		4.99			4.55		6.81			1.25
Historic Abstraction	5	5	9	9	3.4	3	5	5	5	4.55	8	7.5	60	18	
1960/4															
1965/9															
1970/4															
1975/9						3		5	5		8				
1980/4						3		5	5		8				
1985/9						3		5	5		8				
1990/4						3		5	5		8			18	
1995/2000					1.36	3		5	5		8	3	6	18	2
2001/4		2	3.6	7.2	3.4	3	3	5	5	0.45	8			18	0.8
2005/09	5		3.6	7.2		3		5	5		8				
	PHOS	arsenic	bromate	bromate	coliforms	coliforms	coliforms	coliforms	coliforms	coliforms	coliforms	coliforms	crypto	crypto	solvents

	Stockers	Runley Wood	Bricket Wood	Ickenham	Waterhall	Tyttenhanger	Slip End	Chipping	Albert Road	New Barnet	East Barnet	Crescent Road	Broomin Green	Baldock Road	Roestock
Peak Licence	9.09	9.55	27.28	12.5	1.36	9.09	6.82					29.3	2.73	4.55	
Avg. Licence		9.55			1.09		5.46					28.49	2.27	0	
Historic Abstraction	9	9	18	9	1										
1960/4		3.6													
1965/9															
1970/4															
1975/9	9		3.6							0.4					
1980/4	9								5	0.4					
1985/9	9								5	0.4					
1990/4	9									0.4	0.6		2	4.55	
1995/2000	9	0.9		9	1					0.4	0.6		2	4.55	
2001/4	9			9			0.5	0.1		0.4	0.6	3.2	2	4.55	
2005/09				9						0.4	0.6		2		
	Fe etc	hc	NH4	NH4	NH4	NH4	nitrate	nitrate	nitrate	odour	Oil	petrol/diese	solvent	solvents	turbidity

From an examination of historic pollution we have determined the mean pollution figures that will define the exponential functions as described above. The table below shows the parameters of the pollution risk exponential PDF.

Table 5.2b : PDF parameters

	PDF Parameters	
	Mean	
Water Resource Zone	Average	Peak
WRZ1	2	2.52
WRZ2	3.31	4.15
WRZ3	4.9	5.83
WRZ4	1.34	1.49
WRZ5	0.48	0.54
WRZ6	0.18	0.2
Total	**12.21**	**14.73**

S6 Accuracy of supply side data

There is a risk that data inaccuracy or paucity renders any estimates of DO unreliable. This could for example cover the extrapolation of drought bounding curves where no flow/level data exists for a recognised drought period. This is therefore an uncertainty as opposed to a risk as in the above cases and could be either positive or negative. We need to determine:

- Most likely error in Ml/d
- Max error (positive and negative)

An assumption of +/- 2% of DO has been applied.

S8 Uncertainty of climate change on DO

UK Water Industry Research (UKWIR) published a range of climate change scenarios (UKWIR, 2006) derived from the outputs of six Global Climate Models (GCM). The scenarios allow the assessment of the implications of climate change on average monthly river flows and groundwater recharge in the 2020s. The GCM output data are given as a relative change in rainfall and PE in the 2020s compared to observed data spanning the period 1961-1990. This is provided in the form of perturbation factors which can be applied to observed rainfall and potential evapotranspiration data or to a synthesised time series which is statistically based on observed data. The UKWIR06 scenarios have been downscaled from the regional outputs from the GCM and provided on a catchment scale.

The perturbation factors were analysed to select three scenarios that would represent a range of potential future climate conditions predicted from the various GCM, notably dry conditions, wet conditions, and intermediate conditions. The scenarios selected for the dry, intermediate and wet conditions were the ECHAM4, HadCM3 and CCSR GCMs respectively.

Various approaches were taken to the selection of a rainfall sequence. The selected eight year rainfall period for each scenario was then combined with the PE data sets in a spreadsheet that applies a Penman-Grindley style 2-store model in order to estimate recharge[32]. In these spreadsheets the recharge is passed through a simple representation of the Chalk aquifer that is consistent with the Environment Agency's Catchmod approach. These results confirmed that the period selected for application

[32] The same approach as that used in the scoping recharge calculations for the Upper Colne model was used (JacobsGibb/ESI, 2003a Appendix E).

to the model did represent particularly dry conditions (with the obvious exception of the wet scenarios).

These squences were applied to the upper Colne Groundwater model and the model run for 3 scenarios. These produced groundwater heads that were applied to each source to determine the climate change effect corresponding to a dry, median and wet scenario. The dry and wet scenario values were then analysed to determine the headroom parameters to use in the modelling, as shown below.

Table 5.2b : Variability of wet and dry DO changes in Ml/d

Average	2007	2012	2017	2022	2027	2032
Northern Min	0	-0.634	-1.268	-1.902	-2.536	-3.17
Northern Max	0	1.4	2.8	4.2	5.6	7
Central Min	0	-1.474	-2.948	-4.422	-5.896	-7.37
Central Max	0	1.358	2.716	4.074	5.432	6.79
Southern Min	0	-0.89	-1.78	-2.67	-3.56	-4.45
Southern Max	0	1.03	2.06	3.09	4.12	5.15

Peak	2007	2012	2017	2022	2027	2032
Northern Min	0	-0.7	-1.4	-2.1	-2.8	-3.5
Northern Max	0	1.014	2.028	3.042	4.056	5.07
Central Min	0	-1.394	-2.788	-4.182	-5.576	-6.97
Central Max	0	1.257	2.514	3.771	5.028	6.285
Southern Min	0	-0.69	-1.38	-2.07	-2.76	-3.45
Southern Max	0	0.91	1.82	2.73	3.64	4.55

For more detail refer to Jacobs report “Implication of Climate Change – Final Report “ Feb 2008.

S9 and D4 Uncertain output from new resource developments and uncertain outcome from demand management

As described above, these categories require an iterative approach to the economic modelling. An initial capital programme is selected using risks for each scheme in the economic model. Headroom is then reassessed using scheme risks in headroom and unrisked schemes in the economic modelling. Once the initial programme is defined scheme risks and PDF’s are calculated for each measure. This uses the same framework of risks used for the initial estimate.

Table 5.2c : Risk Calculator

Political (Risk of obtaining approval, permits etc.)							Percentage confidence in benefit
None required	1	5%	50%	70%	90%	100%	
More than likely	0.75	4%	38%	53%	68%	75%	
Likely as not	0.5	3%	25%	35%	45%	50%	
Unlikely	0.25	1%	13%	18%	23%	25%	
Extremely unlikely	0.05	0%	3%	4%	5%	5%	
		0.05	0.5	0.7	0.9	1	
		Considerable uncertainty	Uncertain	Fairly confident	Highly confident	Already built	Technical (Risk of project obtaining benefit)

An extreme value PDF was selected on the basis that the risks could be slightly higher but are more likely to be lower.

5.3 Demand Side Risks

For the demand side the assessment occurs at resource zone level. The UKWIR project “Risk and Uncertainty in the Supply/Demand Balance” describes a methodology for assessing uncertainty in the demand forecasts. These methodologies could be applied to headroom estimates.

D1 Accuracy of sub component data

Accuracy of sub component data refers to the closure error in the water balance from where the demand forecast takes its base year. Within the MLE process rebalancing takes place to redistribute errors in the water balance to other components. This inaccuracy generally shows lower values for the sum of components than for the measured distribution input figure. This inaccuracy in forecasting can lead to an under estimation of distribution input which needs to be accounted for in headroom.

Sources of data are zonal base year water balances and demand forecast. Uncertainty of demand forecast component is composed of the error in the zonal water balance related to distribution input. This has been included explicitly in the headroom assessment with no PDF applied.

D2 Demand forecast variation

The variance in the demand forecasts constructed by the EA in their publication “*A Scenario Approach to Water Demand Forecasting*” EA 2002, related to the foresight scenarios were significant. Scenario modelling can provide an understanding of the kinds of boundary conditions that can affect the demand forecast.

Data is derived from the demand forecast. Demand forecast variation was assessed by modelling scenarios in the demand forecasts to define a boundary condition. The scenario was defined by applying a high growth condition for PCC and population coupled with an assumption of no efficiencies in commercial consumption and that the expected savings resulting from the metering programme do not materialise. The low forecast comprises a low PCC forecast coupled with a low population forecast. A triangular function was then applied to represent a most likely outcome of no change from the current demand forecast but a low probability of a maximum/minimum variation in accordance with the modelled scenario.

Table 5.3a : Variance of the demand forecasts in Ml/d

Average						
High	2007	2012	2017	2022	2027	2032
Northern	1.55	10.93	22.96	28.24	33.37	38.57
Central	2.81	15.15	35	51.62	61.16	70.63
Southern	0.86	5.28	11.96	14.61	17.33	20.08
Low	2007	2012	2017	2022	2027	2032
Northern	-0.67	-1.11	-2.42	-3.88	-5.73	-7.95
Central	-4.08	-11.29	-18.96	-24.67	-29.63	-33.31
Southern	-1.27	-3.30	-5.30	-7.10	-8.31	-9.35

Peak						
High	2007	2012	2017	2022	2027	2032
Northern	2.01	13.94	28.81	35.45	41.9	48.44
Central	3.5	18.77	42.64	62.24	73.77	85.21
Southern	1.25	7.54	16.57	20.26	24.04	27.86
Low	2007	2012	2017	2022	2027	2032
Northern	-0.89	-1.49	-3.06	-4.9	-7.24	-10.02
Central	-5.12	-14.15	-23.25	-29.94	-35.95	-40.37
Southern	-1.91	-4.84	-7.41	-9.92	-11.6	-13.05

D3 Uncertainty of climate change on demand

Work from the CC:DEW project (Climate Change and the Demand for Water) is the base point for assessments of the impact of climate change on demand. The demand forecast can be perturbed by the factors emerging from the CC:DEW project to provide an overall demand impact for climate change. Care must be taken not to double count changes due to demand forecast variation and vice-versa.

Data is taken from the demand forecast and CC:DEW. Climate change effect were modelled by applying the factors from the CC:DEW project to the demand forecast in order to derive a maximum effect by 2035. A discrete distribution was applied with the probability of climate change effect rising over time to a probability of 1.0 by 2032.

The tables below show the parameters applied to climate change.

Table 5.3b : Climate change allowances in Ml/d

2022					
DYAA Central Demand Forecast	Domestic	Commercial	Domestic Climate Change	Commercial Climate Change	Total Change
WRZ1	64.41	14.93	65.29	15.30	1.26
WRZ2	89.82	18.46	91.05	18.93	1.69
WRZ3	127.27	28.11	129.02	28.81	2.45
WRZ4	154.66	60.57	156.78	62.08	3.63
WRZ5	56.00	19.66	56.77	20.15	1.26
WRZ6	94.42	31.64	95.71	32.43	2.08

2022					
DYAA Central Demand Forecast	Domestic	Commercial	Domestic Climate Change	Commercial Climate Change	Total Change
WRZ1	82.38	15.67	83.51	16.06	1.52
WRZ2	106.83	19.39	108.30	19.87	1.95
WRZ3	160.64	29.96	162.84	30.71	2.95
WRZ4	184.10	63.60	186.62	65.19	4.11
WRZ5	70.47	20.64	71.43	21.15	1.48
WRZ6	131.65	33.22	133.46	64.05	2.63

5.4 Results of headroom assessment

As the new headroom methodology is based on defining probability distributions, there are a range of outputs which relate to different percentiles, or probabilities of occurrence as shown in the figures below.

Figure 5.4a : Headroom Uncertainty, Northern Zone

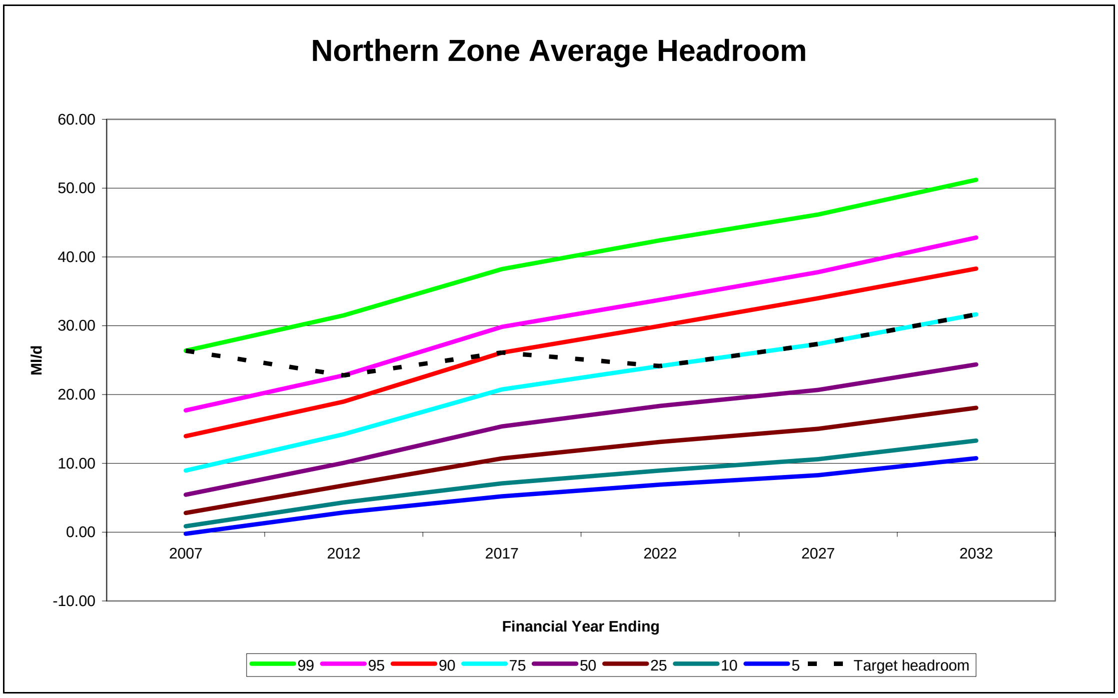


Figure 5.4b : Headroom Uncertainty, Central Zone

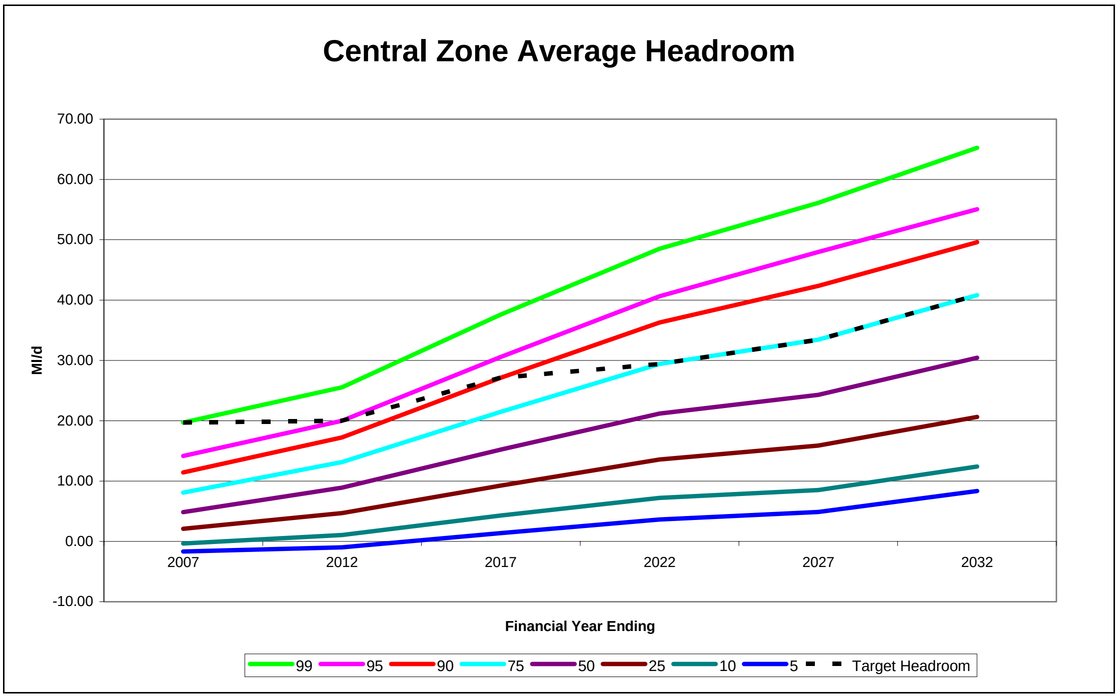
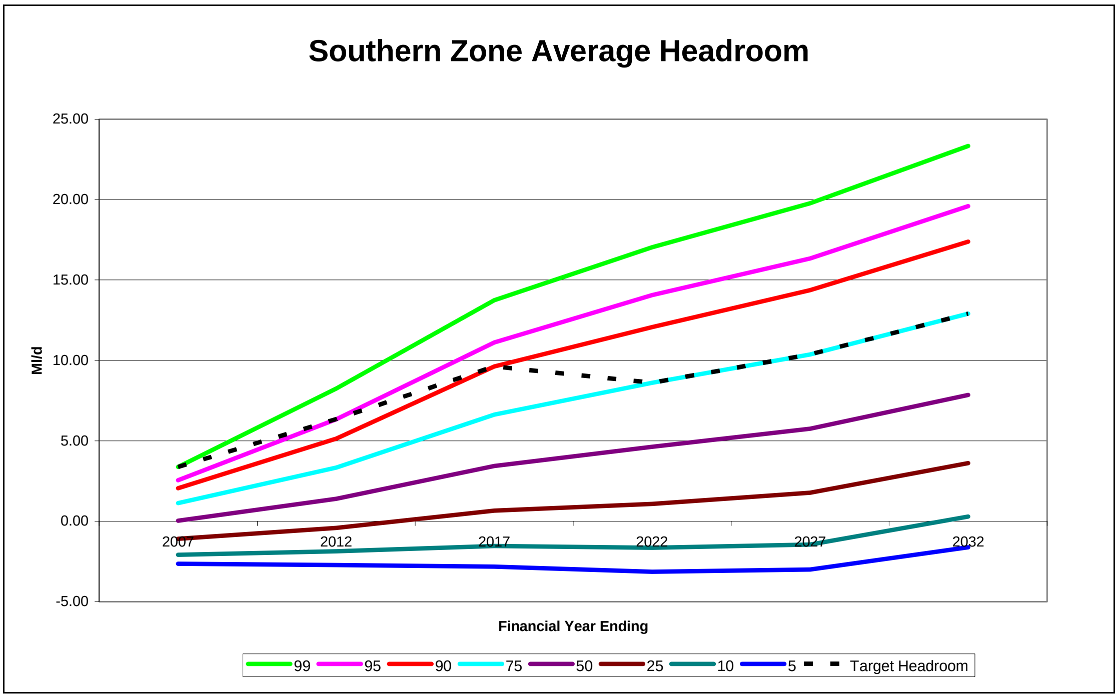


Figure 5.4c : Headroom Uncertainty, Southern Zone



With such a range of potential levels of target headroom it remains a business decision therefore as to what level of risk the business is willing to adopt. Ofwat view headroom as "*an implicit estimate of the costs associated with increased security of supply and the valuation placed by society on the benefits of supply security (i.e. avoidance of supply interruptions).*" We disagree with this definition. Levels of service are defined in the assessment of DO and the trigger levels set in the statutory Drought Plan. As such in theory any headroom at all represents extra security of supply. In fact headroom is to cover for uncertainties in the supply demand balance. Just as one would not assign outage allowances to increased security of supply, in the same way headroom should be ring fenced for protection from uncertain outcomes and not applied to security of supply.

As there is limited scope to react to significant changes within an AMP period it is prudent to cover a large proportion of uncertainties within the 5 year block. Longer term there is more scope to change the plan to react to trends as such the company can afford to adopt a higher level of risk.

The risk profile used in the DWRMP has been defined by the Board and the confidence percentage selected to reflect a reasonable level of risk at any point in time. The degree of risk taken in the future is allowed to rise at a rate that is commensurate with our ability to mobilise additional supply demand measures in sufficient time to compensate for the higher risk. The table below shows the levels of risk selected.

Table 5.4a : Risk profile

Headroom	2007	2012	2017	2022	2027	2032
Percentile	99%	95%	90%	75%	75%	75%

5.5 Summary of Headroom assessment

Headroom has been assessed according to the UKWIR report "*02/WR/13/2 – An improved methodology for assessing headroom*"

Six headroom components have been considered and probability distribution functions prepared at both average and peak for each resource zone. These have then been combined using a Monte-Carlo routine to derive headroom uncertainty and calculate the combined impact of these factors over the planning horizon of 25 years.

Target headroom has been defined pragmatically having some regard to the results of the company's willingness to pay survey. The risk profile has been reviewed and agreed by the Board. The result is target headroom as shown below.

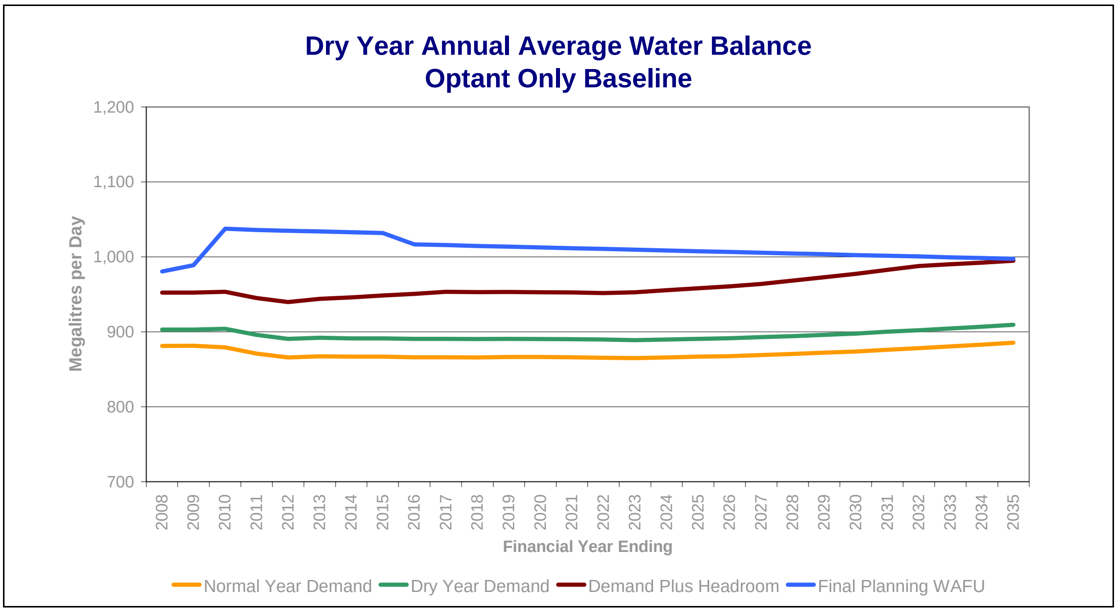
Table 5.5a : Target headroom results by resource zone

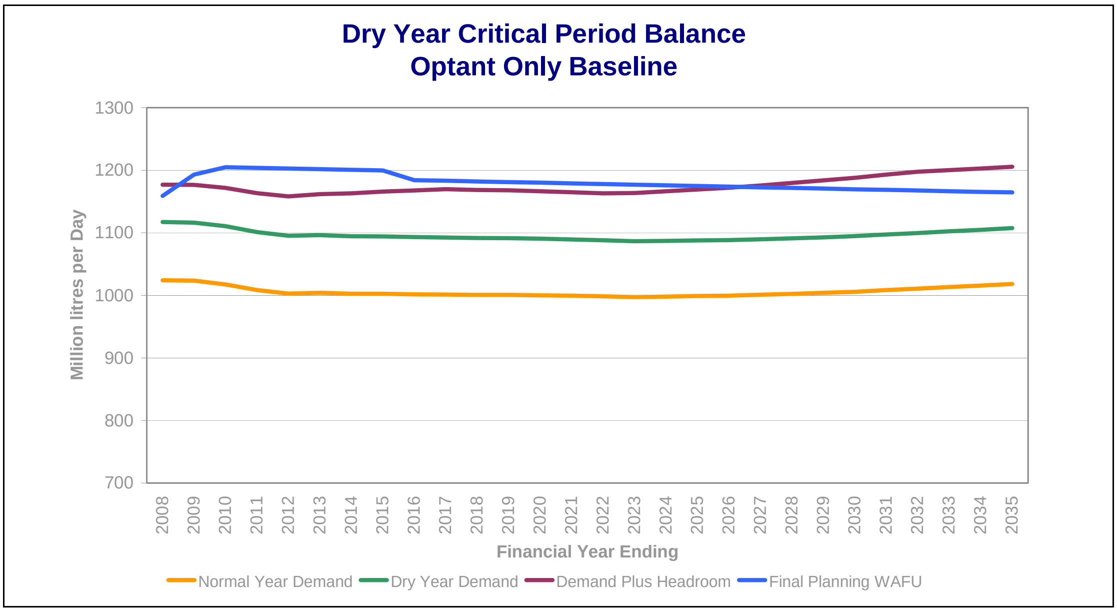
Target Headroom	2007	2012	2017	2022	2027	2032
Northern Average	25.58	23.28	26.5	24.5	28.12	32.38
Northern Peak	31.14	27.98	31.65	29.47	34.34	37.71
Central Average	19.42	20.83	27.61	29.92	35.42	42.63
Central Peak	25.48	26.03	34.33	36.87	42.45	49.12
Southern Average	3.43	6.38	9.97	8.68	10.59	13.60
Southern Peak	4.21	8.47	13.39	11.82	14.30	16.48
Company Average	**48.43**	**50.50**	**64.08**	**63.11**	**74.13**	**88.62**
Company Peak	**60.84**	**62.48**	**79.37**	**78.16**	**91.09**	**103.32**

6 BASELINE SUPPLY-DEMAND BALANCE

The baseline supply demand balance reflects a policy of Optant only metering An initial supply/demand deficit occurs in 2026 at peak. The deficit grows to 40 Ml/d at peak by 2035 as shown in the charts below.

Figure 6 : Baseline Supply / Demand Forecasts





7 OPTION APPRAISAL

7.1 Approach for option appraisal

We are committed to the "twin track" approach of developing new sources in parallel with active management of customers' demand. A programme of supply demand schemes is proposed to enable levels of service to be restored and maintained over the planning period 2010 to 2035.

The approach was guided by the work done by the EA and UKWIR[33].The process comprises the following steps:

Step A. Development of the unconstrained options list

To develop the unconstrained options list a range of options were identified based on a review of PR04 schemes coupled with a review of all assets, industry research and latest technology. Schemes were classified into the following categories:

- Resource management
- Demand management
- Production management
- Customer side management

Step B. Development of the feasible options list

The feasible options list was derived by applying a "screening tool" to the unconstrained list. This generated a feasible list of schemes by screening out high risk schemes on the basis of a consistent and mutually agreed set of criteria.
The screening tool enabled the consideration of technical and financial criteria in conjunction with the environmental and social criteria. In doing so, the tool ensured the feasible list of schemes will:

- be capable of enhancing security of supply,
- be technically feasible and,
- provide environmentally preferred outcomes.

The tool was applied in two stages:

Stage 1 involved the transparent and quick application of pass/fail indicators to measure the performance of a scheme against set criteria. This first stage proved to be a straightforward, complete and efficient way of identifying and separating those schemes considered for PR09 that could go forward for funding under the supply and demand programme (note: being screened out at this stage does not mean that the scheme will be abandoned but merely that it will not be considered for funding under supply and demand).

A few examples that illustrate the use of the criteria could include, for instance: a scheme that is technically infeasible or will not add to the volume of the water supply is immediately screened out; a scheme that carries significant commercial as well as yield uncertainty is screened out; however a scheme whose only uncertainty lies in the area of public unacceptability will not be excluded on the grounds of this criterion alone.

33 Economics of balancing supply and demand (EA and UKWIR, 2002).

The types of schemes considered were:

- Bulk Transfer (including Local Distribution and Security of Supply)
- Demand Management (including Reuse)
- Environmental Protection
- Leakage
- Metering
- Resource Development (including Treatment)
- Tariffs

Stage 2 involved the application of a more detailed set of indicators for an expanded set of criteria to the schemes that successfully passed the stage 1 screening. This stage is not a pass/fail test but rather a scoring process; for each of the selected 26 technical/social/environmental criteria a score was assigned on a range of -2 to +2 according to the relative impact of the schemes on the component examined. The process was completed during a workshop with the scheme sponsors, where it was agreed that only the schemes with a score above 0 would constitute the feasible options List.

The final number of feasible schemes is 104 schemes. A list of these schemes can be found in section 10.1. The screening results are presented in table below:

Table 7.1 : Results from the screening process

CATEGORY	Unconstrained List	Feasible List	% screened out
Bulk Transfer	19	10	47%
Demand Management	35	12	74%
Environmental Protection	31	0	100%
Leakage	29	25	14%
Metering	9	8	11%
Resource Development	144	42	71%
Reuse	11	5	55%
Tariffs	12	2	83%
TOTAL	290	104	64%

The unconstrained water efficiency schemes which were put forward are wide ranging, including the different activity strands that make up our water efficiency strategy. The feasible list of water efficiency schemes compiled as a result of the screening process included both domestic and non domestic schemes, broadening our current level of activities and incorporating a number of initiatives taken from the Ofwat good practice register for water efficiency.

The feasible list of options are distinct from the activities included in the baseline, all of the feasible schemes would result in new activities or a serious change to a current activity, setting them aside from the current baseline, those activities which were considered part of the baseline were screened out in the first stage.

Metering is an essential strand of our twin track approach as it provides information to customers that allows them to choose how they use water and therefore how much they pay. It is also the fairest way to pay for the service provided. The unconstrained list was largely composed of ideas linked to increased awareness of customers who are charged for their water by volume and this mechanism can be used to encourage particular consumption patterns. In particular, the emergence of intelligent metering and automatic reading technologies has made it possible to consider a range of charging schemes in addition to other demand side options.

After screening, the schemes were reduced to a feasible list of 4 metering and 2 tariffs schemes. The primary strategy of compulsory metering from 2010 forms the baseline for assessment of additional options required to maintain supply/demand balance of the planning period of our Plan.

Step C. Economic appraisal of options

Each option description was reviewed in detail and the information recorded was refined and updated throughout the process.

The feasibility of schemes was assessed, based on the interaction of the volume of yield/savings available and the uncertainty (% risk in achieving the benefit) associated with a given option. The following two factors combine the benefit incorporating risk for a particular scheme:

- Volume of water (yield or savings) per mega litre benefit per day.
- Percentage of Confidence in achieving the benefit, which is produced by assessing the political and technical risks associated with the project. The assessment accounts for both the risk of obtaining required permits or licences and also the technical feasibility of obtaining the deployable outputs.

The options with the highest environmental and social impacts were screened out during the first stage. However, feasible options were reviewed and any opportunities for environmental enhancement and energy efficiency were examined. The potential impact of each option against meeting the environmental objectives of the Water Framework Directive was also identified. For any option, which involves taking more water from a water resource management unit currently defined as over-abstracted or over-licensed, considered the potential impact it may have on Water Framework Directive ecological status was considered.

The delivery costs were produced initially using our Infrastructure and Non-infrastructure unit costs (Capex, Opex and AIC master spreadsheets) produced for the Ofwat PR04 Submission. Following discussions with principal engineers, suppliers and/or potential contractors, feasible schemes were developed in greater detail, and the cost of each scheme was calculated using 2002-03 unit cost, uplifted with Construction Industry Price Indices (COPI) values. Schemes, such as leakage, metering and water efficiency were examined and updated with scheme specific costs.

Social and environmental costs were established for the 84 schemes using an approach developed by environmental consultants Jacobs. The approach used to quantify and value the social and environmental costs was based on the Environment Agency's latest (2003) guidance documents entitled "Assessment of benefits for water quality and water resources schemes in the PR04 Environment Programme". This process involved completion of five excel spreadsheet tables for each scheme examined.

The approach developed by Jacobs to quantify the carbon footprint of the feasible schemes was based on Jacobs' experience of doing the same for construction projects and for industrial processes. There was no explicit guidance on the calculation of carbon footprint from the EA or Defra, except for that on applying a shadow price of carbon. Carbon accounting was carried out for both Capex and Opex elements of the schemes.

Step D. Development of the preferred options list

In order to calculate the best combination of schemes to ensure security of supply we have used the "least cost optimisation" model developed by our consultants Jacobs. The model has been designed to assess the difference in the supply and demand forecasts of the Water Resources Plan and select an optimal combination of feasible options to satisfy any deficiencies progressively through the planning period. The model calculates the least-cost development scenario for each water resource zone. The model is flexible and rapid in operation which allows the Plan to be varied to reflect and assess a range of scenarios with changes in demand forecasts, deployable outputs, headroom, alternative climate change scenarios and sustainability reductions as necessary.

The methodology adopted follows the procedures outlined in the *Economics of Balancing Supply and Demand (EBSD)*[34]. The optimisation routine uses dynamic programming (DP) which is probably one of the most robust optimisation techniques for determining a global solution for a staged process such as is presented by a water resources development plan.

The Least-Cost Optimisation Model includes provision for calculating the following economic costs:

- *AIC* - Average Incremental Costs, for each option is defined as the NPV of the combined Capex and Opex, at a given *discount rate*, divided by the NPV of the expected output (yield) for that option.
- *AISC* - Average Incremental & Social Costs, for each option is defined as the NPV of the combined Capex and Opex, together with the estimated environmental and social costs added in, divided by the NPV of the expected output (yield) for that option.
- *NPV* – Net Present Value, of the range of options in a given scenario is the combined Capex and Opex cost streams, together with estimated social and environmental costs (over time), discounted at a given *discount rate*, of all options included in that scenario.

The model calculated these economic costs for the feasible options list to arrive at an optimum selection of schemes, and implementation sequence, that meets the projected demand supply balance (including an allowance for headroom) at a minimum NPV, for a given target level-of-service.

Following identification of the preferred scheme options to maintain supply and demand over the planning period, target headroom was reassessed to reflect the specific combination of scheme risk and the dynamic model was re-run to verify the least cost solution identified.

[34] Economics of Balancing Supply and Demand

7.2 Preferred (feasible) options List

A schedule of our preferred supply/demand options is included in Supporting Information section 10.2. Table 7.2 below demonstrates the range of options considered in the economic appraisal

.

Table 7.2 : Summary of Preferred Schemes and Groups

Summary of feasible schemes after multi-criterion screening and including social and environmental costs						
Scheme Category (total schemes in category)	**Example schemes from each scheme in category**	**Scheme AISC p/m3**	**Total benefit for scheme category**		**Range of AISC p/m3**	
			Av. Ml/d	**Pk Ml/d**	**Low**	**High**
Transfers (10)	ANGL additional supply	40	102	149	2	245
	LOWE bulk supply	124				
	FORT utilisation	134				
	Thames regional reservoir	245				
Demand Mgt (12)	Community WE scheme	21	15	15	21	1174
	Retrofit aerated showers	228				
Leakage (25)	New technologies	3	25	25	3	1306
	Mains renewals	1306				
Metering (8)	Targeted plus AMR	32	65	65	32	277
	Difficult properties	227				
Resource Development (35)	Purchase licences	30	20	150	8	593
	Essex confined	235				
	HILF	238				
Water reuse (5)	Greywater in new communities	11	5	5	11	501
	Relocation of STW	502				
Tariffs (2)	Seasonal	5	51	51	4	16
	Rising block	16				
Treatment (7)	ICKE ammonia	65	20	65	21	271
	LANE 160 restoration	138				
Total 104 feasible schemes			303	534	2	1306

8 FINAL WATER RESOURCES STRATEGY

8.1 Optimum solution

Our supply/demand balance will be stable by 2010 as a result of our programme of investment to improve capacity and reliability of our system. Our analysis indicates that we do not need to carry out further investment to maintain security of supplies until 2025 at average or 2026 for the critical period. No supply or demand side option are selected before 2026 since we do not have a deficit of demand plus headroom over water availability before this date. A supply-demand deficit emerges after 2025-26 so that at 2035 we have a supply demand surplus of 0.6 Ml/d at average demand and a deficit of 44 Ml/d during our critical period demand.

The least cost of schemes that are required to close this supply demand identified using our least cost optimisation model is £19.4 millions in net present value terms. These schemes are detailed in Table 8.1 and represent the least cost combination of additional schemes to balance supply and demand in the longer term. The schemes selected are set out in the table below and include metering, resource development, strategic transfers, pressure management, water audits, optimisations of licences and water efficiency and water audit schemes. No active leakage control (ALC) options to reduce leakage are included in the least cost set of options indicating and confirming that we are operating below our long term economic level of leakage.

For the period 2010-2015 therefore, a least cost solution would not require any expenditure on new resource development or any programmes of metering beyond optant metering. We would stop further leakage reductions and maintain total leakage from our system at current levels and finally our current compulsory Change of Occupier metering programme would cease.

However we do think that our customers, local interest groups, environmental regulators and other stakeholders would understand or condone a temporary cessation in our metering and leakage policies since we operate in a seriously water stressed area where 60% of our supply is derived from chalk aquifers which have been classified by the EA as over abstracted and over licensed.

Therefore we considered alternative metering and leakage options to secure our supply demand balance over the planning period to 2035.

Table 8.1 : Least Cost Schemes to Secure Supply Demand Balance

Option ID	Option Name	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
612	ROYD Artificial Recharge	546,247	13,727	66,171	626,145
169	STAN Licence	87,843	118,323	-	206,166
31	HWFS/ARKR Transfer Upgrade	960,311	1,424,354	461,460	2,846,125
33	ROYD Number 4 Borehole	273,107	443,905	50,010	767,022
567	Community water efficiency scheme	111,041	-	(29,171)	81,870
Group 6c	Options(155,604,428,185,603,607,569,573,388,636,4,160)	1,249,332	545,596	657,314	2,452,242
155	ARMI & THAX Source Optimisation	7,783	2,448	-	10,232
604	Communal Greywater reuse	28,015	-	(6,917)	21,099
428	Leakage Control - New Detection Technologies	36,343	-	-	36,343
185	Commercial Water Audits	19,524	-	(8,108)	11,415
603	Communal rainwater reuse	60,233	-	(8,173)	52,059
607	Large User - Water Efficiency retrofiting	28,805	-	(2,526)	26,280
569	Targeted Water Efficiency promotion -Housing Associations	10,882	-	(1,433)	9,449
573	Hose gun triggers (targeted DMAs)	31,046	-	(5,347)	25,699
388	New Cistern Displacement Devices	111,201	-	(19)	111,182
636	Leakage reduction - Pressure management	74,169	24,435	-	98,604
4	NEWP and WEND maximisation	311,005	180,618	639,923	1,131,546
160	HEMP Source Optimisation	530,327	338,095	37,477	905,898
Group 7c	Options(330,511,112,548)	1,787,549	483,826	60,922	2,332,297
330	WE projects for SMEs	156,813	-	(21,877)	134,937
511	RUNGS Peak Licence	934,005	90,409	24,454	1,048,868
112	LOND Peak Licence Scheme	283,474	212,360	51,817	547,651
548	HART Borehole - Replacement for PORT	413,257	181,057	7,392	601,706
134	VAUXI Groundwater	1,066,257	1,209,802	105,066	2,381,124
161	LOWE Bulk Import Increase	1,253,358	1,556,611	44,444	2,854,413
261	Tap re-washering	280,412	-	(9,977)	270,435
ZONE: 1	**ALL OPTIONS**	**7,615,456**	**5,796,144**	**1,406,238**	**14,817,840**
87	SHAK Source Optimisation	374,902	42,396	10,481	427,779
Group 2c	Options(607,604,185)	118,009	-	(67,859)	50,149
607	Large User - Water Efficiency retrofiting	43,479	-	(41,562)	1,916
604	Communal Greywater reuse	42,286	-	(11,122)	31,164
185	Commercial Water Audits	32,243	-	(8,032)	24,211
ZONE: 2	**ALL OPTIONS**	**492,911**	**42,396**	**(57,378)**	**477,928**
Group 1c	Options(428,185,567,569,573,388)	168,136	-	(22,093)	146,043
428	Leakage Control - New Detection Technologies	19,383	-	-	19,383
185	Commercial Water Audits	10,413	-	(4,167)	6,245
567	Community water efficiency scheme	56,672	-	(14,431)	42,240
569	Targeted Water Efficiency promotion -Housing Associations	5,804	-	(737)	5,067
573	Hose gun triggers (targeted DMAs)	16,558	-	(2,748)	13,809
388	New Cistern Displacement Devices	59,307	-	(10)	59,298
560	LADY Optimisation	1,058,196	573,378	12,625	1,644,199
Group 3c	Options(604,636,330)	129,938	11,590	(16,036)	125,492
604	Communal Greywater reuse	13,682	-	(3,426)	10,256
636	Leakage reduction - Pressure management	36,223	11,590	-	47,813
330	WE projects for SMEs	80,032	-	(10,810)	69,222
533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	2,242,334	(459,385)	(26,301)	1,756,649
528	Leakage reduction - Speed of Repair	-	418,448	(5,497)	412,951
ZONE: 3	**ALL OPTIONS**	**3,598,603**	**544,031**	**(57,301)**	**4,085,333**
	Total	**11,706,970**	**6,382,571**	**1,291,558**	**19,381,101**

8.2 Leakage

Our analysis of the long term balance of resource development and leakage options to secure a balance of supply and demand has included the costs of schemes to reduce and maintain leakage levels below those that we currently achieve.

Our analyses indicate that we are currently operating at or slightly below our long term Economic Level of Leakage (ELL) and Socially Efficient Level of Leakage (SELL) which takes into account the environmental factors of both leakage and leakage detection and repair activities. This is due to the significant extra effort we have put into active leakage detection and repair in order to meet our ongoing Ofwat leakage target.

Our future leakage strategy is to continue to find and fix leaks efficiently through active leakage control methods at our currently funded level. We will make use of increased metering and the mains renewal programme to reduce leakage as much as we can.

Our least cost strategy would therefore be to allow leakage to remain at the economic level. However we did not consider that this policy will be acceptable to our customers and our stakeholders for a number of reasons.

Allowing leakage to remain stable or to rise will bring forward expensive investment in additional resources and force increased abstraction from our resources in the interim.

Our metering programme will deliver some savings in total leakage due to the discovery of customer side leakage on or shortly after meter installation. This will drive total leakage lower and we therefore consider that we should continue to reduce leakage at the same rate that we have achieved to date.

The level of our current operating costs includes for a reduction in leakage by 2 Ml/d per year and therefore no additional increases in prices are required to fund continued reduction in leakage levels.

The degree of uncertainty in the determination of the Economic Level of Leakage and the sensitivity of the result make it sensible to drive leakage lower and reduce the risks in managing levels of leakage at the margin.

However in our Final Business Plan we were not able to satisfy Ofwat that further leakage reductions are cost beneficial for the period 2010-2015 so they have specified a steady leakage target for the AMP5 period. In light of the wider benefits we still believe that further reductions in leakage are warranted in the longer term and therefore propose to continue our reduction in total leakage further after 2015 as indicated in the following table.

Table 8.2 : Proposed leakage reductions

Water Resource Zone	Leakage as at 2007-08	Leakage as at the end of AMP4	Proposed Leakage Target (Ml/d)		
			Years 2010-2020	Years 2021-2025	Years 2026-2030
Northern Water Resource Zone	48	48	46	45	43
Central Water Resource Zone	118	117	113	109	105
Southern Water Resource Zone	20	20	19	18	17
Total	**186**	**185**	**178**	**171**	**164**

8.3 Metering

Our assessment of our supply demand position is that we have a surplus of supply over demand for the period up until 2026. We will review this position annually and prepare updated Water Resources Management Plans at five yearly intervals between now and 2025 so that the factors underpinning this assessment are updated. However in these circumstances we consider we do not need to accelerate our current metering programme as originally proposed in the DWRMP and strategic direction statement.

In addition, our cost benefit analysis of metering which we outline below suggests that none of the metering programmes we have evaluated are cost beneficial without the inclusion of wider benefits which are not justified for inclusion in prices for 2010-2015. Therefore we propose to continue optant metering until that time and resume our compulsory programme of metering on change of occupier from 2015. Meanwhile we will prepare the ground for future accelerated metering programmes should the need arise in the future.

Our revised programme for metering includes for acceleration and means that we will still achieve near universal metering by 2030. The only properties to remain unmeasured will be those where it is impossible or unreasonably expensive to fit a meter.

We forecast that the number of optional meter installations will decline from current levels reflecting the falling numbers of potential Optants as compulsory metering progresses.

The evidence suggests that where customers are metered they use 12.5% less water than if they had remained unmeasured. The volume of water saved through our metering programme allows us to accommodate expected population growth in our area and be able to defer investment in the next major water resources scheme until after 2035.

Apart from reducing resource development there are other reasons for continuing metering. First, we believe that metering is the fairest way to charge for water. Where metering reduces demand it helps reduce carbon dioxide emissions and reduces pressure on local rivers at risk of low flows. Secondly, where metering is near universal it also helps to introduce tariffs that can influence demand for water during times of greatest water stress and metering can also help with affordability issues because it gives customers control over the size of their bill.

We wish to introduce Advanced Meter Reading (AMR) in due course to improve the efficiency with which we read meters, to enable tariff innovation and to improve customer service, allowing more frequent reading which will provide timely information on consumption and assist our customers in managing their payments. Recent approval of 'smart meters for the electricity and gas' domestic market suggests AMR technology and 'multi-utility' metering are likely to undergo a significant transformation in the next few years. Accordingly we propose to examine our requirements for AMR technology over the period to 2015 and the cost-benefit for AMR metering will be re-considered for our next regulatory review in 2014.

AMR will allow us to bill accurately based on actual readings and reduce the need for estimated bills, also reducing queries and contacts. It will enable initiatives like electronic billing for customers who choose it and AMR is therefore a key requirement for us to achieve the customer service outcomes we seek in the longer term. Finally AMR meters send alarms to us where there are supply pipe leaks, backflow or meter tampering. Once again these benefits will be examined more closely over the next five years.

As part of our strategy for managing demand we have considered how to use price signals to encourage our customers to change their consumption behaviours. From April 2009 we will introduce a trial seasonal tariff to about 1,000 properties in Bishops Stortford. These AMR meters have already been installed and the technology is currently being tested. The trial tariff offers a discount to the standard rate during the months September through April but a premium rate of almost double the standard tariff in summer months, May through August. The purpose of the trial is to discover customers' demand response to peak pricing signals to determine if a seasonal tariff should be introduced throughout our supply area.

To be able to operate a seasonal tariff in future, it is essential that we are able to collect meter readings taken at the beginning and end of the summer charging period. It is impractical to read large numbers of meters on a single day using manual meter readers, therefore AMR is a necessary enabler for tariff innovation. Assuming the tariff trial is successful, we plan to extend seasonal tariffs to those areas which are near universally AMR metered as our programme proceeds.

Our metering programme for 2015 to 2030 combined with our leakage reduction programme will ensure that we do not need to invest in alternative supply or demand options before 2035.

8.4 Cost Benefit Analysis for metering

For the draft Water Resources Management Plan our 'meter optant only' baseline indicates we have a supply surplus through to 2026 and therefore a positive robust cost benefit is required for Ofwat to agree funding for any supply/demand capital investment such as for further metering within prices.

We have carried out a cost benefit analysis (CBA) to derive the impacts of a variety of metering strategies including street by street compulsory metering with and without

AMR, Optant only metering and continuation of our enhanced Change of Occupier compulsory metering programme with the results as indicated in the table below.

Our CBA has included the costs to supply and install meters, the costs of meter reading and the monetarised benefits of metering in terms of reductions in carbon emissions associated with treating and pumping water. We have also included environmental and social costs such as traffic disruption and customer disturbance during the installation process. Installation costs are the CAPEX costs for installing meters.

Communication costs are associated with compulsory Advanced Meter Reading (AMR) programmes in order to maintain demand savings by providing enhanced information.

Environment and social costs are divided into several items: manufacturing a meter has a carbon cost, as well as installing it by using transport and other manufacturing tools (operation of installation equipment). There is also a cost when a meter is read (transport is also used).

Disruption caused when a household is being internally metered is accounted for since the owner must be at home and stay during the installation (waste of time). The same happens when the meter is being read. All this is gathered in the disruption costs.

Wider benefits that were considered included our customers' Willingness to Pay and the impact on customers' electricity bills associated with hot water savings.

Willingness to pay benefit is the monetarised marginal cost of our customers' willingness to pay for reductions in abstraction as a result of water efficiency programmes.

When a meter is installed, water consumption is reduced, meaning that less hot water is heated up. This electricity saving is included in the 'Electricity bill/Gas bill' line. The same process of less heating means less carbon, therefore carbon emissions are reduced due to metering (energy – carbon savings).

Table 8.4.1a : Cost Benefit Analysis for Metering

CBA Component	2a	2b	3	4
	Compulsort metering as DBP 90% to 2020		Phased strategy AMR from AMP6	Continuation of current CoH policy
	No AMR	AMR	AMR	Internal AMR
Costs				
Installation (supply and fit)	£78,327,201	£155,083,733	£137,900,008	£73,724,679
Customer communications	£2,626,838	£22,626,838	£1,643,908	
Customer communications and subsidy for supply pipe leakage	£6,377,584	£6,377,584	£5,431,251	£5,198,925
Enhanced customer communications to maintain demand savings from AMR		£9,993,767	£3,884,277	£1,078,008
E & S costs sub total	£10,923,964	£2,902,351	£4,070,398	£8,539,557
Meter reading with no AMR	£42,044,993	£(39,595,354)	£(27,051,643)	£27,923,624
Sub total costs	£140,300,597	£137,388,919	£125,878,199	£116,464,793
Benefits				
Marginal cost of water	£(4,019,874)	£(16,149,943)	£(12,762,762)	£(4,997,129)
Water saved (carbon saving)	£(1,001,568)	£(4,157,300)	£(3,574,981)	£(1,414,713)
Least cost alternative schemed to close supply demand deficit	£(19,930,000)	£(19,930,000)	£(19,930,000)	£(19,930,000)
Sub total benefits	£(24,951,442)	£(40,237,243)	£36,267,743)	£(26,341,843)
Total CB	£115,349,137	£97,151,675	£86,610,456	£90,122,950
Water savings (WTP)	£(43,464,977)	£(178,467,819)	£(149,819,853)	£(48,018,953)
Electricity/Gas bill	£(21,382,674)	£(73,048,714)	£(48,922,911)	£(19,943,562)
Energy from hot water (carbon saving)	£(3,100,773)	£(11,200,859)	£(10,255,457)	£(4,282,562)
Total wider benefits	£(67,948,424)	£(262,717,392)	£(208,998,239)	£(72,245,059)
% of wider benefits for break even	170%	37%	43%	125%

The results of our Cost Benefit Analysis (CBA) are included in Table 8.4.1 above.

The CBA indicates none of the metering strategies reviewed is cost beneficial without the inclusion of significant proportions of wider benefits.

For metering without AMR, 170% of these wider benefits are required before the scheme becomes cost beneficial. This figure drops to 37% for metering with AMR and 439% for a strategy whereby full street by street compulsory metering with AMR is adopted from 2016 onwards.

The scheme with the lowest cost is continuation with compulsory metering at change of ownership of properties as we are currently doing during AMP4.

As we have a supply demand surplus an optant only metering policy is indicated until 2026. However, although we do not need to invest in supply demand schemes until then we believe that customers and environmental regulators would find it difficult to see a sense in a temporary cessation of our "compulsory metering" change of occupier programme during AMP5. Most stakeholders we believe support metering at a rate that is limited in order to control the impacts on customer bills.

Justifcation for metering strategy
The baseline supply demand forecast for 'optant' and new metered properties shows a supply surplus until 2026. Thereafter the economics of balancing supply and demand requires that investment options are determined to either increase supply capacity or reduce demand or change outage or headroom in order to eradicate the supply deficiency to 2035.

The least cost planning solution (Table 8.1) indicates that neither metering nor leakage are cost effective until the end of the planning period (2035) when this option is chosen for one water supply zone. Those activities which are cost effective for the least cost solution are :-

Table 8.4b : Least Cost Investment Programme

Investment period	Investment scheme for least cost solution
First traunch (2025-2030)	Water resource schemes in the Northern Region
Second traunch (2030-2035)	Water resource schemes Local community water efficiency Local water re-use schemes
Third traunch (post 2035)	Metering, zone by zone Leakage
Fourth traunch (long term)	Regional water resource schemes

Our Cost Benefit Assessment shows that neither metering or leakage is cost beneficial based upon reliable and robust estimates of cost and benefit. Accordingly the choices available to us for our business plan strategy are :

- Maintain the least cost planning strategy and in effect accept a supply side approach to satisfying SDB: Or
- Maintain the existing demand side strategy.

The case for demand side measures and for consideration as 'wider benefits are:

- Continuity of our demand management strategy and policy.
- Less water removed from the environment therefore less impact on water bodies.
- Compatibility with long term indications of strategy for CAMS and WFD.
- Sustainable approach to SDB as this uses less energy and emits less carbon.

- 'Future Water' strongly advocates water metering and demand side policy.
- Enables fair means of charging.
- Equity in the eyes of customers saving water through metering and compared to water companies 'doing their bit' in reducing leakage(leakage).
- Provides opportunities for the use of tariffs in the future for customers to make their own choices.
- Customers who cause damage through high consumption will pay proportionately the cost of the damage.

It is extremely difficult if not impossible to assign monetary values to each of these components, however, we are confident that taken together they clearly result in a demand side strategy being cost beneficial and common sense in the long run.

The only question then is one of pace: Either an opportunist basis (cost) or compulsory 'street by street'.

Street by street has a marginal but similar benefit to Change of Occupancy COO (post 2016) in the long run. However, the element of compulsion on a street by street basis is we believe unaccepable to our customers particularly at this time of recession. When surveyed, only around 53% of non-metered customers are in favour of (compulsory) metering and we believe that faced with compulsion this could rapidly deteriorate and be the cause of substantial dissatisfaction and increased frequency of contact and complaints.

Our conclusion of the above was that we should continue to compulsorily meter customers on an opportunistic basis when properties change occupancy. This is proportionate in the interest of the supply demand balance at this time and the reasonably foreseeable future, limits the impact on customer's bills whilst retaining the benefits and enables us to continue a demand side strategy for the longer term. However Ofwat disagreed that our proposals were cost beneficial for AMP5. Consequently the cost for continuing with metering was not included in prices for 2010 to 2015 and so we will return to optant only metering until the end of 2014. Our long term strategy remains to have universal metering as far as practicable by 2030.

In summary therefore our strategy for AMP5 is to continue optant only metering until 2015 and then to resume COO metering after 2015. We will reconsider the cost benefit of metering in our next WRMP and business plan and will prepare the ground for an increase in metering by evaluating the range of services that enhanced metering technologies will allow us to offer our customers and the savings that metering can achieve through our tariff and AMR metering trial.

8.5 Preferred Solution

Our revised draft Plan assumed a strategy for securing our supply demand balance over the planning period was to continue our current compulsory change of occupier metering policy achieving 90% metering penetration by 2030 and to prepare the ground for an increase in metering should the need arise at the next regulatory review by evaluating the range of services that enhanced metering technologies will allow us to offer our customers and the savings that metering can achieve through our tariff and AMR metering trial. As a result of the recent price determination we have rescheduled our compulsory metering programme which will now recommence in 2015. However we still expect to achieve 90% metering by 2030.

The price determination also means that we are not funded to reduce leakage over the next 5 years. But we will also continue to drive total leakage down over the subsequent 15 years so that the level reduces by 20 Ml/d from 2015 to 2030.

The additional NPV of our compulsory metering programme for 2010 to 2030 is £106 million and this compares to the NPV of securing supplies over the planning period through development of resources and alternative demand options of £19 millions.

8.6 Final planning supply-demand balance

As described previously we have examined a wide range of options for either increasing our resource base or reducing the demand for water in order to ensure we maintain security of supply.

Our preferred solution to achieve this is through continuation of our current compulsory metering programme and further leakage reductions and details are shown in table 8.1 above. The result of implementing these schemes after the final determination is shown in Figures 8.6 (2) and 8.6 (4) below. And are compared to our original planned supply demand balance in figures 8.6 (1) and 8.6 (3).

Figure 8.6 (1) Business plan supply demand balance

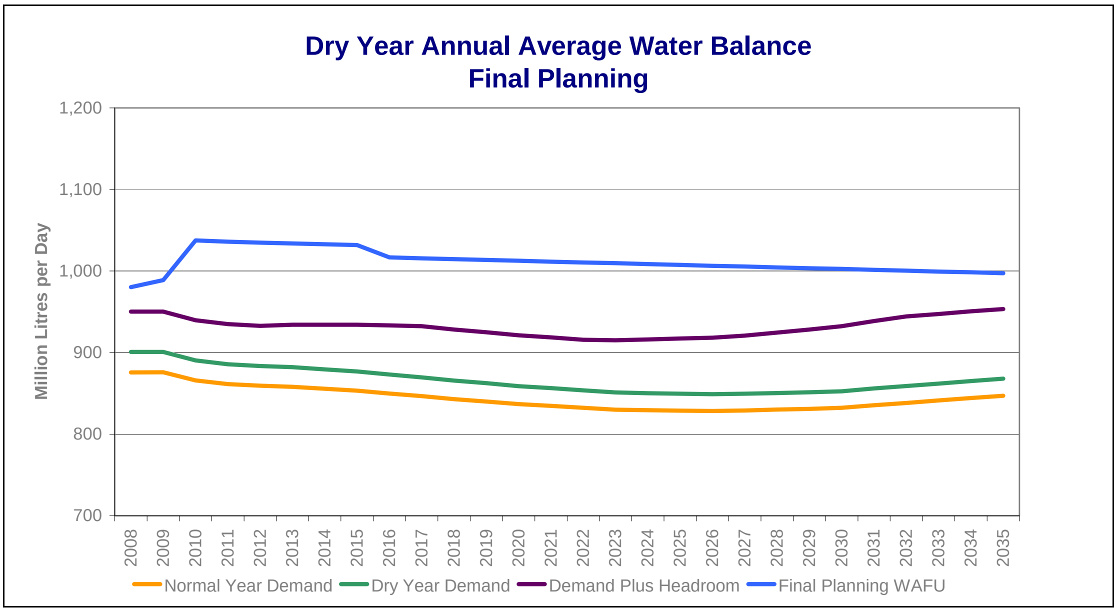


Figure 8.6 (2) : Final Average Supply /Demand Forecast Showing the Benefits of our Investment Programme

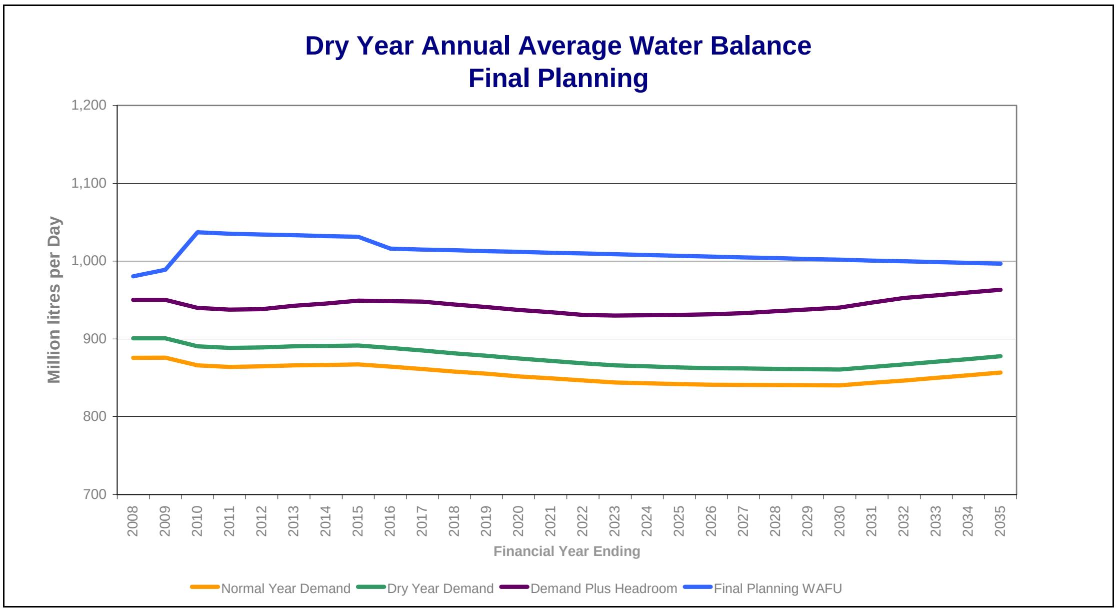


Figure 8.6 (3) Business Plan critical period balance

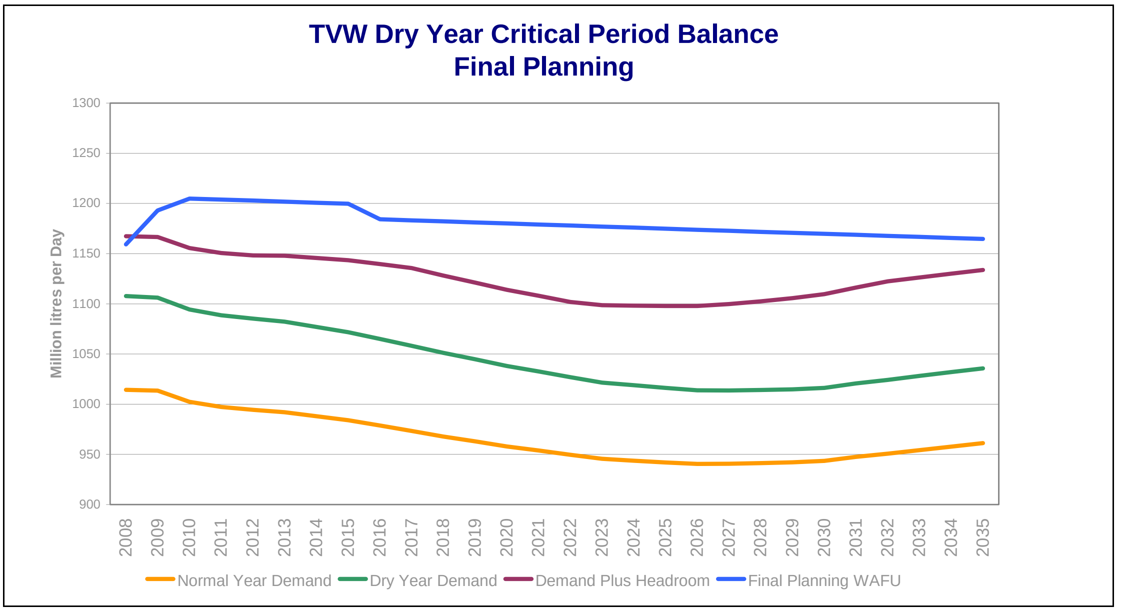
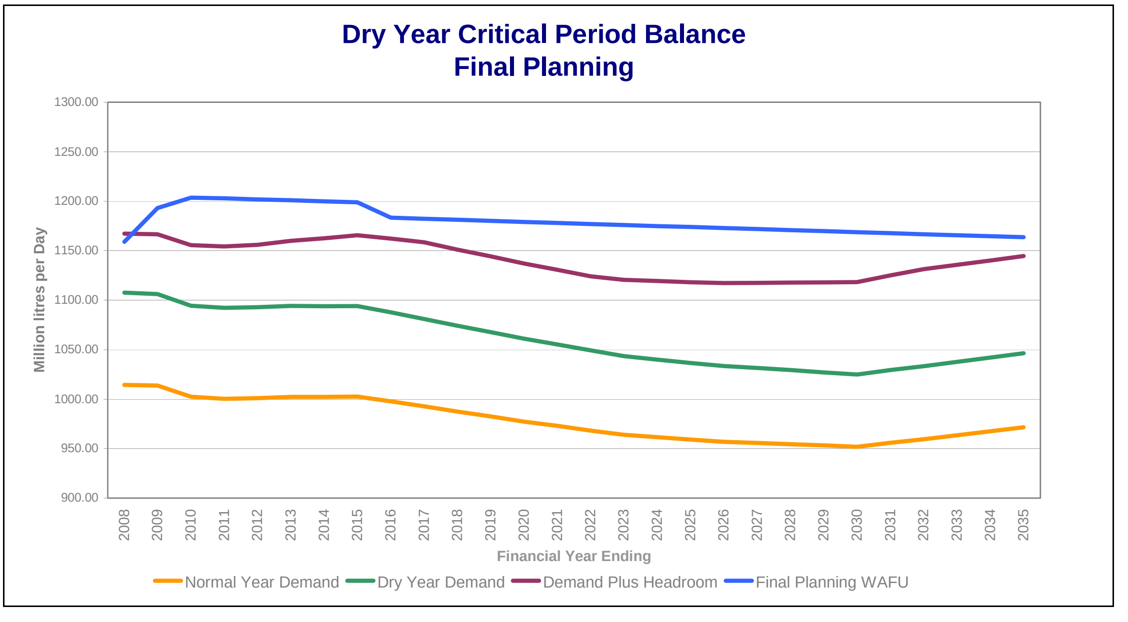


Figure 8.6 (4) : Final Critical Period Supply /Demand Forecast Showing the Benefits of our Investment Programme



These charts show that although the surplus of supply compared with demand is reduced as a result of the changes in our leakage and metering strategies for AMP5, overall security of supply to customers in unaffected until beyond 2035.

8.7 Our carbon footprint

We have calculated our carbon footprint for the planning period 2010-2035 based on the emissions required to meet the dry year annual average forecasted demand in each of the next 25 years excluding headroom allowance.

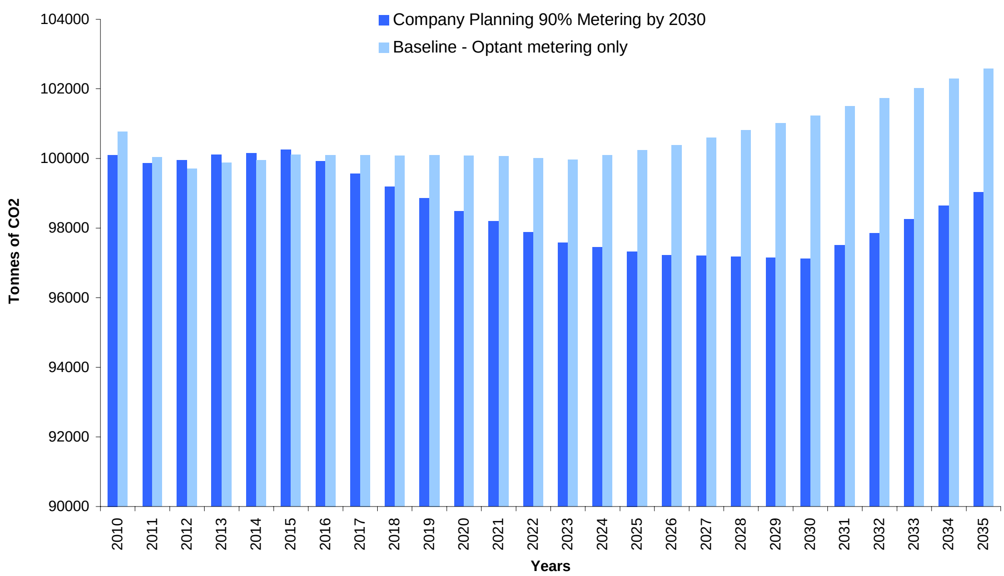
Our Corporate Responsibility report includes an evaluation of our overall carbon footprint. The figure for 2006/7 stated that the operational electricity used to supply water that year was equivalent to 107,500 tonnes of CO_2 emissions.

Figure 8.7 illustrates the resulting CO_2 emissions for the baseline and final planning scenarios. It can be seen that our preferred strategy of metering and leakage reduces our carbon emissions significantly in comparison to an optant only baseline scenario. As a result of the preferred strategy, there is a steady decrease in emissions to 2023 after which there is a gradual increase as the impact of housing growth can no longer be contained by demand reductions alone. These figures relate to water produced but a more detailed assessment of the carbon impact of the business as a whole is included in our final business plan (section C8). The overall cumulative savings in CO_2 emissions over the planning period are shown in the table below.

Table 8.7 : Quantum of savings for each quinqennium of the planning period

Quantum of tCO_2 emissions saved over the planning period (cumulative)				
2010/11 – 2014/15	2015/16 – 2019/20	2020/21 – 2024/25	2025/26 – 2029/30	2030/31 – 2034/35
210	4643	16585	34726	53552

Figure 8.7: Our carbon footprint for the planning period 2010-2035.



As can be seen in figure 8.7, the impact of our preferred strategy is to reduce carbon emissions below the baseline carbon emissions. The majority of our carbon emissions are associated with the electricity costs of treating and pumping water into supply. The impact of reducing leakage and metering is to reduce demand and therefore the volumes of water that are needed to be abstracted and pumped into supply. Our programme overall has a net saving in carbon emissions which is compatible with the expressed views of our customers.

8.8 Overall water resources strategy

The final water resources strategy for our Final Water Resources Management Plan 2010 is:

- A demand led approach to managing supply and demand. Our programme is demand management led throughout the planning period to 2035 although there is a significant uncertainty over whether demand reductions will be sustained in the longer term.
- Continuing to make best use of our existing resources through improving and enhancing their performance and by protecting them from pollution.
- A continuation of our compulsory 'change of occupier' metering programme from 2015 to reduce non-essential use of water, save energy and minimise impacts on the water environment. The pace of metering reflects the market conditions
- The impact of our metering programme will increase prices to customers by 0.5% in real terms.
- Continuing to reduce leakage by 20 Ml/d per year by 2030 starting 2015
- Offering water efficiency advice and services to our customers that are cost-effective and reduce non-essential use of water.
- Achieving around 90% of meters installed by 2030 to minimise environmental impacts and greenhouse gas emissions.
- Fitting automatic meter reading equipment on all multiple unit new property developments and internal meters.
- Evaluating 'smart metering' technology' through the AMP5 period so that we are able to define the optimum metering to use for AMP6 and beyond.
- Working with our customers to evaluate the benefits of additional consumption information and billing services from AMR metering and also to determine the conditions that would mean customers are willing to accept street by street compulsory metering in preparation for the next business planning cycle.
- Continuing with a seasonal tariff trial and Investigating new methods of charging for the future.
- Maintaining a comprehensive programme of studies working with other water companies to ensure we can bring forward investment in resource development options should we see the effects of metering reducing or if the effects of climate change are more rapid or to be able to respond to challenges to the resource we use to meet the demand for water for our customers.

The above strategy is predicated on a level of service of restrictions on supply at a frequency of 1 in 10 years for hosepipe bans and 1 in 20 years for drought permits and orders although we are of the view that customers are likely to become less tolerant of restrictions on supply in future. Our assessment of the impact of reducing the frequency of restrictions on supply corresponds to our assessment of 50 Ml/d loss of resource that we calculated in 2006 with the prospect of a ‘third dry winter.

8.9 Sensitivity Analysis

Our Plan is based on a continuation of our leakage reduction and progressive compulsory metering programmes leading to achieve total leakage reductions between 2010 and 2030 of 30 Ml/d and a level of meter penetration of 90% by 2030.

We forecast that water savings resulting from our metering and leakage programmes will be sustained over time and that these programmes will gain approval from our financial regulator Ofwat. However, our Plan is sensitive to the extent of water saving on metering and leakage and we have therefore examined various metering scenarios, including a reversion to optant metering only. These are included in the sensitivity test schedule below.

Uncertainties due to demand forecast variation, source pollution and climate change considered in our headroom analysis (section 5) along with other minor uncertainties and are therefore an implicit part of our plan.

With these strategies in place we forecast that there will be no deficit between supply of water and demand for water plus headroom until after the end of the planning period in 2035. But how sensitive is our preferred plan to changes in strategy?

In order to illustrate this we have considered the effect of nine alternative scenarios and the changes that would be required to maintain security of supply. Results are presented in the following sections together with the increased WAFU that we would need to secure to close the supply demand deficit at 2035. The analysis also shows the net present value of the capital investment and operating costs for the additional investment in resource development and demand management schemes, where these are required. Details of the sensitivity analysis are included in section 10.6.

The sensitivity scenarios considered are:

1. **High Headroom** – The profile of the level of headroom risk adopted and incorporated into our planning is discussed in section 5.0. Under this scenario the impact of adopting and allowing for a greater degree of demand forecast inaccuracy is assessed.

2. **Loss of time limited licences** – The Environment Agency has indicated to us that we cannot presume that any of our time limited licences will be replaced when they are due for review. Over 30 Ml/d of our resource base is made up from such licences and all new licences currently granted are on a time limited basis. We have carried out a sensitivity based upon non renewal of these licences. Our experience is that the costs to replace a revoked licence will also include other site specific aspects that are not captured by the modelling framework, such as stranded asset value and installation of additional infrastructure to maintain security of supply. We have made an allowance of £2 million per Ml for this.

3. **Optant only metering strategy**, **30 Ml/d leakage reduction** – Our preferred policy is for a continuation of our current compulsory change of occupier metering

strategy. In proposing a metering strategy we are required to demonstrate that the investment is cost beneficial in order to secure the necessary funding to achieve it. However, our Cost Benefit Analysis suggests that none of our metering policies are cost beneficial without the inclusion of significant elements of wider benefits. We are therefore at risk that only an Optant only policy is approved and allowed for by our financial regulator.

4. **Preferred metering strategy, 0 Ml/d total leakage reduction** - Our preferred plan is for a continuation of our current leakage glide path through the next regulatory periods as this level of activity is already funded within our base operating costs however, current activity levels may either be insufficient to reduce total leakage by the estimated amount over the next 25 years or may not be funded and there is therefore a risk that reductions in total leakage level may not be achieved.

5. **30 Ml/d leakage reduction, only "Optant" metering demand savings** – By metering on change of occupier we assume savings associated with reduced demand at approximately 8% when compared to our unmeasured customer base. We may find that these savings are not achieved over the plan period and that a lesser saving (an Optant level of savings) is achieved.

6. **Metering demand savings, low supply pipe leakage reductions** – We believe that there is a greater chance that leaks that occur on underground supply pipes will be reported and repaired by our measured customers who received regular bills which include consumption information and we use industry estimates for supply pipe leakage in the preparation of our demand forecasts. By metering at the boundary we believe that we will achieve savings not only in terms of demand reduction but also in terms of reduced supply pipe leakage. However the anticipated level of leakage reduction may not be achieved.

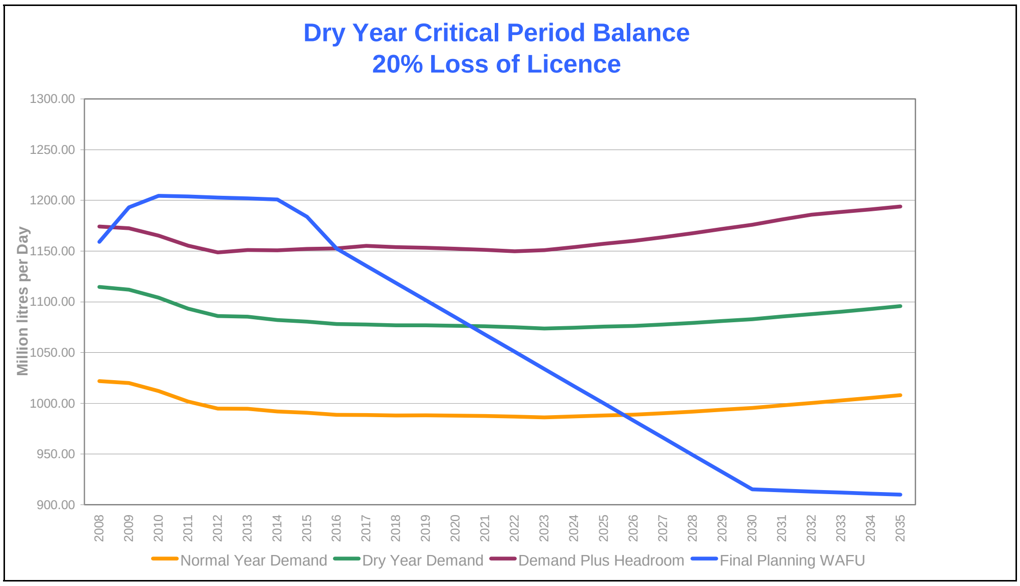
7. **Optant only demand savings, low supply pipe leakage reductions** – This scenario is a combination of scenarios 5. and 6.

8. **130 PCC** – We have estimated the cost and impact of achieving the reductions in normal year Per Capita Consumption of 130 litres per person per day by 2030 in line with Defra targets for household consumption set out in "Future Water" taking into account our preferred strategy. The impact of this scenario is shown in table 8.6 by the negative yield of additional water that would be required since our plan assumes that, without the measures indicated, a measured PCC of 148 litres per person per day is otherwise achieved in 2030. This scenario depend s on improving the number and reliability of water efficiency schemes available over and above those already included in our micro-component demand forecast. The uncertainty over sustained benefits from water efficiency means limited availability of schemes at this point in time but we will improver the availability and reliability ogf schemes during AMP5 as the industry evidence base expands and becomes more robust. The uncertainties over current water efficiency options is detailed in section 10.7 – supplementary information.

9. **Water Framework Directive** - A considerable uncertainty for the water industry as a whole is the potential impact of the Water Framework Directive. We have followed the advice from the Environment Agency that we should not plan for changes in our licences to abstract water from the environment. However we are concerned that this approach neglects the possibility that changes in licences may be required to improve local environmental objectives as indicated in the Agency's own

Catchment Management Strategies[35] and in turn River Basin Management Plans to meet targets set under the Water Framework Directive. We await the river basin management plans and the Environment Agency's intentions with respect to over licensed and over abstracted catchments. Meanwhile the Preliminary Cost Effectiveness Analysis (PCEA) work undertaken for Ofwat attempted to put some "ball park" figures to the potential licence reductions that could occur and this suggested we need to consider replacement of up to 20% of our abstraction licences and the effect of this is shown in Figure 8.9a.

Figure 8.9a : Supply/Demand Forecast with Water Framework Directive Targets



The effect of this scale of licence loss is so large that our modelling is not able to resolve the ensuing supply demand deficit without the inclusion of both a desalination scheme and the reductions in PCC as outlined in scenario 8. We have also allowed in Table 8.9 for the loss of stranded assets and infrastructure required to maintain security of supply and current levels of service at a uniform rate of £2 million per Ml loss of licence although under this eventuality the investment required would be assessed on a case by case basis. The Environment Agency will be consulting on their River Basin Management Plans and Programmes of Measures to meet Water Framework Directive by 2015 or 2021 or 2027.

The results of our analysis are indicated in the table below. All figures are rounded.

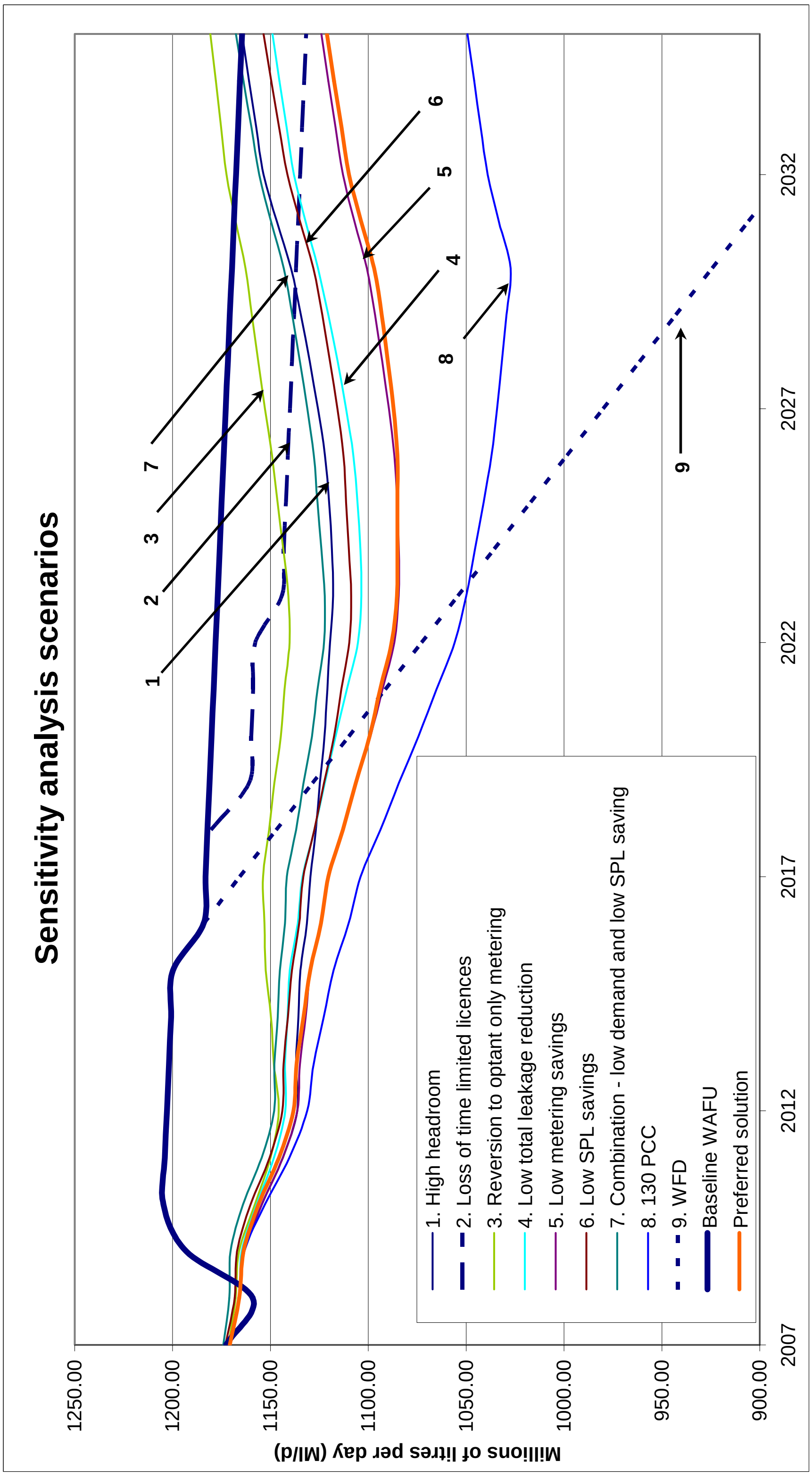
[35] Catchment Management Strategies are published by the Environment Agency and consider the pressures on water bodies in the local water environment. They form the building blocks for the assessment of the Programme of Measures that will be required to meet targets to be set for River Basin Management Plans as required by the Water Framework Directive.

Table 8.9 : Modelling Results of Sensitivity Scenarios

Scenarios	Additional Average Yield (Ml/d) Required	NPV Capex (£ millions)	NPV Capex & Opex (£ millions)
1 High headroom	4	1	1
2 Loss of time limited licenses	14	*60*	*60*
3 Reversion to Optant only metering	16	2	4
4 Low total leakage reduction	0	0	0
5 "Optant" only demand reductions	0	0	0
6 Low supply pipe leakage savings	0	0	1
7 Combination of 5 and 6	2	1	1
8 Defra 130 PCC by 2030	-55	323	316
9 Water Framework Directive	171	1326	1355

The different scenarios described above require alternative investment strategies to balance supply and demand. Details of the modelling outputs for the sensitivity tests are included in section 10.5. However figure 8.9b below provides a graphical summary of the investigations undertaken. It can be seen from this that our plan is robust to most changes in scenario's excluding severe reductions in deployable output.

Figure 8.9b : Summary of Sensitivity Scenarios



8.10 Further investigations

There remain a number of challenges to our strategy and it is important we maintain our efforts to reduce uncertainty and seek improvements in our planning for the longer term. A summary of these projects is shown in the table below. The cost of the Upper Thames Reservoir and ANGL Extension are included in our capital programme. Other studies will be evaluated within our base operating programme.

Table 8.10 : Projects for further investigations

Upper Thames Reservoir
ANGL Extension
Essex Confined Aquifer
WRSE proposals evaluation
Supply Pipe Leakage
Impact of compulsory metering
Water cycle studies

Regional water resource development.
The significant uncertainty over whether demand reductions from metering and water efficiency will be maintained mean it is essential we continue developing plans for new water resource development in the South-East. We will continue working on projects for

- Development of a new regional resource in partnership with Thames Water or Anglian Water
- Re-commissioning HILF Reservoir

Essex Confined Aquifer Study
Continuation of AMP4 study to determine the suitability of confined chalk in North West Essex. The AMP4 studies will demonstrate the locations and viability of available water, including the potential for artificial recharge/re-use. The AMP5 study will take this information and build production boreholes and trial recharge holes for system testing to determine the potential yield of the entire resource together with further studies and programmes of work to evaluate treatment requirements for recharge water that could be used to replenish the aquifer during average demand periods.

Water Resources in the South East (WRSE)
We believe that it is important that regional solutions should be explored to solve regional problems. The south east of England has been declared an area of Water Scarcity by the Environment Agency and we remain committed to working in full co-operation with them and other water companies to discover and explore the implications of regional based water resources strategy

To this end we have been fully engaged with the Environment Agency and other water companies to explore the possibilities for integrated least cost water solutions for the South east of England.

Supply pipe leakage
Surveys and field work to determine the size and contribution of supply pipe leakage to savings achieved through compulsory metering and therefore the likely impact of supply pipe leakage at PR14.

We have a number of meter boxes fitted on unmeasured supplies which will be used to compile a comprehensive database of supply pipe leaks sufficient to apply statistical modelling techniques.

This study will provide the evidence base for our projections for the impact of metering on customer side leakage, the component of metering savings that are directly attributable to reduction in customer side leakage and the effect of compulsory metering on supply pipe leakage going into AMP6.

Impact of compulsory metering
The effectiveness of our compulsory metering programme in terms of both reductions in consumption and changes in customers attitudes towards water using behaviours and responses to calls to reduce water consumption in the event of further droughts are essential factors to be determined before the submission of our Water Resource Management Plan and Business Plan Submissions in 2014 since these will form the backbone of our demand management strategy until at least 2020.
.
Working alongside and following on from areas that have been compulsory metered the study will be carried our using surveys and questionnaires to understand the contributory factors towards any savings achieved as well as to validate and quantify reductions in demand.

Water reuse, recycling and water cycle studies
We believe it is important to understand how water recycling and effluent reuse schemes may be implemented safely and effectively. Our studies suggest effluent re-use may be feasible at Stevenage and this project will look in detail at how such a scheme may be delivered.

We work closely with Local Authorities, Planning Authorities and the Environment Agency to plan for future growth and to ensure there is a safe and secure supply of water now and in the future.

Where Regional Spatial Strategies prescribe housing allocations to Local Authority level we work closely with the Local Authority and specific developers to ensure that the infrastructure requirements are fully understood and planned for.

For specific large developments it is often necessary to produce bespoke Water Cycle Studies to more thoroughly understand the impact of the planned growth on the environment and the surrounding area.

In these instances we work closely with a range of organisations including the sewerage undertaker, local authorities, the Environment Agency and the consultant collating the work to produce a robust holistic assessment of the impact of any planned growth and how to mitigate for this impact.

This will involve options to mitigate for low river flows, over-abstracted sources and potentially more general environmental degradation on a wider scale. This process also provides a further opportunity to ensure that wherever possible new developments are built to the highest efficiency standards and phased accordingly to ensure infrastructure requirements are planned, costed and in place in a timely and robust fashion.

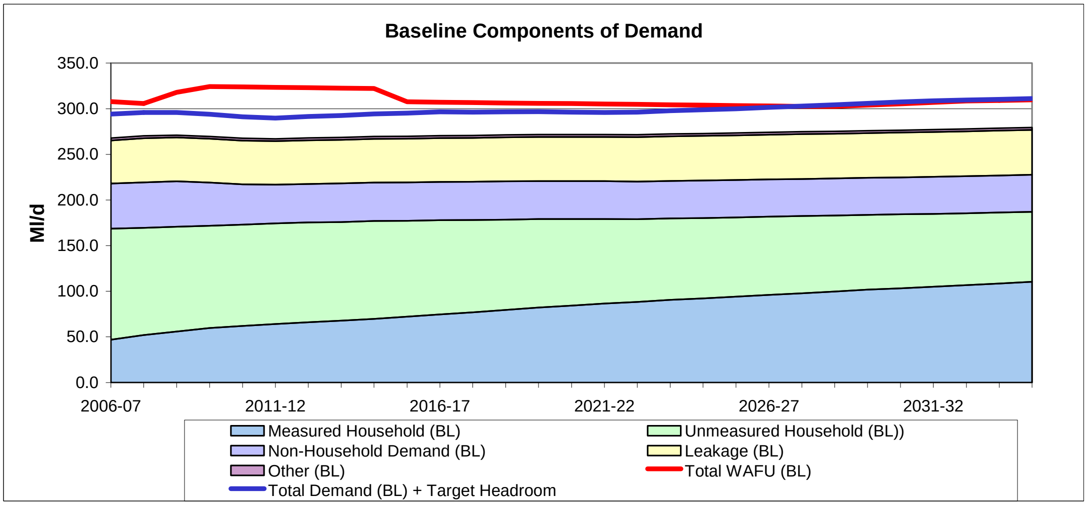
Specific Water Cycle Studies that we are currently involved in include the Luton/Houghton Regis study and the Rye Meads Water Cycle Study, both of which encompass planned housing growth in excess of 20,000 properties over the next 20 years.

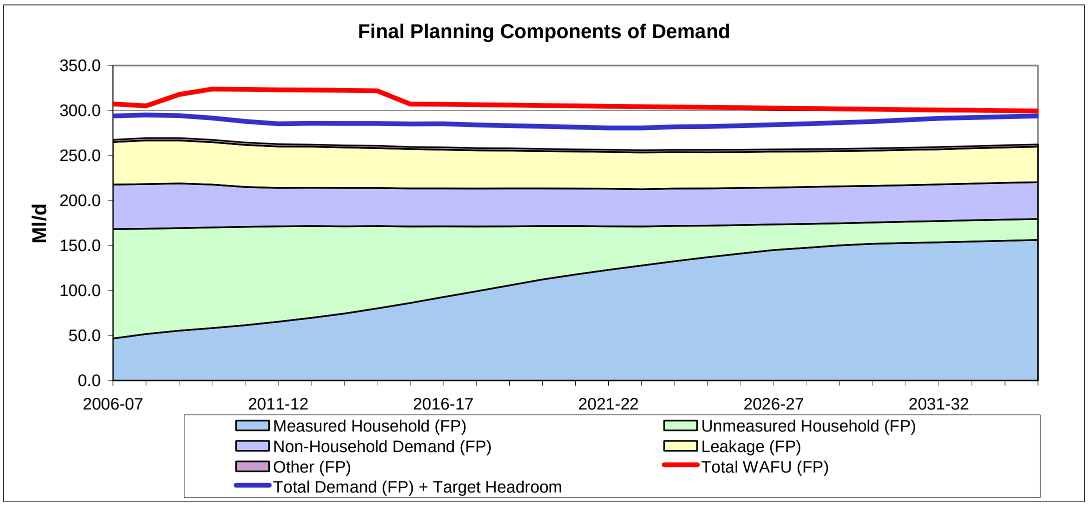
Throughout this process, close working and the sharing of information is paramount to ensure the outcome is robust, accurate and to highest standard.

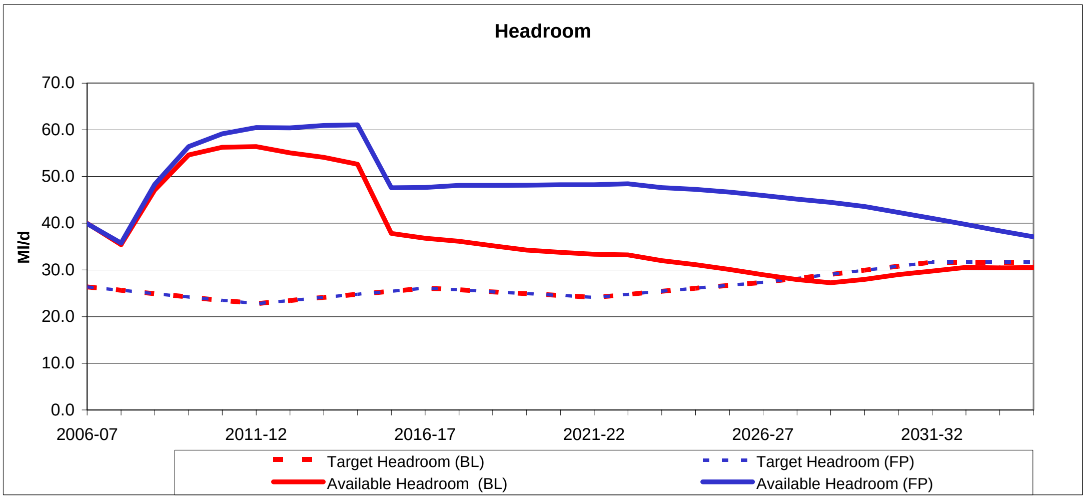
We will continue to work closely with our partner organisations to ensure this remains the case for all current and future studies of this nature.

9 SUMMARY TABLES

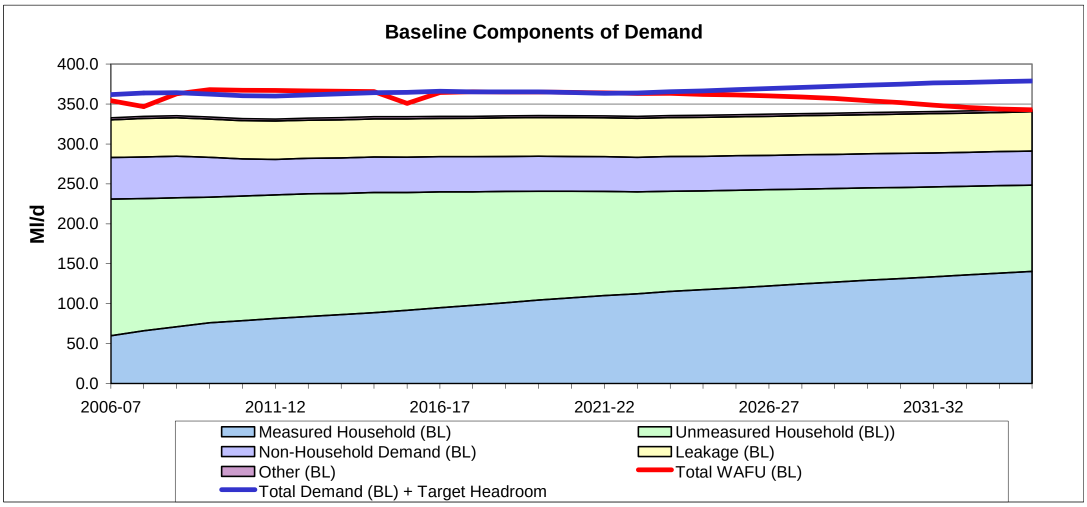
The following pages include summaries of the supply-demand balance tables for each water resource zone at both dry year annual average and critical periods. They illustrate the baseline and final planning scenarios as well as the results of the headroom assessments for each of these.

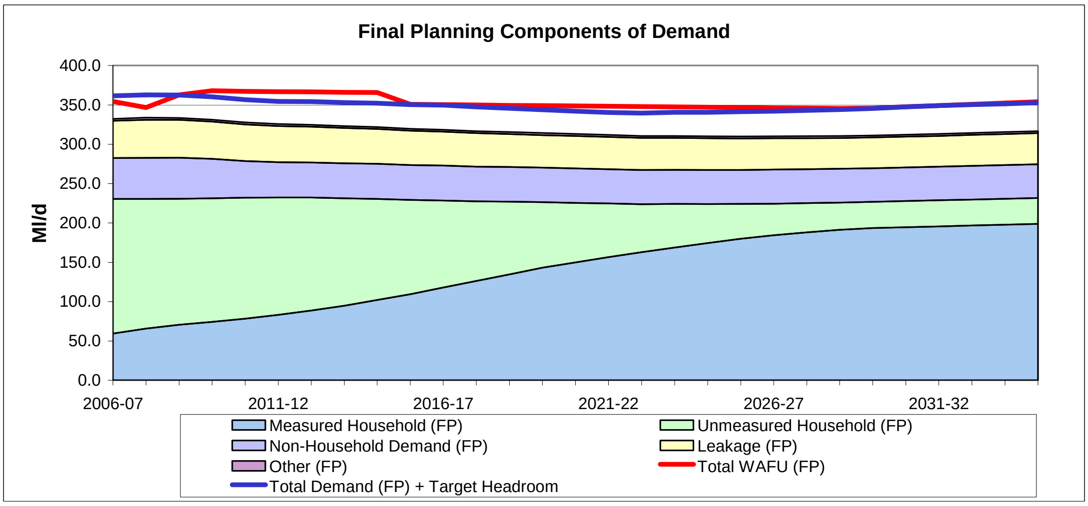


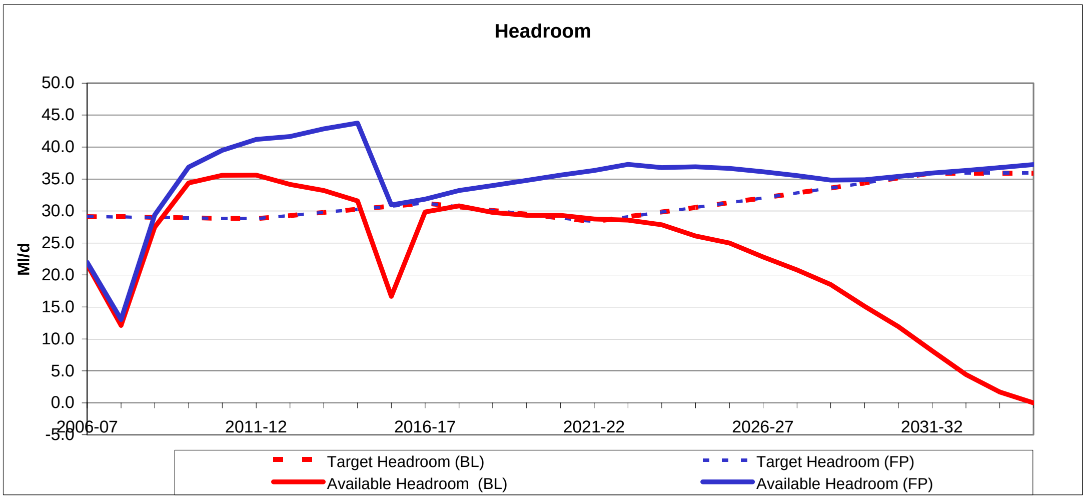




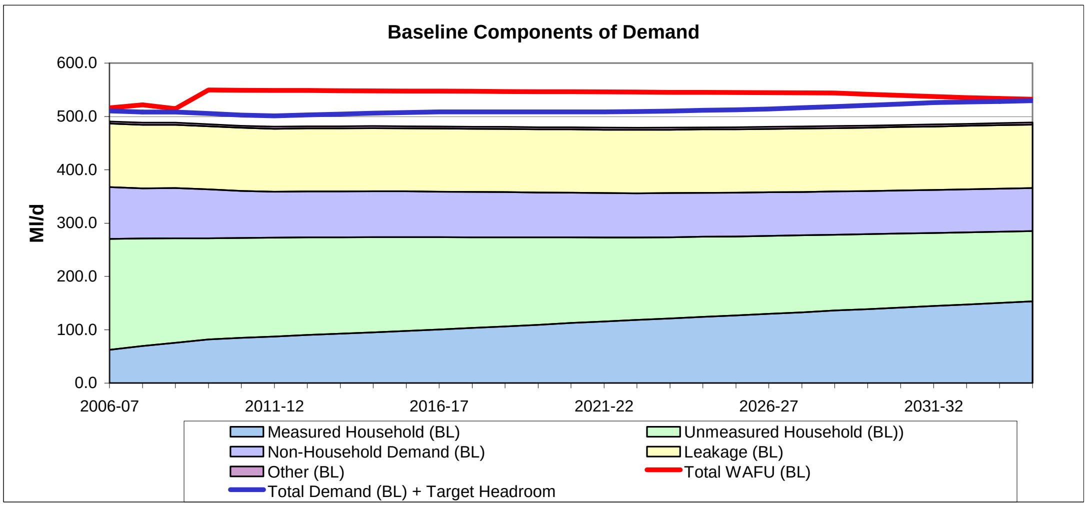
Company:	**Veolia Water Central**
Resource Zone Name	**Northern**
Resource Zone Number:	**1 of 3**
Planning Scenario Name:	**Dry year annual average**
Chosen Level of Service:	**1 in 10**

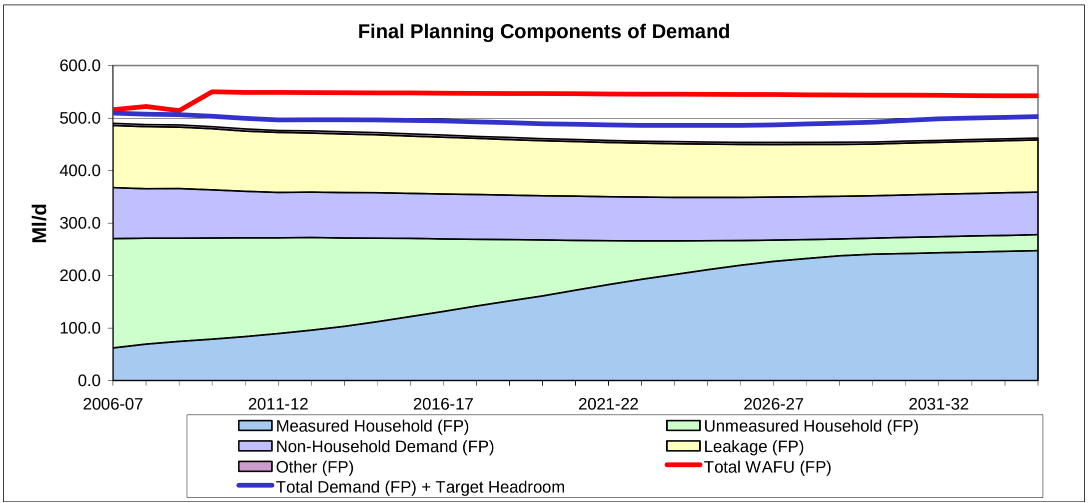


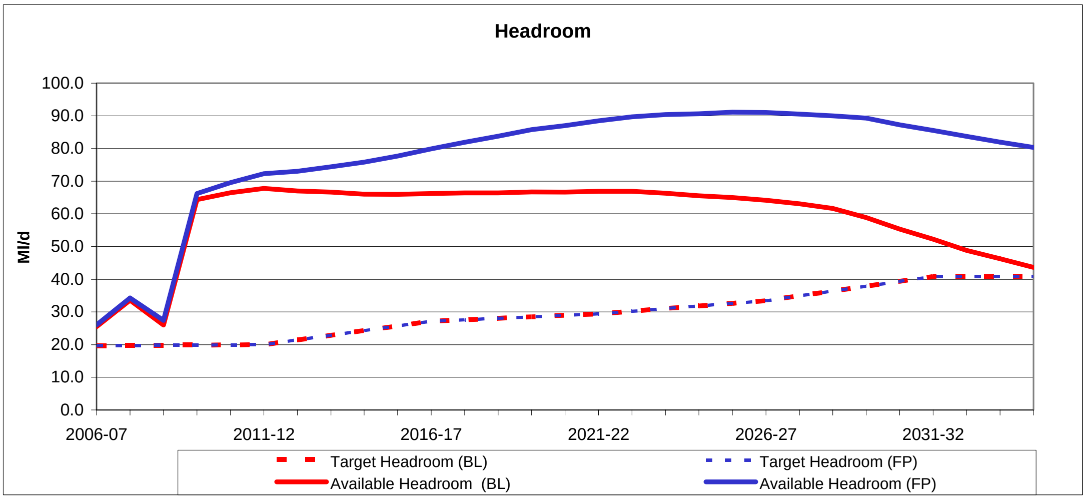




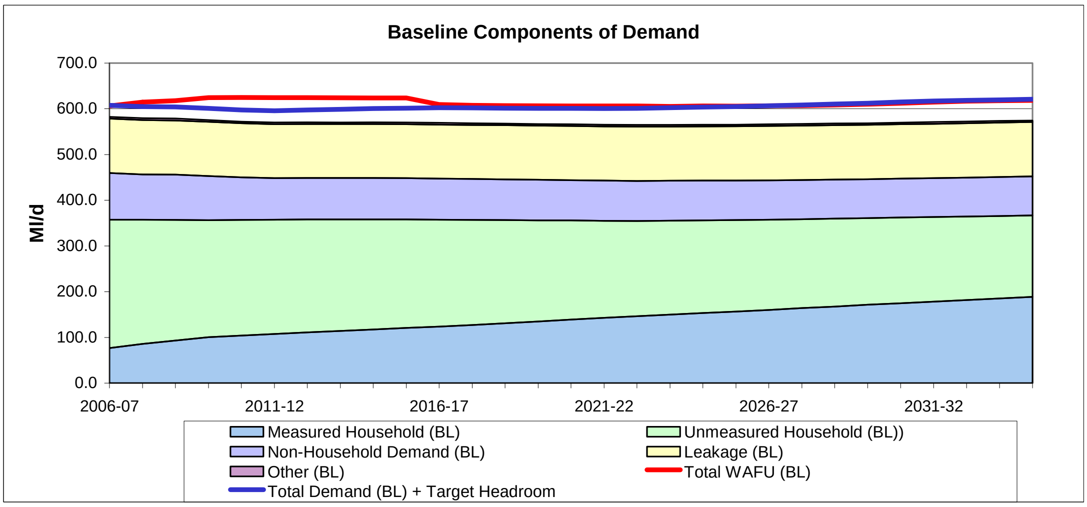
Company:	**Veolia Water Central**
Resource Zone Name	**Northern**
Resource Zone Number:	**1 of 3**
Planning Scenario Name:	**Critical Period**
Chosen Level of Service:	**1 in 10**

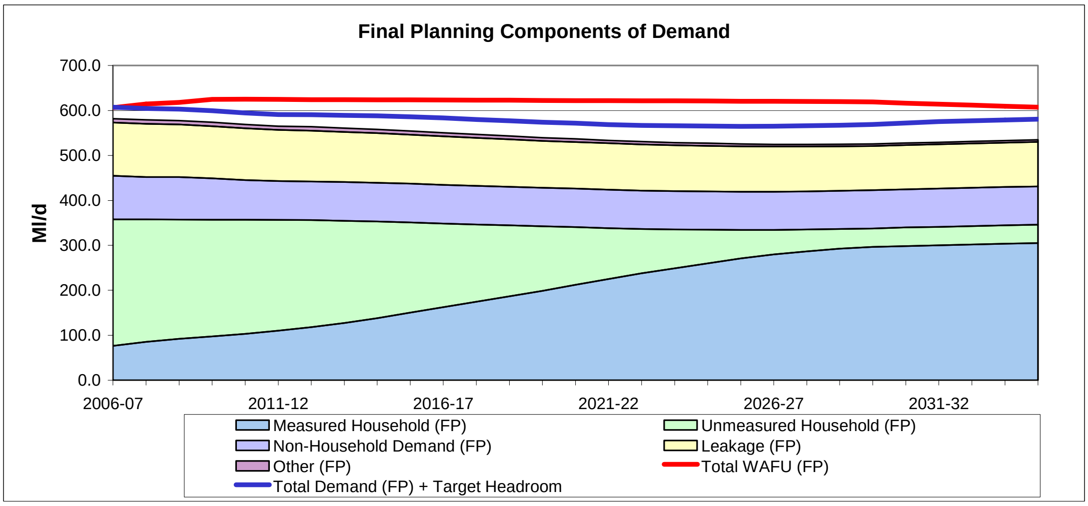


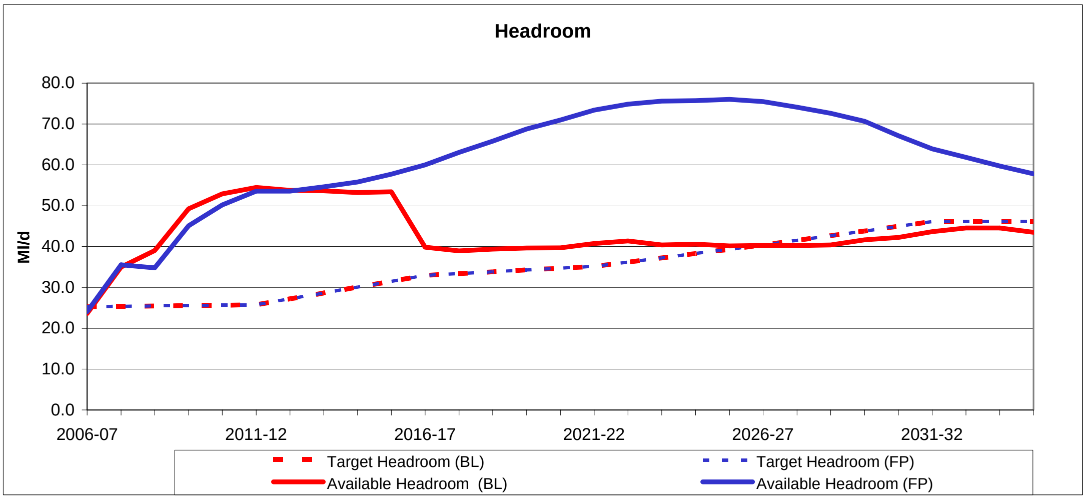




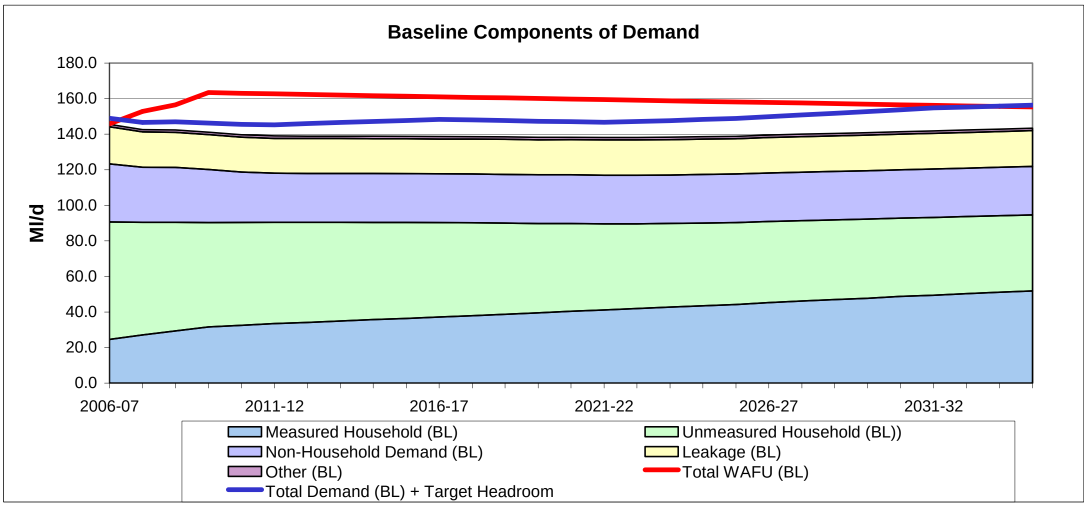
Company:	**Veolia Water Central**
Resource Zone Name	**Central**
Resource Zone Number:	**2 of 3**
Planning Scenario Name:	**Dry year annual average**
Chosen Level of Service:	**1 in 10**

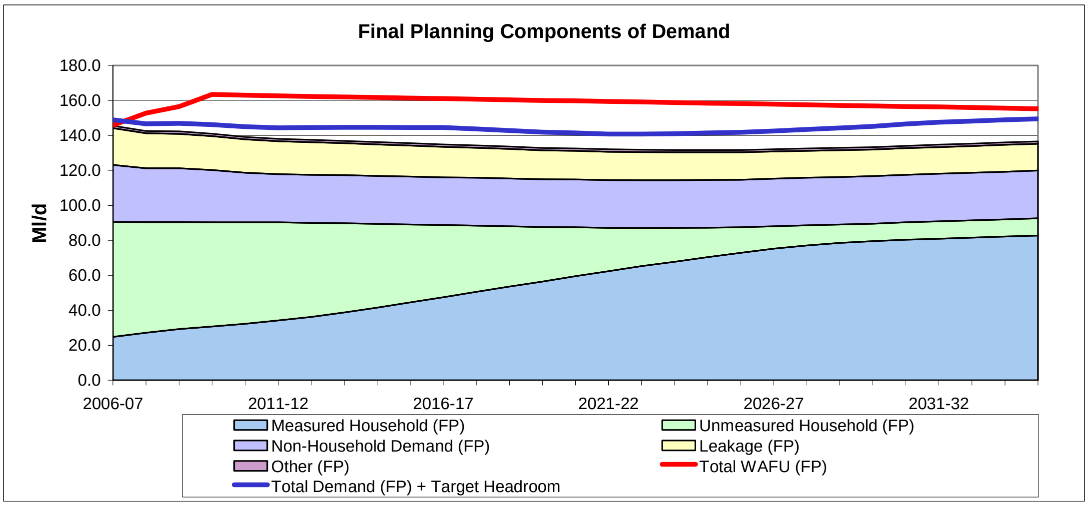


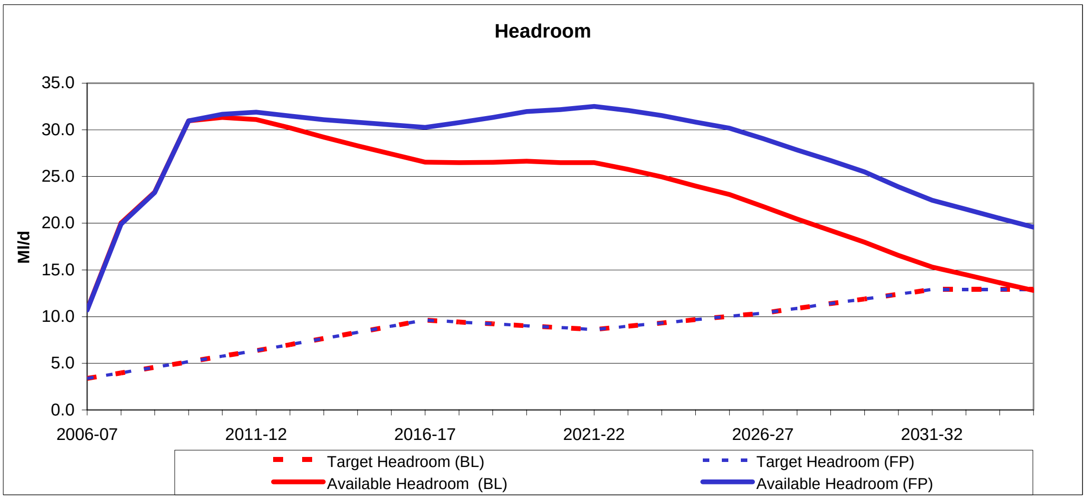




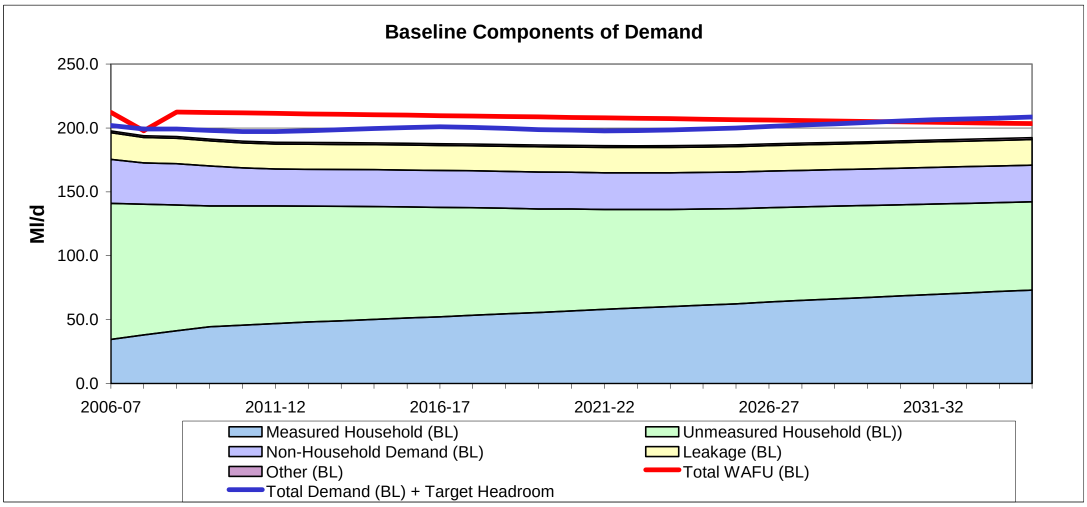
Company:	**Veolia Water Central**
Resource Zone Name	**Central**
Resource Zone Number:	**2 of 3**
Planning Scenario Name:	**Critical Period**
Chosen Level of Service:	**1 in 10**

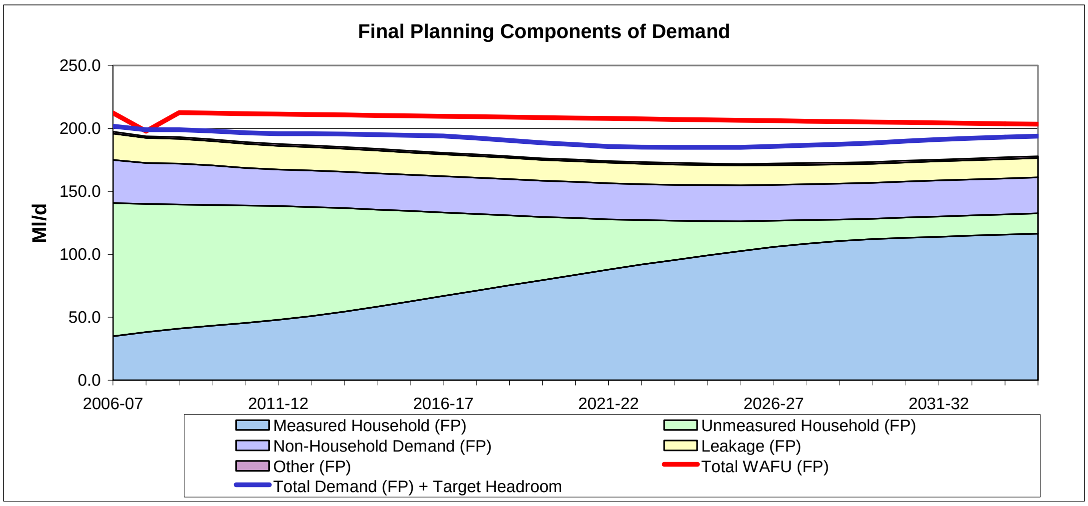


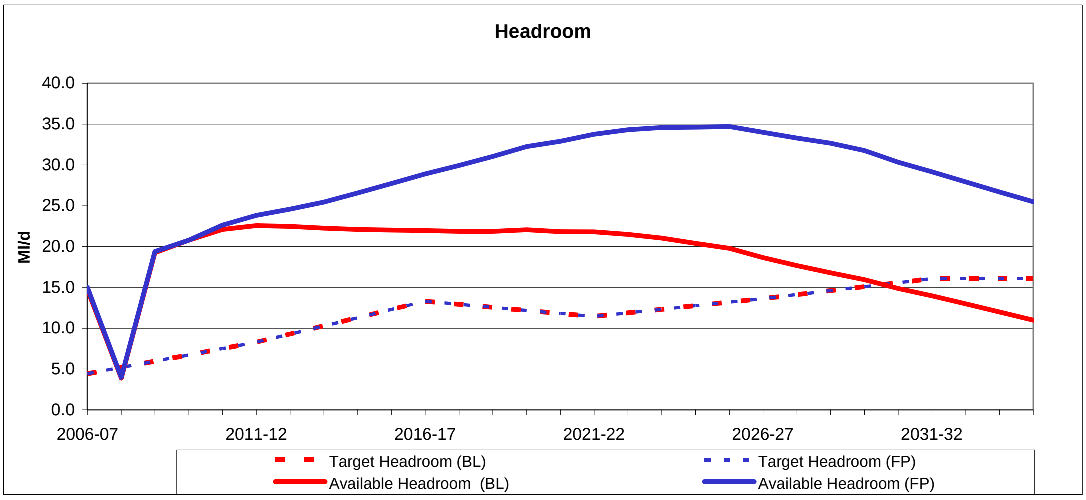




Company:	**Veolia Water Central**
Resource Zone Name	**Southern**
Resource Zone Number:	**3 of 3**
Planning Scenario Name:	**Dry year annual average**
Chosen Level of Service:	**1 in 10**







Company:	**Veolia Water Central**
Resource Zone Name	**Southern**
Resource Zone Number:	**3 of 3**
Planning Scenario Name:	**Critical Period**
Chosen Level of Service:	**1 in 10**

10

SUPPLEMENTARY INFORMATION AND ASSUMPTIONS

In this section we include supporting data for the preceding analysis covering: preferred options list, comparison with previous plans, CAMS, NEP and sensitivity analysis.

10.1 Preferred (constrained/ feasible) Schedule of Options

ID	Option Name	Category	Output Ml/d Average	Output Ml/d Peak	Confidence in Benefit %
23	ANGL Extension	Bulk Transfer	36.00	44.00	53%
25	ABIN	Bulk Transfer	0	40	68%
28	HWFS/ARKR Transfer Upgrade	Bulk Transfer	15.00	15.00	90%
31	ARKS/BUGR Transfer Maximising ARKN	Bulk Transfer	15.00	15.00	90%
76	BUGR/PREP	Bulk Transfer	15.00	0.00	68%
144	FORT Transfer Upgrade	Bulk Transfer	17.00	27.00	35%
161	LOWE Bulk Import Increase	Bulk Transfer	2.00	4.00	68%
559	Treated Water Storage	Bulk Transfer	0.00	9.14	50%
560	LADY Optimisation	Bulk Transfer	2.00	4.00	53%
654	KEMP WRSE Option	Bulk Transfer	0.00	22.00	35%
185	Commercial Water Audits	Demand Mgt	0.53	0.53	53%
249	Water Saving Devices - Voucher Scheme	Demand Mgt	0.08	0.08	90%
250	Water Saving Devices - Customer subsidy for purchasing	Demand Mgt	8.40	8.40	53%
261	Tap re-washering	Demand Mgt	0.99	0.99	100%
330	WE projects for SMEs	Demand Mgt	1.62	1.62	53%
385	Retrofit Dual Flush Mechanism	Demand Mgt	0.31	0.31	100%
388	New Cistern Displacement Devices	Demand Mgt	2.20	2.20	53%

ID	Option Name	Category	Output Ml/d Average	Output Ml/d Peak	Confidence in Benefit %
567	Community water efficiency scheme	Demand Mgt	2.00	2.00	90%
569	Targeted Water Efficiency promotion -Housing Associations	Demand Mgt	0.18	0.18	68%
571	Dual Flush valve failures investigations	Demand Mgt	0.03	0.03	68%
572	Retrofit aerated shower head	Demand Mgt	0.13	0.13	90%
573	Hose gun triggers (targeted DMAs)	Demand Mgt	0.33	0.33	90%
270	Leakage reduction - Distribution Main Renewals	Leakage	1.01	1.01	90%
271	Leakage reduction - Communication Pipes	Leakage	5.89	5.89	70%
426	Leakage reduction - Service Reservoir	Leakage	0.20	0.20	50%
427	Leakage reduction - Global Supply Pipes	Leakage	2.00	2.00	70%
428	Leakage Control - New Detection Technologies	Leakage	1.50	1.50	70%
528	Leakage reduction - Speed of Repair	Leakage	1.70	1.70	90%
633	Leakage reduction - distribution mains and CP renewals	Leakage	4.64	4.64	70%
634	Leakage reduction - DMA Renewal	Leakage	5.19	5.19	70%
635	Leakage reduction - District Metering	Leakage	0.90	0.90	50%
636	Leakage reduction - Pressure management	Leakage	1.39	1.39	50%
637	Leakage reduction by 1 Ml/d	Leakage	0.50	0.50	90%
638	Leakage reduction by 2 Ml/d	Leakage	1.00	1.00	90%
639	Leakage reduction by 3 Ml/d	Leakage	1.00	1.00	90%

ID	Option Name	Category	Output Ml/d Average	Output Ml/d Peak	Confidence in Benefit %
640	Leakage reduction by 4 Ml/d	Leakage	1.00	1.00	90%
641	Leakage reduction by 5 Ml/d	Leakage	1.00	1.00	90%
642	Leakage reduction by 6 Ml/d	Leakage	1.00	1.00	90%
643	Leakage reduction by 7 Ml/d	Leakage	1.00	1.00	90%
644	Leakage reduction by 8 Ml/d	Leakage	1.00	1.00	90%
645	Leakage reduction by 9 Ml/d	Leakage	1.00	1.00	90%
646	Leakage reduction by 10 Ml/d	Leakage	1.00	1.00	90%
647	Leakage reduction by 11 Ml/d	Leakage	1.00	1.00	90%
648	Leakage reduction by 12 Ml/d	Leakage	1.00	1.00	90%
649	Leakage reduction by 13 Ml/d	Leakage	1.00	1.00	90%
650	Leakage reduction by 14 Ml/d	Leakage	1.00	1.00	90%
651	Leakage reduction by 15 Ml/d	Leakage	1.00	1.00	90%
213	Compulsory metering - Water stressed areas	Metering	15.84	15.84	68%
531	Left Over Commercials (metering of)	Metering	0.37	0.37	90%
532	Left Over Domestics (metering of)	Metering	7.31	7.31	90%
652	Change of occupier metering (no AMR)	Metering	6.43	7.89	68%
653	Compulsory metering (no AMR) - 15yr Prog	Metering	19.94	36.31	68%
533a	Compulsory metering (AMR) - 5yr Prog	Metering	43.58	62.07	18%
533b	Compulsory metering (AMR) - 10yr Prog	Metering	43.58	62.07	35%
533c	Compulsory metering (AMR) - 15yr Prog	Metering	43.58	62.07	53%

ID	Option Name	Category	Output Ml/d Average	Output Ml/d Peak	Confidence in Benefit %
463	NORT Treatment Scheme	Resource Development	0.00	3.41	68%
464	POOR Treatment Scheme	Resource Development	0.00	11.37	53%
466	RUIS New Treatment	Resource Development	4.00	7.96	45%
4	NEWP and WEND maximisation	Resource Dvpt	2.25	2.89	70%
5	HORS Source Recommissioning	Resource Dvpt	0.68	1.14	38%
26	SPRF - maximise average group licence	Resource Dvpt	1.90	3.09	45%
33	ROYD Number 4 Borehole	Resource Dvpt	2.37	6.91	68%
63	CHES Source Optimisation	Resource Dvpt	0.00	1.09	90%
64	CHOR 4	Resource Dvpt	0.00	3.00	18%
65	DENH/UXBR New Source	Resource Dvpt	5.00	5.00	35%
66	GERR Source optimisation	Resource Dvpt	0.77	0.77	90%
67	HUGH Source Optimisation	Resource Dvpt	0.68	0.52	90%
70	LITT Source Optimisation	Resource Dvpt	0.00	0.20	50%
87	SHAK Source Optimisation	Resource Dvpt	0.00	2.63	90%
90	STON Source Optimisation	Resource Dvpt	0.00	0.41	50%
105	HADHI New Borehole	Resource Dvpt	3.35	2.55	45%
112	LOND Peak Licence Scheme	Resource Dvpt	1.13	1.13	68%
114	LUTG LGS Boreholes	Resource Dvpt	2.00	2.00	25%
130	RUNL (Chalk) Optimisation	Resource Dvpt	2.55	1.95	68%
134	VAUXI Groundwater	Resource Dvpt	4.00	4.00	68%
155	ARMI & THAX Source Optimisation	Resource Dvpt	0.09	0.27	70%
160	HEMP Source Optimisation	Resource Dvpt	0.57	1.68	90%
169	STAN Licence	Resource Dvpt	1.50	2.39	50%
342	Essex Confined Aquifer - No Storage	Resource Dvpt	5.00	5.00	45%
422	SGSK	Resource Dvpt	10.00	10.00	68%

ID	Option Name	Category	Output Ml/d Average	Output Ml/d Peak	Confidence in Benefit %
470	SCHO Relocation	Resource Dvpt	0.91	0.91	68%
483	REDB Optimisation	Resource Dvpt	0.00	0.52	90%
511	RUNGS Peak Licence	Resource Dvpt	0.00	3.00	53%
514	TEMP Peak Optimisation	Resource Dvpt	0.06	1.19	70%
548	HART Borehole - Replacement for PORT	Resource Dvpt	0.71	1.07	68%
612	ROYD Artificial Recharge	Resource Dvpt	-2.00	5.00	35%
614	EASH Peak Licence Scheme	Resource Dvpt	0.00	2.00	68%
615	WHEA Peak Licence Scheme	Resource Dvpt	0.00	2.00	68%
618	HILF Option A1 (b)	Resource Dvpt	0.00	60.00	45%
622	HILF Park Dual Pump Option	Resource Dvpt	0.00	28.00	68%
624	BWB - Slough Arm	Resource Dvpt	3.00	3.00	68%
625	BWB - Grand Union Canal	Resource Dvpt	2.00	2.00	45%
133	STEVS	Reuse	5.00	5.00	45%
603	Communal rainwater reuse	Reuse	0.88	0.88	53%
604	Communal Greywater reuse	Reuse	0.75	0.75	53%
607	Large User - Water Efficiency retrofiting	Reuse	0.31	0.31	68%
620	Large User - Rainwater harvesting	Reuse	0.05	0.05	68%
224	Rising Block Tariffs	Tariffs	12.80	12.80	53%
225	Summer Winter Tariffs	Tariffs	19.68	39.36	53%
24	ICKE Treatment Recommissioning	Treatment	0.00	11.00	75%
47	LANE 160	Treatment	0.00	28.00	50%
48	THEG Peak Licence - Watford Fields Treatment	Treatment	0.00	8.50	68%
415	ICKE Treatment Recommissioning - New Licence Option	Treatment	12.50	12.50	23%
561	NORM borehole treatment	Treatment	0.56	0.56	70%
566	NORM - Detailed Review of Process	Treatment	9.00	9.00	70%
608	RUNL (Treatment)	Treatment	0.00	3.00	70%

10.2 Key elements in our strategy compared with our previous plan

Issues			2009 Water Resources Management Plan position
Water availability	Sustainability	Water stress	Three Valleys is designated an area of ‘water stress’.
		Conjunctive use	Our final WRMP will demonstrate consistency with neighbouring water companies. We will put in place joint working agreements or supply agreements – New Thames regional storage reservoir and additional supplies from ANGL are targeted for supply post 2030.
		National Env. Programme	One scheme, the River Hiz Operating Agreement, is included for PR09. The Environment Agency is not seeking further reductions in licensed abstraction for the next five years.
		Strategic Environmental Assessment (SEA)	Our WRMP has significant potential environmental impacts thus a SEA is required.
		WFD impacts	Excluded as a regulatory driver from plan by the EA Guidelines but we have identified this as a risk in our assessment. Ofwat’s pCEA[36] work suggests substantial impacts with potential to double water prices. Extensive new water resource developments will be required to mitigate licence changes required.
		Water Reuse	Feasibility studies show how water reuse options could play a part post 2020. Gains are possible in the water cycle from decentralising sewerage treatment and installation of grey water schemes in new developments. Possible schemes are included in our options appraisal.
	Supply : Deployable Output	Aquifer yield	Our plan includes revisions to deployable output following evaluation of drought performance in 2006 and results in changes for this plan with our average demand increasing but peak demand decreasing. We have also gained from improved efficiency due to higher output from membrane treatment plants.
		Network constraints	Our 2004 programme of network enhancements has been completed and results in increased resources being available in our three water resources zones.
		Outage	Outage risk and provision is lower in 2009 than in 2004 due to improvements in reliability from capital maintenance investments and is based on evidence of unplanned and planned operational outage
		New resources	Study projects at HILF Reservoir (a confined aquifer), a new Thames Regional Storage Reservoir and ANGL remain feasible and will continue through to 2015.

[36] Ofwat’s Preliminary Cost Effectiveness Assessment (pCEA) was carried out by Ofwat with the support of water companies in 2007. This work made an assessment of potential impacts and costs of the Water Framework Directive (WFD) on water company assets and operation.

Issues			2009 Water Resources Management Plan position
Demand	Metering	Policy	A continuation of our compulsory change of occupier metering programme is to be adopted. We will trial alternative technologies and tariffs during the period to 2015 in order to prepare the ground for an accelerated programme for metering should the need arise.
		Meters	We propose to continue to use class D meters. We will target local water stress locations for trials of innovative tariffs where these are to be undertaken.
		Tariffs	Our plan includes a proposal for pilot trials of a seasonal tariff and we will explore further innovative options such as a special drought year enhanced tariff for all customers.
		Customers	We have sought the views of our customers who have expressed a preference for action to promote water savings to help customers with their lifestyle choices we have reintroduced twice yearly meter reading/billing and expect to improve bill information with benchmark consumption data.
		Impact of metering	12.5% average demand reduction assumption retained, based on best evidence to date. Peak savings have been estimated at 15%.
	Demand Forecast	Household Consumption baseline	Our studies to assess customer consumption (WATCOM1 and 2) are continuing as they help us understand our customers demand patterns for the future however we will stop these once metering reaches 70% of households. We have surveyed 10,000 customers to assess baseline consumption patterns. Our benchmark dry year assumption is 2005/6.
		Household MCC, measured and unmeasured	Based on our assessment of future changes in lifestyle our unmeasured and measured Per Capita Consumption forecasts are expected to fall over time through the influence of metering, the provision of water efficiency advice to customers and new tariffs.
		Water Efficiency	Our plan is based on a progressive programme of water efficiency promotion with baseline activity and information to supplement our metering and education programme plus research studies. Demand savings have been included from water efficiency projects where these are cost-effective compared to other measures. We have assumed public housing will adopt the Sustainable Building Code standards of 105 l/h/d internal consumption.
		Housing growth	We have reassessed forecasts and have adopted a policy scenario that is consistent with regional and local plans (central estimate). However we have allowed for policy numbers to be completed by 2025 in view of poor prospects for the housing market medium term.
		Population	CACI based but amended to reflect the effects of legal/illegal immigrants and seasonal/weekly migrants.
		Non-household forecast	We have re-assessed our customer base and assume our non-household consumption will continue to decline. This is consistent with the decline we have experienced in recent years.
		Water taken unbilled	Stable, We have updated our PR04 study on small components of the water balance and there is little change in our forecasts.
		Leakage	Our new leakage forecast shows a 30 Ml/d reduction in total leakage over the 25 year planning period.

Issues			2008 Water Resources Management Plan Position
Supply Demand investment programme	Headroom risk	Climate change	The impact of climate change on demand remains as our previous forecast of 2% increase at average in 25 years and 5% at peak. The impact on water availability shows a marked increase as our forecasts have been informed by our recent drought analyses and new modelling predictions. We have allowed for a 50 Ml/d loss of water availability by 2035.
		Pollution risk	We continue to see evidence of pollution of our sources and therefore we include the risk of further loss of output in our plans. We expect to remain active in promoting the 'polluter pays' principle to reduce costs to our customers in the longer term. Water Safety Plans (required by the Drinking Water Inspectorate to assess the risk to water quality from a wide range of factors), will allow the potential for a more proactive pollution risk minimisation to be undertaken.
		Uncertainties	An estimate of uncertainty is made for each component of supply and demand forecast
		Loss of abstraction licences	We are not able to include the risk of losing our abstraction licences in order to meet the targets for the Water Framework Directive but we have identified this as a risk in our assessment as we believe it is important to plan to maintain security of supply for those matters beyond our control.
	Economics of Balancing Supply and Demand	Economic Level of Leakage (ELL)	ELL forecast to fall substantially over the 25 year period as a result of major renewal programme, metering (SPL) and increasing cost of alternative resources
		Options appraisal	Unconstrained options are our initial schedule of schemes without considering if they are feasible or not. Constrained options are those that are considered feasible. 300 unconstrained options reduced to 104 constrained options that are used in our economic modelling. We have worked with the EA and other water companies to explore options for new regional transfers of water. Our programme suggests new supplies will be required in the long term so we are planning to reinforce our working relationships with other companies.
		Sustainability appraisal	We have included full social and environmental costs in our economic modelling and this has been symmetrically applied between supply and demand options.
		S/D investment programme	We have used an economic model that considers the least cost solution from a range of scenario's. We have evaluated the risk of schemes individually and collectively.
		CBA and stakeholder engagement	We have carried out consultations with our customers to assess the value of a range of attributes such as hosepipe restrictions and water efficiency measures so that we can align our plan accordingly. We are also seeking stakeholder views on our DWRMP.
		Security Of Supply Index (SOSI)	We will maintain our security of supply and report an index of 100 average and peak. A value of 100 means supply equals demand in a dry year.

10.3 Catchment Abstraction Management Strategy (CAMS) for our supply area and River Basin Management Plans

Our supply area falls under the licensing strategy of 11 Catchment Abstraction Management Strategy (CAMS) areas. Nine of these CAMS areas have been assessed for the resource status of both groundwater and surface water. The two CAMS area that have not been assessed are the Wey and the Maidenhead to Sunbury. The Wey CAMS is currently ongoing and the Maidenhead to Sunbury CAMS has been deferred to be included in the New Thames CAMS. These two outstanding CAMS areas cover the part of our supply area formally supplied by North Surrey Water and include our EGHS, CHERS and WALS abstractions, although these are currently included in the TCAMS for the River Thames itself.

The CAMS process designates catchments into Water Resource Management Units (WRMU) and Groundwater Management Units (GMU) and classifies these as one of four categories based on a standard resource assessment, Table 10.3. The GMU's and WRMU's differ in spatial extent due to differences in groundwater and topographic catchments. The Resource Assessment Methodology (RAM) relies on historic hydrological data and is therefore potentially limited by the availability of suitable assessment points e.g. gauging stations and their accuracy. The location of these assessment points and the length of their record relative to abstractions and discharges has the potentially to significantly bias the result of the resource assessment.

Table 10.3 : Resource Availability Status Categories

Indicative Resource Availability Status	Licence Availability
Water Available	Water is likely to be available at all flows including low flows. Restrictions may apply.
No Water Available	No water is available for further licensing at low flows. Water may be available at higher flows with appropriate restrictions.
Over Licensed	Current actual abstraction is such that no water is available at low flows. If existing license were used to their full allocation they could cause unacceptable environmental damage at low flows. Water may be available at high flows, with appropriate restrictions.
Over Abstracted	Existing abstraction is causing unacceptable damage to the environment at low flows. Water may still be available at high flows, with appropriate restrictions.

Source: Environment Agency

The Groundwater Management Units (GMU) and Integrated Water Resources Management Units (WRMU) published in the relevant CAMS documents have been reviewed for all our abstractions, Figure 2.3.1 and Figure 2.3.2. The GMU were assessed by the EA to determine the resource availability status based on the balance between recharge, abstraction and summer outflows from the groundwater unit. Surface water resources assessments have been carried out using the definition of river flow objectives based on the sensitivity of the local ecology to flow variations. These two assessments are then incorporated into a WRMU which generally cover a slightly different geographical area to the GWMU. The preliminary results for a river reach or a groundwater management unit may be overridden in order to protect a downstream river reach or underlying groundwater management unit that has a worse low flow resources availability status than its own (EA, 2006).

The majority of the our supply area has either been classified as Over Abstracted or Over Licensed with a small area of Water Available in the Confined Chalk. Fifty-four groundwater sources are classified as Over Abstracted representing around 80% of our peak licensed groundwater capacity. A further 35 groundwater sources are classified as Over Licensed with an equivalent peak licensed capacity of around 12%. We are the largest abstractor in the majority of these CAMS areas and whilst there are only limited proposed measures to alter abstractions in the short term, we consider that there remains significant potential for future reductions to meet CAMS and Water Framework Directive targets linked to River Basin Management Plans.

A number of CAMS documents have identified measures to be carried out within the first CAMS cycle (a 6-year period). These measures include a reduction in actual abstraction and the implementation of Hands Off Flows (HOF). Where a reduction abstraction has been identified we consider that these are ambitious given the mismatch of the CAMS cycles, the 5 year Business Planning process, company Water Resources Plans and the Water Framework Directive. However, for the AMP5 period we have been told by the EA that there are no sustainability reductions required, despite the CAMS classification. There may however be a requirement to undertake additional investigations during this period, for as yet unspecified locations, to prepare for such reductions in AMP6 and beyond.

Licensing Strategy

Only two Groundwater Management Units have been designated as having Water Available (Highlighted blue on the Figures). The Confined Chalk and Lower Greensand of the Mole WRMU4, which is currently under re-evaluation by the EA, and the Confined Chalk of the Roding, Beam and Ingrebourne (RBI) GWMU1. Groundwater investigations in the mid 1990s in the Confined Chalk of the RBI identified that there was limited potable water in this area due to water quality constraint. This is therefore unlikely to provide a suitable resource for new groundwater abstractions of any significant volume, despite the classification of water available. However, we are continuing to research this area as part of the Essex confined Chalk aquifer investigations.

Colne

The Colne Cams Area is classified as Over Abstracted and accounts for some 38% of the Companies peak DO capability, around 422 Ml/d. The CAMS process has identified a recovery of 5Ml/d of actual abstraction over the 6 year CAMS cycle for WRMU1. This is not considered to be the full volume of resources required to be recovered but it was recognised that this would not be feasible within the six-year CAMS cycle. The Water Resources Licensing Officers have recorded that just under 1 Ml/day has been recovered in the last year (2006-7) in the area through voluntary reductions and water efficiency measures. Therefore the EA consider that 5 Ml/d is an achievable target over this 6 year CAMS cycle in this catchment, however they do not state how this remainder will be achieved. A HOF (Hands Off Flow) of Q50 at Kingston (on the River Thames) will also be imposed for any new abstractions, thus limiting the period over which any water will be available, which will include droughts when river flows are naturally low .

North London
The Confined Chalk of Lower Colne/North London CAMS has been classified as over licensed. However, due to the complexity and large area covered by the confined chalk aquifer it was decided that no one policy statement could be applied and that applications would be subject to a local impact assessment. Experience has demonstrated that individual well outputs from this part of the aquifer system are low and that water quality is poor, requiring treatment/blending. This CAMS only accounts for less than one percent of the Company's peak DO.

Upper Lee
The Upper Lee CAMS is predominantly classified as Over Abstracted at the WRMU level and accounts for some 17% of the Companies peak DO capability, around 194 Ml/d. The CAMS process has identified a recovery of 5Ml/d over the 6-year CAMS cycle. It is recognised that the majority of abstraction in the catchment is for public water supply. Water efficiency is considered to be the main option for this recovery of this volume although the document details little on how this will be achieved. It is recognised that this will not reduce licensed abstraction and that any reduction may actually be taken up by increase in demand from housing growth.

Thame and South Chiltern
The Thame and South Chilterns WRMU3 (River Wye and unconfined Chalk) which covers a small area to the West of our supply area, has no recovery of licensed volume identified. The target for this Management Unit remaining at 'Over Licensed' with no water available at low flows and any new consumptive licence will be subject to HOF (Hands Off Flow) of Q50 at Kingston Gauging Station, again limiting the period over which any water will be available. This area only accounts for 0.16% of the Company's peak DO.

Cam and Ely Ouse
The Upper Cam Chalk has been assessed as Over Abstracted with the target of remaining at this status for the next 2 CAMS cycles. The EA propose not to take any action against existing abstractions in this Management Unit unless action is needed under the Restoring Sustainable Abstraction programme (RSAP). A HOF will be assigned to their corresponding local gauging station to any new licences issued, which will restrict water availability during droughts. This area accounts for approximately 1% of the Companies peak DO.

Upper Ouse and Bedford Ouse
The Upper Ouse and Bedford Ouse WRMU6 (River Hiz) have been assessed as having a resource availability status of Over Licensed at low flows. If licensed holders were to fully utilise their licensed volumes this Unit would become Over Abstracted. It is recognised that the Hiz Alleviation of Low Flow (ALF) Scheme mitigates the impact of our public water supply groundwater abstraction. The aim for this management unit is to prevent it becoming Over Abstracted and therefore the aim is to maintain the current resource status. Any increase in actual abstraction within current licenses would be against this aim but it is unclear how the EA will enforce this target. This area accounts for approximately 2% of the Company's peak DO.

The Combined Essex CAMS
This CAMS area includes both North and South Essex. The company has a limited number of abstractions in the North Essex area which are generally small in volume but of significant local importance, accounting for around 0.7% of peak DO. Our

abstractions fall under WRMU 1 (Pant/Blackwater, Ter, Roman/Layer, Wid, Brain and Chelmer) and also Groundwater Management Unit 7 (Confined Chalk). The groundwater for both these management units is classified as Over Abstracted with a target of staying at Over Abstracted over the next CAMS cycle. The licensing strategy therefore means that no further consumptive abstraction licences will be granted and the potential for time limited licences to have more restricted terms imposed. The EA will be writing to licence holders to request voluntary reductions and will inform licence holders who have not used their licence for more than 4 years that they are minded to revoke them. Licence holders are also to be encouraged to build storage reservoirs to ease the pressure of water resources in times of low flows.

The Wey CAMS

Water Resource Management 7 (Lower Wey Chalk) has been classified as Over Licensed with a target to become 'less over licensed' as it was considered unachievable to move to 'no water available' before 2019 due to the size of the resource deficit. The licensing strategy means that no new consumptive licenses will be granted and existing licence holders will be encouraged to make voluntary reductions and to promote water efficiency. This area constitutes approximately 2% of the Company's peak DO.

Thames Corridor Abstraction Management Strategy (TCAMS)

The TCAMS area covers the river and adjoining shallow groundwater gravel system and accounts for some 37% of the Companies peak DO, around 418Ml/d, from both surface and groundwater. The Lower Thames is classified as Over Abstracted, The preferred strategy is to move from *Over Abstracted* to *Over Licensed.* To achieve this, abstraction above Teddington would need to be reduced by 940Ml/d. This is unlikely to be feasible and therefore should remain at *Over Abstracted*.

10.4 River Basin Management Plans

The Water Framework Directive requires the establishment of River Basin Management Plans (RBMP), which uses the classification of different aspects of both surface and ground waters to establish the status of these waters. These run over 6 year periods, the first starting in 2009. A Programme of Measures will be developed to deal with each of the aspects identified during the classification process and as highlighted in the Significant Water Management Issues Reports produced for each river basin district. For the Thames Basin, the following 7 issues have been identified. Low flow and depleted groundwater due to abstraction, Physical Modification, Diffuse Pollution–Rural, Diffuse pollution-Urban & transport, Urban Development, Alien Species and point source pollution.

These plans are still being formulated by the Environment Agency, and are only now being rolled out. The mismatch in timings between these works and the AMP planning cycle mean that we are currently unable to specify what works or investigations that may be in these plans that we may be required to undertake.

We understand that the focus will be on no deterioration during the first planning cycle. In abstraction terms, this will result in pressures to reduce licenses to current outputs (not the outputs themselves). This has been confirmed by a letter from the Environment Agency stating there are no sustainability reductions that we must allow for during the AMP5 period. Many of our current and future scheme options rely on taking DO closer to license, which will result in a net increase in abstraction, which could be deemed to be derogation in already stressed areas. This is a significant threat to our plans for increasing our resource base. Additionally, there may be a requirement for us to reduce abstraction in some areas in future. We are currently unaware of where or how much such reductions may be. However, if such reductions are required, then we will have to make provision for investigations and works during AMP5 due to the long lead times associated with replacement of such losses. If such indicators are available in time, then a provision will be made in the draft business plan to be submitted later this year, but it is possible that such information will not become available until December 2008 when the plans are published, and thus will only be able to be included in the final water resources and business plans. One indicator of the potential impact of such reductions in DO forms part of the sensitivity analyses and looks at a 20% reduction in our DO due to these pressures. The preliminary cost effectiveness assessment (pCEA) work at national level has already demonstrated the potential costs of such measures.

Not all measures will be directed at the Water Companies, but water efficiency and demand reduction measures will feature highly in addition to additional leakage management, customer education and alternative resource developments. Our preferred strategy of accelerated compulsory metering is consistent with our stated intentions of protecting the environment wherever possible. The demand savings attributed to metering will go some way to alleviating environmental stress in over licensed/abstracted catchments.

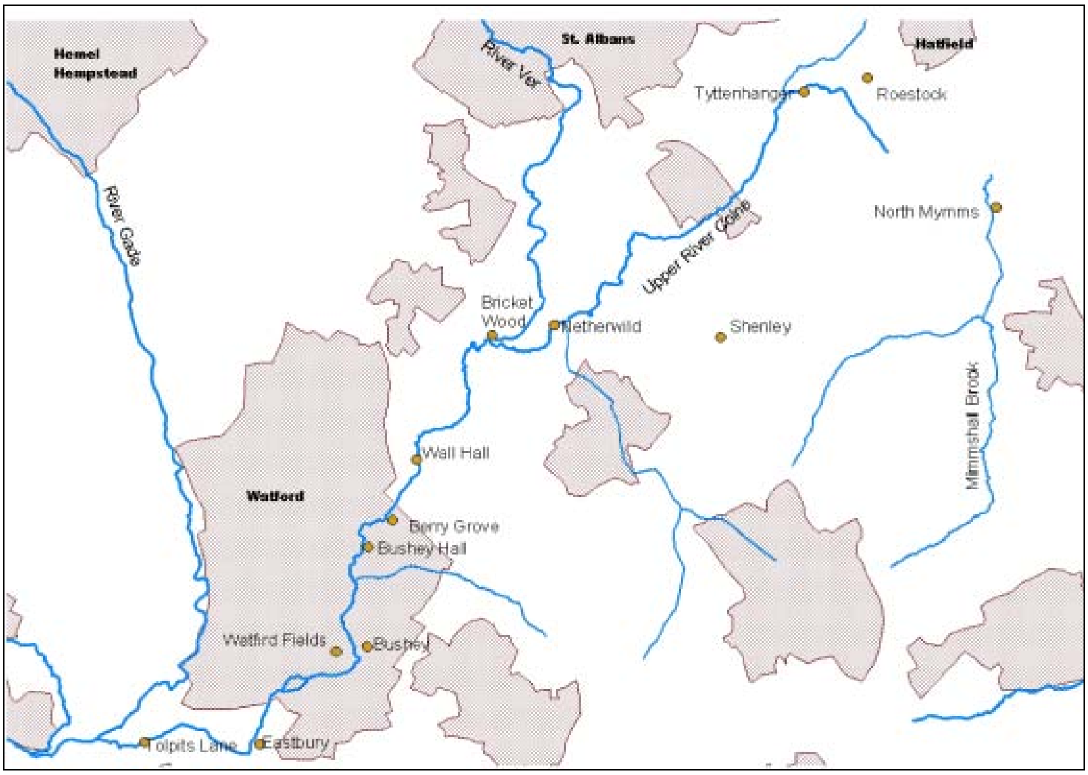
10.5 AMP5 NEP Programme

10.5.1 Upper Colne investigation

This is an investigation into the impact of our groundwater abstractions in the Upper River Colne on river flows, under a biodiversity (BAPw1) driver. The Colne receives a significant proportion of flow from chalk groundwater and is defined as a chalk river, which is listed as a priority habitat under the UK Biodiversity Action Plan. For the purpose of this study, the Upper Colne has been defined as the reach of river from the ephemeral source at Colney Heath, south of Hatfield, to upstream of the Gade confluence to the west of Watford and the area is illustrated in Figure 9. The EA have undertaken an initial Restoring Sustainable Abstraction Programme (RSAp) investigation on the Upper Colne and have identified that there is a potential impact from our abstractions on flows in the River Colne.

A total of 13 sources have been identified for investigation with a total peak licensed capacity of 316.64Ml/d and a drought peak Deployable Output (DO) of 156.58Ml/d and a normal peak DO of 168.58Ml/d. The findings from this investigation will therefore have the potential to significantly influence availability of our water resources into the future.

Figure 10.5.1: Location of Upper River Colne



The investigation will include a hydro-ecological assessment of the current conditions, reviewing historic studies and collecting new environmental monitoring data to establish current conditions. It is anticipated that the work will require groundwater modelling, pumping tests at our sources and land use assessments.

This work has been costed based on our experience of undertaking similar AMP3 and AMP4 investigations of other catchments. This new investigation includes a much greater number of sources, including those of strategic importance and will therefore be a much larger piece of work than those investigations undertaken to date. There are also three WFD investigations identified for the Upper Colne. This has been included in the Upper Colne investigation with costs limited at present to the assessment of the abstractions on meeting Good Ecological Status (GES), as we have been provided no specific details by the EA.

10.5.2 Misbourne options appraisal

The River Misbourne is a chalk river that rises at the village of Great Missenden and flows to the southeast to meet the River Colne at Denham, a distance of 28km. It's general location is shown in Figure 10.5.1. This scheme has been identified under a biodiversity (BAPw1) driver as it is defined as a chalk river which is listed as a priority habitat under the UK Biodiversity Action Plan.

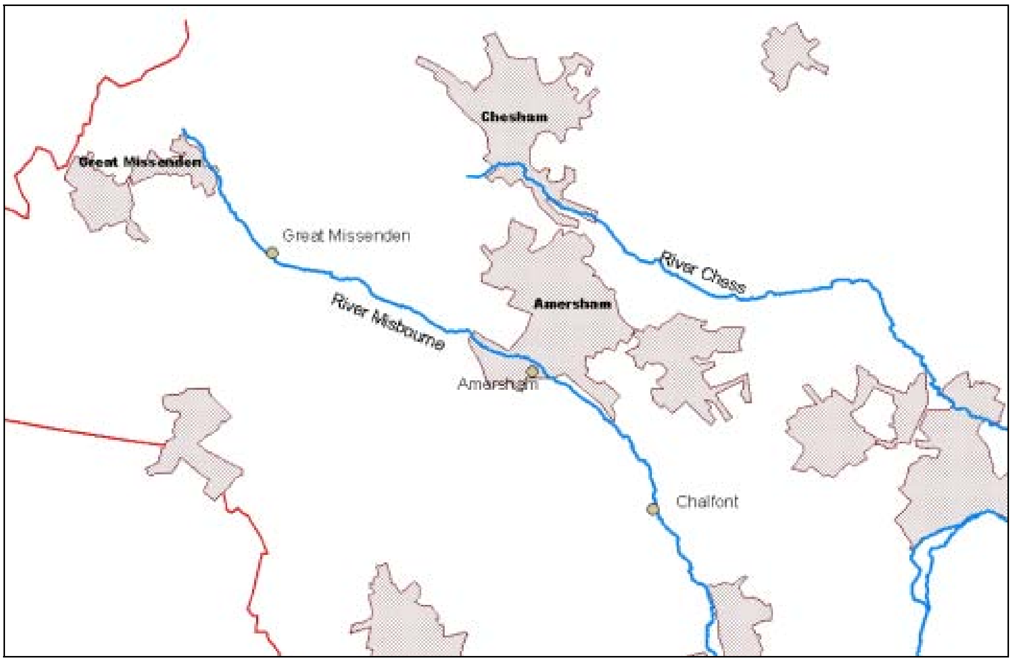
Three of our sources at Great Missenden, Amersham and Chalfont will be included in these investigations. They have a peak licensed volume of 28.41Ml/d and a peak DO of 23.88Ml/d (normal and drought).

Low flows in the Misbourne were investigated by us during AMP1 and also by Thames Water and the EA. An implementation scheme followed, including infrastructure work and an 8Ml/d reduction in Public Water Supply (PWS) abstraction from our sources at AMER, GREM and CHAL. A further reduction in abstraction was implemented by Thames Water at the head of the Misbourne. A licence variation and operating agreement was completed in AMP3 for our Misbourne Group of sources with a time limited licence variation also secured for an equivalent 8Ml/d increase in the Blackford Group of sources in the Mid-Colne (see RSA-THNE-28/02 Mid Colne and RSA-THNE-28/19 Mid Colne Lakes investigations below).

Whilst it is accepted that the reduction in abstraction in the Misbourne Valley has been a success and has improved low flows, the River is considered to still suffer from low flows and a further reduction in abstraction maybe required.

A scheme has been put forward by the EA for options appraisal. This scheme will therefore involve reviewing all the studies to date and looking at options and the cost benefits of implementing a further reduction in abstraction at Great Missenden, Amersham and Chalfont. This work has been costed based on the AMP4 options appraisal work on the River Gade.

Figure 10.5.2: Location of River Misbourne



10.5.3 Ver options appraisal

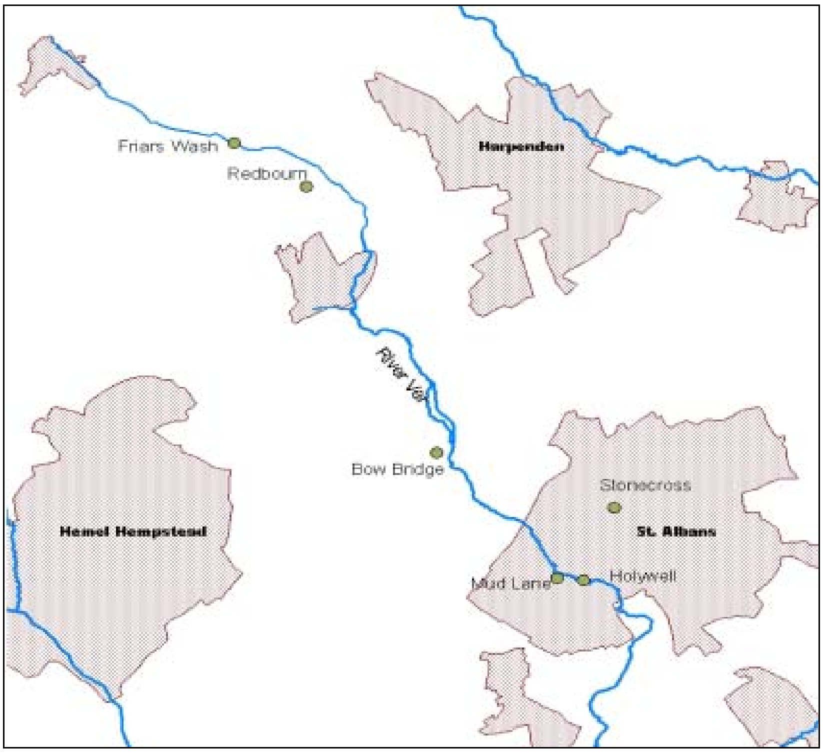
The River Ver is a chalk river that has its ephemeral source near Kensworth Lynch (south of Luton) and flows in a south easterly direction for approximately 25km to its confluence with the River Colne at Bricketwood, just to the south of the area shown on Figure 10.5.3. The scheme has been included under a biodiversity (BAPw1) driver as it is defined as a chalk river which is listed as a priority habitat under the UK Biodiversity Action Plan.

We have 7 sources in this catchment that have a cumulative DO of 52.49Ml/d and a peak licence of 62.5Ml/d.

Studies undertaken in the 1980's concluded that low flows were attributable to an increase in groundwater abstraction within the catchment. Groundwater abstraction was reduced at FRIA Pumping Station (28/39/28/0130) from 15.9M/d to emergency use only in 1993. Current investigations have concluded that the Ver continues to suffer from low flows.

This scheme put forward by the EA requires options appraisal of both the Upper and Middle Ver, covering a reach of the river 13.2km in length. The objective of the project is the identification of an appropriate scheme to improve the flow regime within the River Ver from its Source to Verulam Park (St. Albans) to enable the enhancement and establishment of the characteristic habitats, plants and animals of chalk streams, and to establish a sustainable abstraction regime within the catchment to support the above objective. The new abstraction regime needs to be designed to redress the impact on the local environment resulting from the present abstraction regime. This work has been costed based on the AMP4 options appraisal work on the Gade.

Figure 10.5.3: Location of the River Ver



For the Final Business Plan, the EA added another investigation on the Upper Ver (see GB106039029920 Upper Ver), which was requested to be dealt with as a separate scheme (see 4.4.7 below). However, results from this investigation will be especially valuable for the evaluation of the different options along the whole length of the river. It is, therefore, prudent that we undertake the Ver investigation before we proceed to the options appraisal, always within timeframes set by the EA.

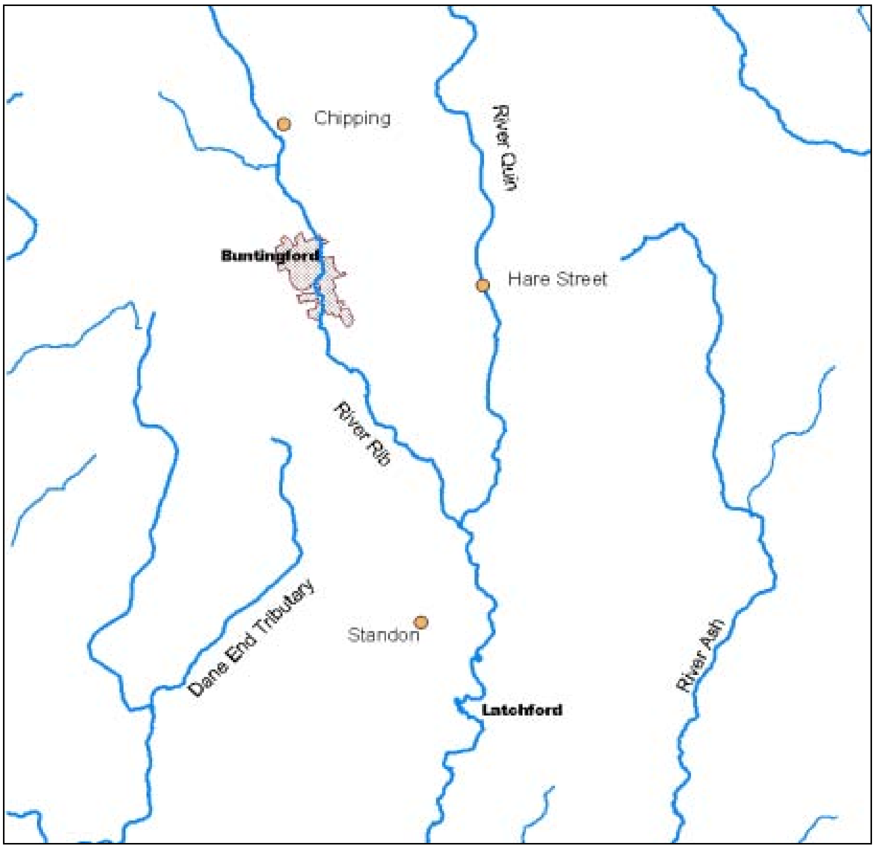
10.5.4 Mid Rib investigation

The River Rib has been classified as a chalk river, despite exhibiting flow characteristics of a flashy boulder clay catchment. The scheme has been included under a biodiversity (BAPw1) driver as it is defined as a chalk river and as such listed as a priority habitat under the UK Biodiversity Action Plan. The Rib upstream of the hamlet of Latchford has been identified as potentially being affected by abstraction and is shown in Figure 12.

This investigation will look at the impact of our CHIP, STAD AND HARS Pumping Stations, with a total peak licensed volume of 11.82Ml/d and drought and normal peak DO of 8.32Ml/d on flows in the Upper/Mid Rib. The investigation will require us to undertake hydro-ecological monitoring, which we have costed based on experience gained in similar projects undertaken during AMP3 and AMP4.

The EA have identified a reach of 12.3km to be investigated. The River Rib has been recorded by the EA as suffering from low flows during summer months and drought conditions, resulting periodically in the headwaters and tributaries running dry. This affects the biological potential of the river with available habitat subsequently reduced to isolated pools.

Figure 10.5.4: Location of River Rib



10.5.5 Mid Colne River and Lakes investigation

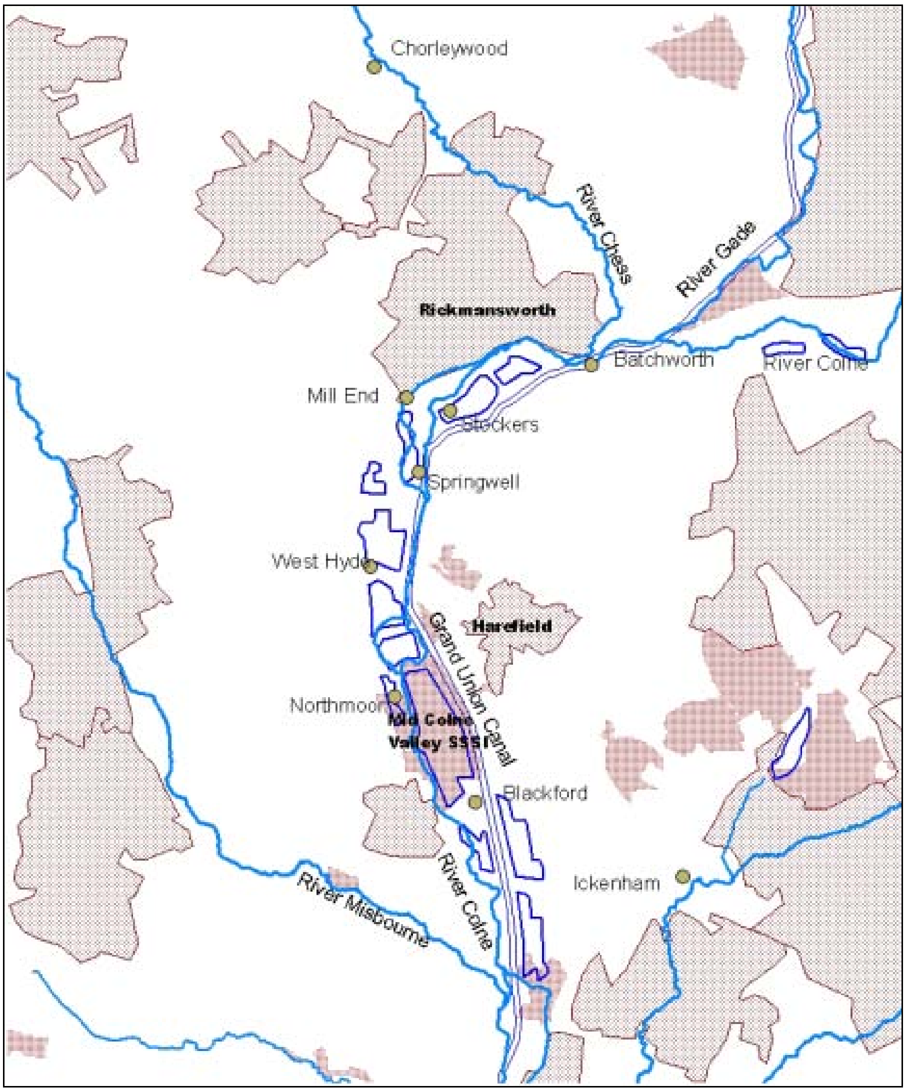
The Mid Colne River for the purpose of this scheme is defined as the River Colne from the confluence with the Gade to confluence with the Misbourne, a length of approximately 8km. This reach of the Colne is linked with the water of the Grand Union Canal and also the Middle Colne Lakes. The Middle Colne Lakes are a series of 18 water bodies formed from historic gravel extraction along the valley floor. The Colne is classified as a chalk stream and has therefore been allocated a BAPw1 driver.

The EA have undertaken an initial Restoring Sustainable Abstraction programme (RSAp) investigation on the this area and have identified that there is a potential impact from our abstraction at Chorleywood, BATC, MILE, STOC, SPRW, WESY, NORO, BLAF and ICKE on both river flows and lake levels.

These abstractions have a total peak licensed volume of 146.14Ml/d and a peak DO of 121.84Ml/d (drought and normal) and include the 8Ml/d transferred from the Misbourne catchment as part of the earlier implementation of the Misbourne ALF scheme.

The lakes are used for a variety of recreational purposes including angling and sailing, as well as having local and national importance in terms of their biological interest. There is one Site of Special Scientific Interest (SSSI) in the reach to be investigated, the Mid Colne Valley SSSI which includes Allen Lake and Broadwater and covers an area of 2.3km^2. This scheme is therefore also allocated an Iw3 driver due to the SSSI designation.

Figure 10.5.5: Location of Mid Colne River and Lakes



The Ickenham source has been out of service for a number of years due to contamination from the adjacent New Years Green Landfill site. The designation of this site through Part IIA would allow the installation of suitable treatment, under the polluter pays principle. To date, neither the Local Authority (who operate the site) nor the EA have classified this land as contaminated. We have long believed that the EA should use its powers to designate the site and break the current stalemate and move towards resolving this problem. Due to its location away from the valley floor, this source is considered to have limited impact on the area of interest (River Colne and Lakes), and would thus benefit flows in the Middle Colne if it could be returned to service by changing the pattern of abstraction.

The EA's RSAp investigations concluded that a relationship exists between abstractions to the north of the SSSI site and upstream lakes and the River Colne. The report however concluded that for the River Colne there was insignificant data to determine the impact of groundwater abstractions on flows between Batchworth and

Denham. Further investigations undertaken by the Environment Agency in 2007 as part of an annual review of abstraction licences in the area have concluded that there is a potential relationship between, or a potential for abstractions to negatively influence lake levels and river flows. The investigations have concluded that a further monitoring programme needs to be developed to gain to gain a better understanding of the hydrology / hydrogeology and the requirements of the lakes and the River Colne and to assess any potential improvement measures.

10.5.6 Upper Ver investigation

The EA have added a new investigation to the original list that was given to us for the draft business plan. This requires an investigation on the Upper Ver. The driver for this scheme is the WFD for Water Resources Investigations to help deliver Good Ecological Status.

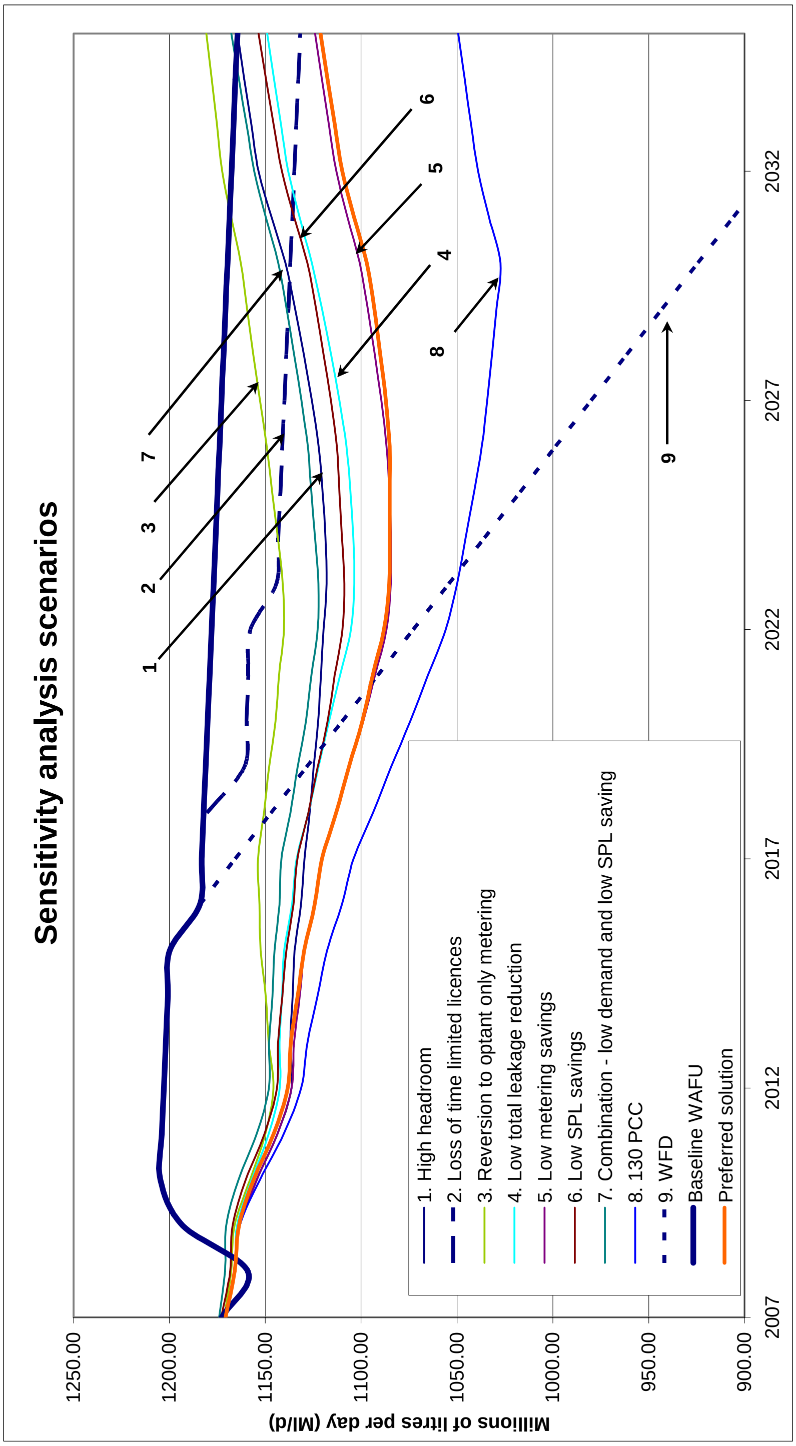
The objective of the investigation is to quantify the impact of our abstractions on the upper reaches of the river. The abstractions associated with this part of the river are REDB, FRIAand KENS, which operate under an emergency operation agreement, as mentioned in Ver Options Appraisal description (4.4.5). The total peak licensed volume of theses sources is 27.27Ml/d and the drought and normal peak DO is 25.11Ml/d. These volumes are included in the totals given in 4.4.5 above. The impact assessment will include desk study, hydro-ecological monitoring and review of the Vale of St Albans Groundwater Model. The costing of the components of the investigation was completed using our AMP3 and AMP4 experience of similar studies.

This investigation focuses on the upper reaches of the river and it should precede the options appraisal, which focuses on the upper and lower reaches. Thus the results of the investigation can be taken into account when assessing the different options for achieving

10.6 Sensitivity analysis

The following pages outline the results of our sensitivity analyses.

Figure 10.6.1 : Comparative presentation of the effects of the different scenarios on water available for use and demand (plus headroom)



10.6.1 High headroom

Under this scenario a small deficit occurs at the end of the planning period in our northern and southern water resources zones which requires £2m of schemes to close. No deficit occurs in the central water resources zone.

Schemes selected include a range of demand reduction, water resources, leakage and water efficiency schemes.

Total NPV of Capex and Opex is estimated at £0.95 millions.

Table 10.6.1a : Total Capex of selected schemes – Scenario 1

Zone No	Zone Name	Implementation Year	Option ID	Option Name	Total Capex	
1	Northern_Zone	2032/33	33	ROYD Number 4 Borehole	£	375,551
1	Northern_Zone	2035/36	Group 2c	Options(155,604,428,185,567)	£	492,741
1	Northern_Zone	2035/36	155	ARMI & THAX Source Optimisation	£	19,615
1	Northern_Zone	2035/36	604	Communal Greywater reuse	£	64,530
1	Northern_Zone	2035/36	428	Leakage Control - New Detection Technologies	£	91,592
1	Northern_Zone	2035/36	185	Commercial Water Audits	£	49,204
1	Northern_Zone	2035/36	567	Community water efficiency scheme	£	267,799
1	**Northern_Zone**	**2035/36**	**ZONE: 1**	**ALL OPTIONS**	**£**	**868,292**
3	Southern_Zone	2035/36	Group 1b	Options(428,185,567,569,604,573,388,636)	£	557,850
3	Southern_Zone	2035/36	428	Leakage Control - New Detection Technologies	£	48,849
3	Southern_Zone	2035/36	185	Commercial Water Audits	£	26,242
3	Southern_Zone	2035/36	567	Community water efficiency scheme	£	142,826
3	Southern_Zone	2035/36	569	Targeted Water Efficiency promotion -Housing Associations	£	14,627
3	Southern_Zone	2035/36	604	Communal Greywater reuse	£	34,416
3	Southern_Zone	2035/36	573	Hose gun triggers (targeted DMAs)	£	41,729
3	Southern_Zone	2035/36	388	New Cistern Displacement Devices	£	149,468
3	Southern_Zone	2035/36	636	Leakage reduction - Pressure management	£	99,692
3	**Southern_Zone**	**2035/36**	**ZONE: 3**	**ALL OPTIONS**	**£**	**1,115,701**
				Total	**£**	**1,983,993**

Figure 10.6.1a : Supply and demand balance, Annual Average, Northern Zone

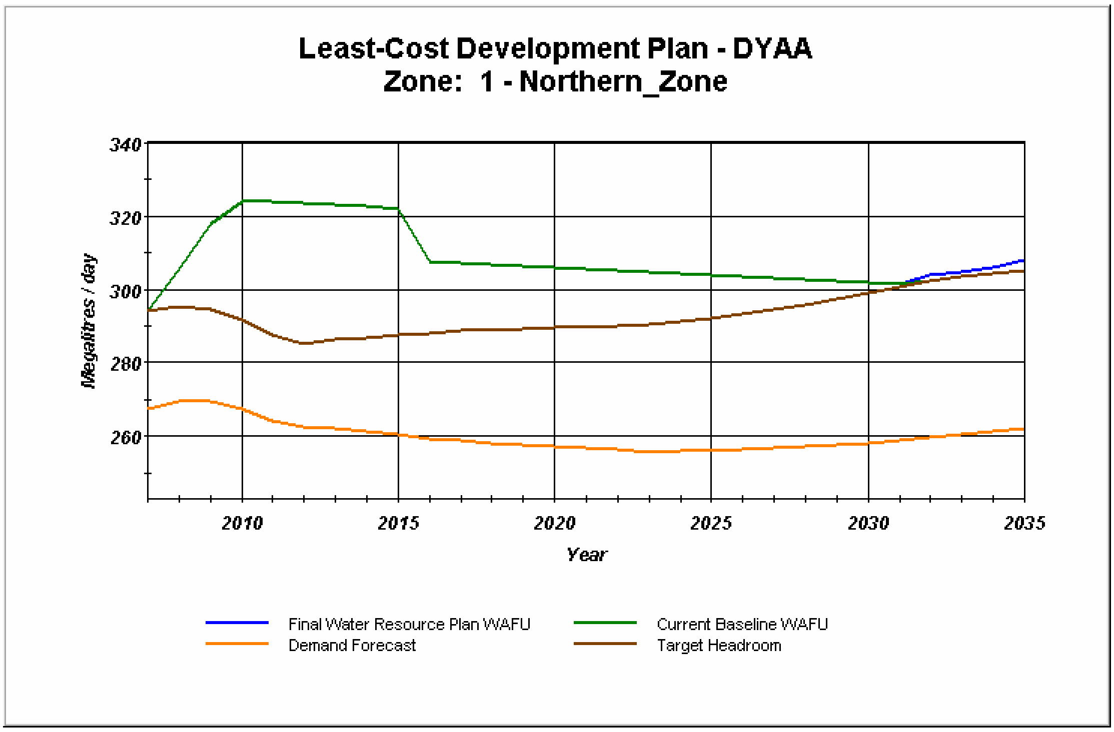


Figure 10.6.1b : Supply and demand balance, Critical Period, Northern Zone

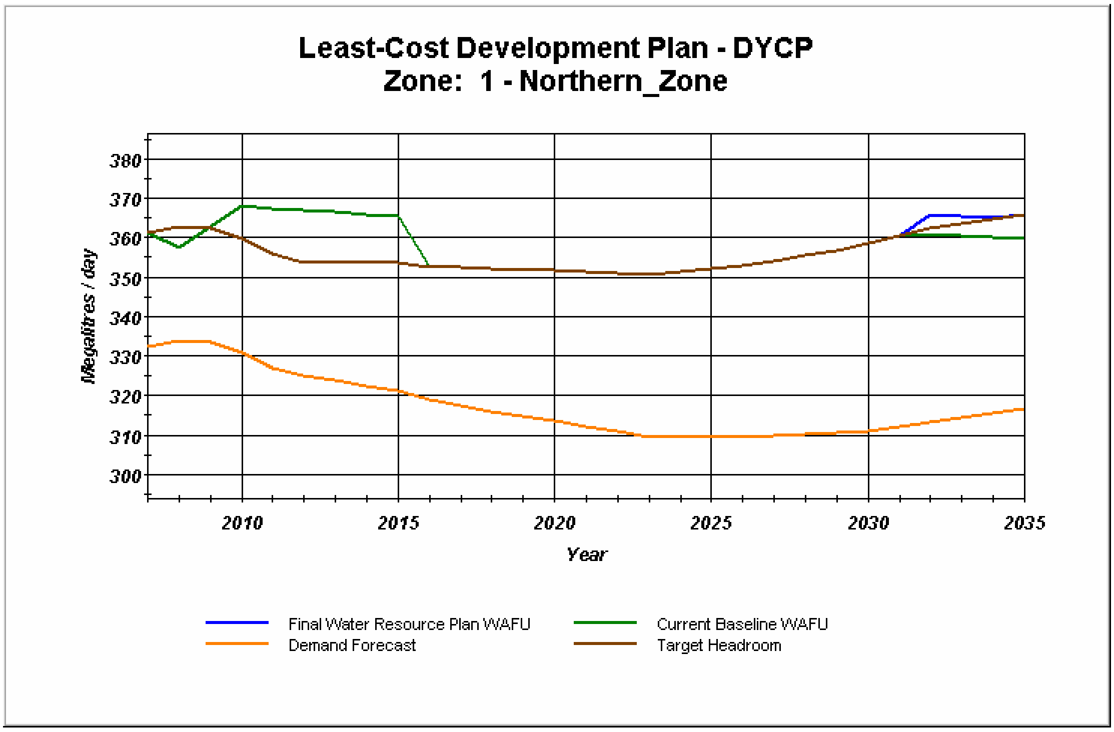


Figure 10.6.1c : Supply and demand balance, Annual Average, Southern Zone

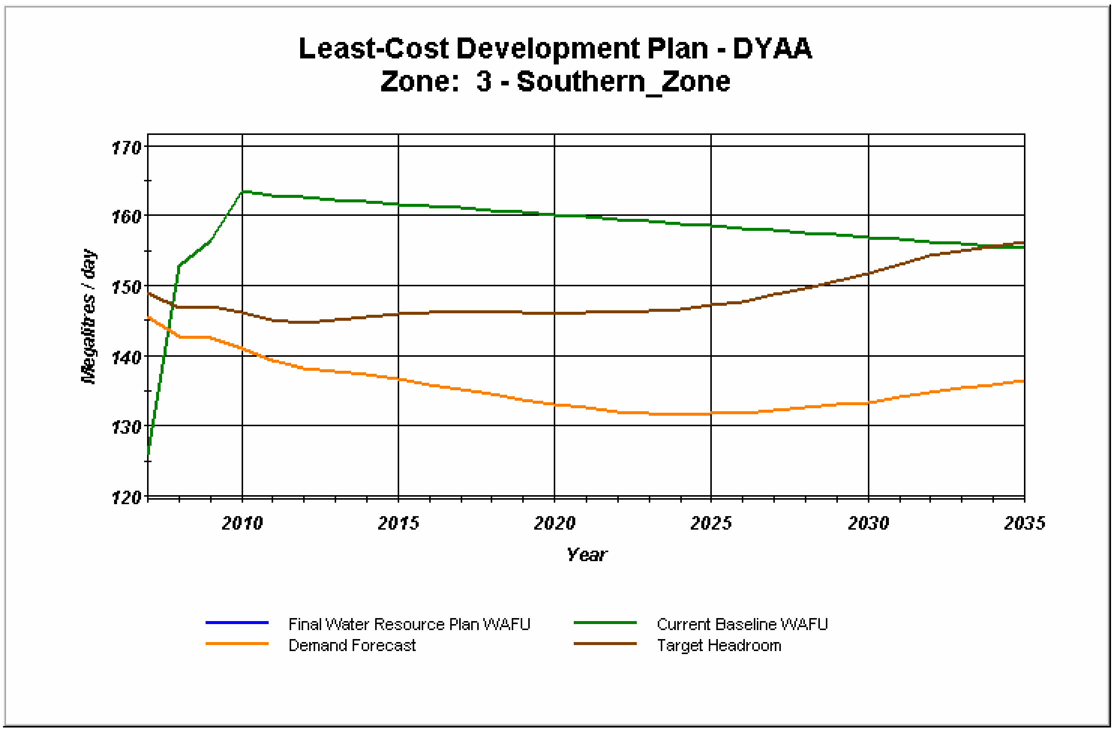


Figure 10.6.1d : Supply and demand balance, Critical Period, Southern Zone

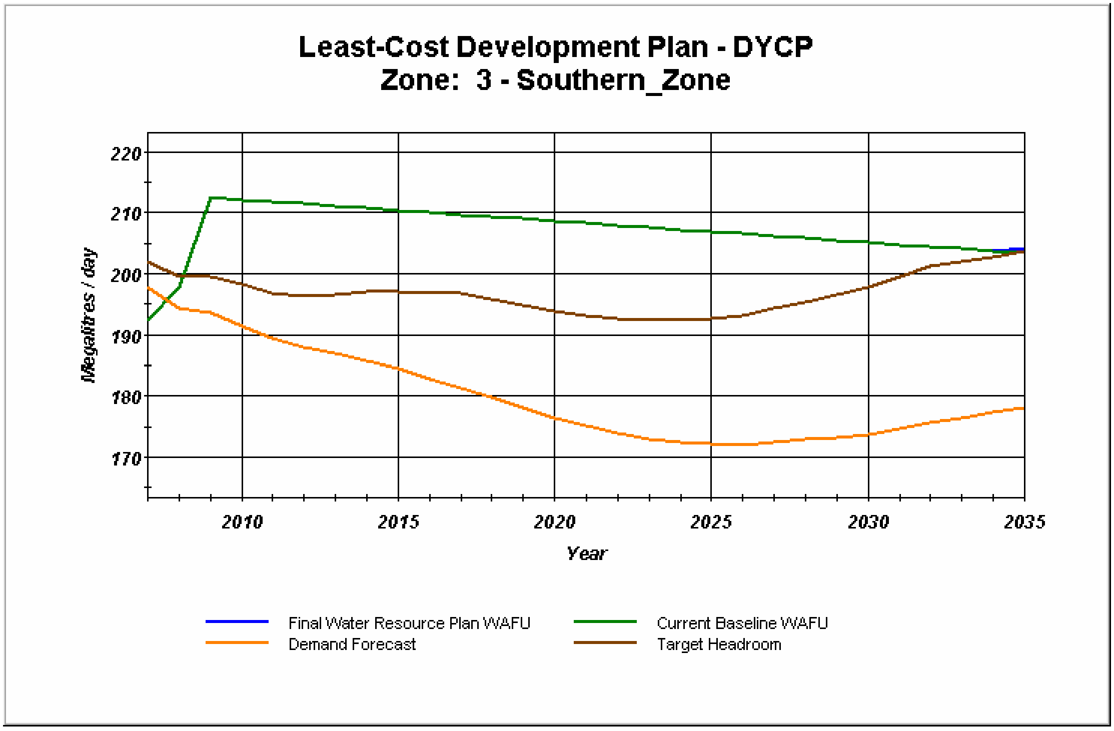


Table 10.6.1b : Net Present Value of costs for selected schemes – Scenario 1

Option ID	Option Name	Average Yield (Ml/d)	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
33	ROYD Number 4 Borehole	1.6	£ 227,184	£ 378,159	£ 44,656	£ 649,999
Group 2c	Options(155,604,428,185,567)	1.23	£ 165,971	£ 1,928	-£ 42,146	£ 125,752
155	ARMI & THAX Source Optimisation	0.06	£ 6,527	£ 1,928	£ -	£ 8,454
604	Communal Greywater reuse	0.23	£ 23,492	£ -	-£ 5,955	£ 17,538
428	Leakage Control - New Detection Technologies	0.32	£ 30,476	£ -	£ -	£ 30,476
185	Commercial Water Audits	0.08	£ 16,372	£ -	-£ 6,920	£ 9,452
567	Community water efficiency scheme	0.54	£ 89,105	£ -	-£ 23,960	£ 65,145
ZONE: 1	**ALL OPTIONS**	**2.83**	**£ 393,155**	**£ 380,086**	**£ 2,509**	**£ 775,751**
Group 1b	Options(428,185,567,569,604,573,388,636)	0.9	£ 186,692	£ 11,133	-£ 25,272	£ 172,553
428	Leakage Control - New Detection Technologies	0.17	£ 16,254	£ -	£ -	£ 16,254
185	Commercial Water Audits	0.04	£ 8,732	£ -	-£ 3,557	£ 5,175
567	Community water efficiency scheme	0.29	£ 47,523	£ -	-£ 12,315	£ 35,208
569	Targeted Water Efficiency promotion -Housing Associations	0.02	£ 4,867	£ -	-£ 629	£ 4,238
604	Communal Greywater reuse	0.04	£ 12,529	£ -	-£ 3,176	£ 9,354
573	Hose gun triggers (targeted DMAs)	0.05	£ 13,885	£ -	-£ 2,345	£ 11,539
388	New Cistern Displacement Devices	0.18	£ 49,733	£ -	-£ 8	£ 49,725
636	Leakage reduction - Pressure management	0.11	£ 33,171	£ 11,133	£ -	£ 44,304
ZONE: 3	**ALL OPTIONS**	**0.9**	**£ 186,692**	**£ 11,133**	**-£ 25,272**	**£ 172,553**
	Total	**3.73**	**£ 579,847**	**£ 391,220**	**-£ 22,762**	**£ 948,304**

10.6.2 Loss of time limited licences

Under this scenario, a 14 Ml/d deficit is incurred at the end of the planning period in our Northern water resources zone which is where all the licences affected are located.

No deficit occurs in either the central or the southern water resources zone. A small deficit occurs in our Northern water resources zone which will be met by increased transfers from other water resources zones at elevated marginal cost.

In order to assess the true impact on our system, including the financial impact of the creation of stranded assets and the necessary installation of bulk transfer mains to enable levels of service to be maintained in the areas affected, we have made an allowance of £2 million per Ml of licence lost and therefore since 30 Ml/d of licence is affected, the total Capex for this scenario is estimated to be £60 millions.

10.6.3 Reversion to Optant only metering

Under this scenario, plans for a continuation of our previous compulsory Change of Occupier metering policy to achieve 90% meter penetration by 2030 are not approved by our financial regulator and we therefore revert to an Optant only metering policy at a rate which our customers demand.

Under this scenario deficits occur in both our Northern and Southern water resources zones towards the end of the planning period which require £5.1 million worth of schemes to close (in terms of total Capex). No deficit occurs in the central water resources zone.

Schemes selected include a range of demand reduction, water resources, leakage and water efficiency schemes.

Total NPV of Capex and Opex is estimated at £4.6 millions.

Table 10.6.3a : Total Capex of selected schemes – Scenario 3

Zone No	Zone Name	Implementation Year	Option ID	Option Name	Total Capex	
1	Northern_Zone	2028/29	612	ROYD Artificial Recharge	£	856,807
1	Northern_Zone	2029/30	Group 2c	Options(604,428,185,155,569,169)	£	422,368
1	Northern_Zone	2029/30	604	Communal Greywater reuse	£	64,530
1	Northern_Zone	2029/30	428	Leakage Control - New Detection Technologies	£	91,592
1	Northern_Zone	2029/30	185	Commercial Water Audits	£	49,204
1	Northern_Zone	2029/30	155	ARMI & THAX Source Optimisation	£	19,615
1	Northern_Zone	2029/30	569	Targeted Water Efficiency promotion -Housing Associations	£	27,425
1	Northern_Zone	2029/30	169	STAN Licence	£	170,001
1	Northern_Zone	2030/31	31	ARKS/BUGR Transfer Maximising ARKN	£	1,070,872
1	**Northern_Zone**	**2030/31**	**ZONE: 1**	**ALL OPTIONS**	**£**	**2,350,046**
3	Southern_Zone	2034/35	Group 1c	Options(428,185,567,569,604,573)	£	308,690
3	Southern_Zone	2034/35	428	Leakage Control - New Detection Technologies	£	48,849
3	Southern_Zone	2034/35	185	Commercial Water Audits	£	26,242
3	Southern_Zone	2034/35	567	Community water efficiency scheme	£	142,826
3	Southern_Zone	2034/35	569	Targeted Water Efficiency promotion -Housing Associations	£	14,627
3	Southern_Zone	2034/35	604	Communal Greywater reuse	£	34,416
3	Southern_Zone	2034/35	573	Hose gun triggers (targeted DMAs)	£	41,729
3	Southern_Zone	2035/36	560	LADY Optimisation	£	2,469,392
3	**Southern_Zone**	**2035/36**	**ZONE: 3**	**ALL OPTIONS**	**£**	**2,778,082**
				Total	**£**	**5,128,128**

Figure 10.6.3a : Supply and demand balance, Annual Average, Northern Zone

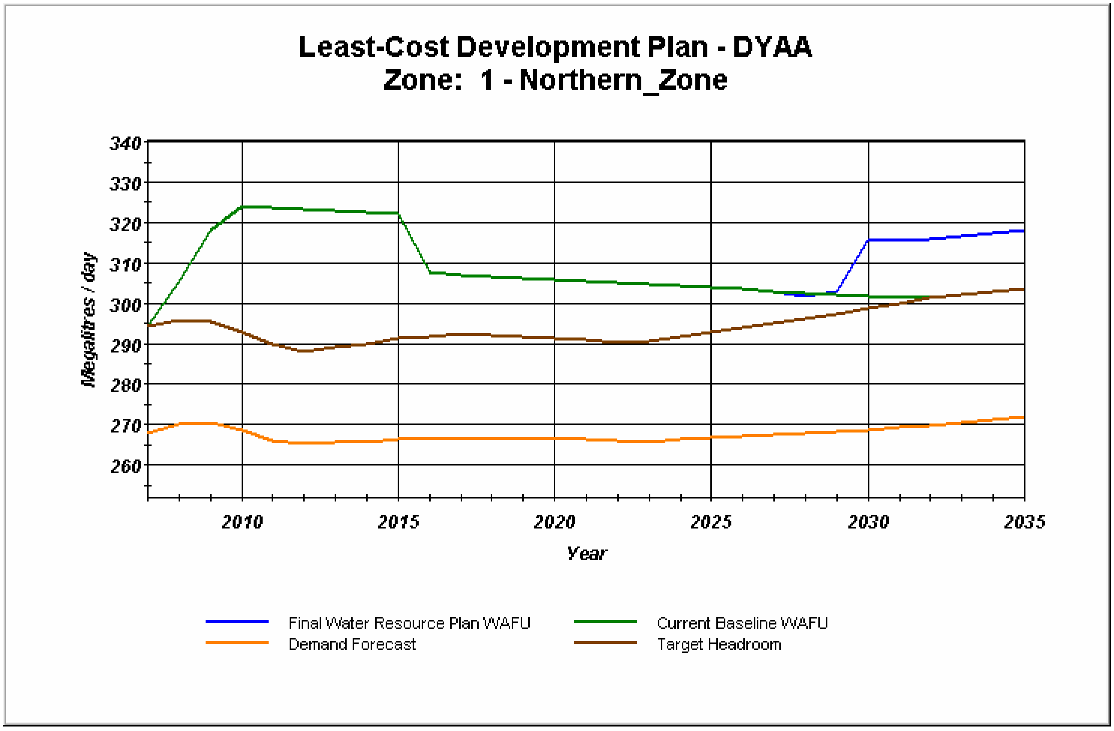


Figure 10.6.3b : Supply and demand balance, Annual Average, Northern Zone

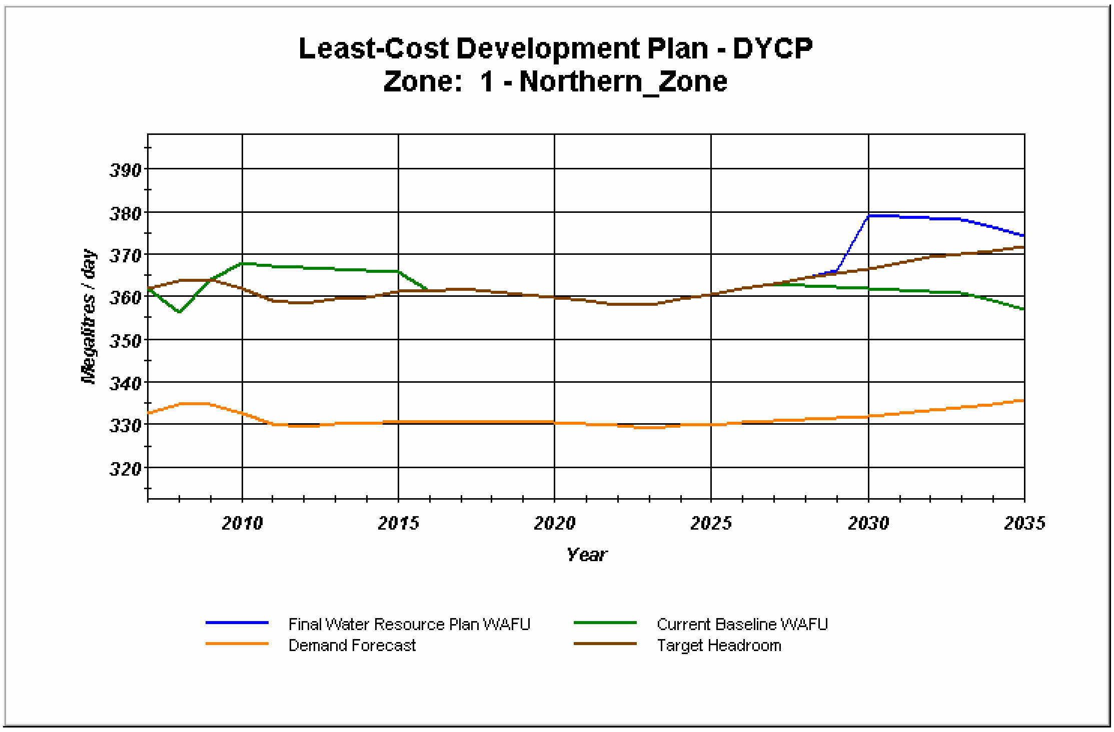


Figure 10.6.3c : Supply and demand balance, Annual Average, Southern Zone

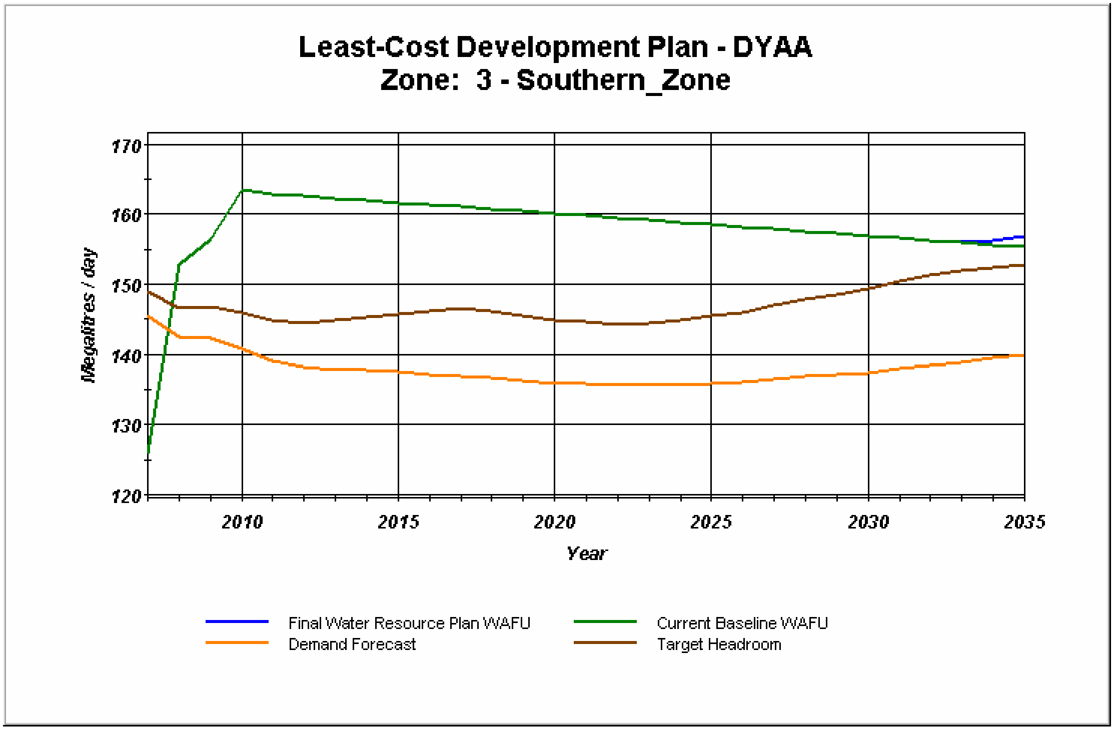


Figure 10.6.3d : Supply and demand balance, Critical Period, Southern Zone

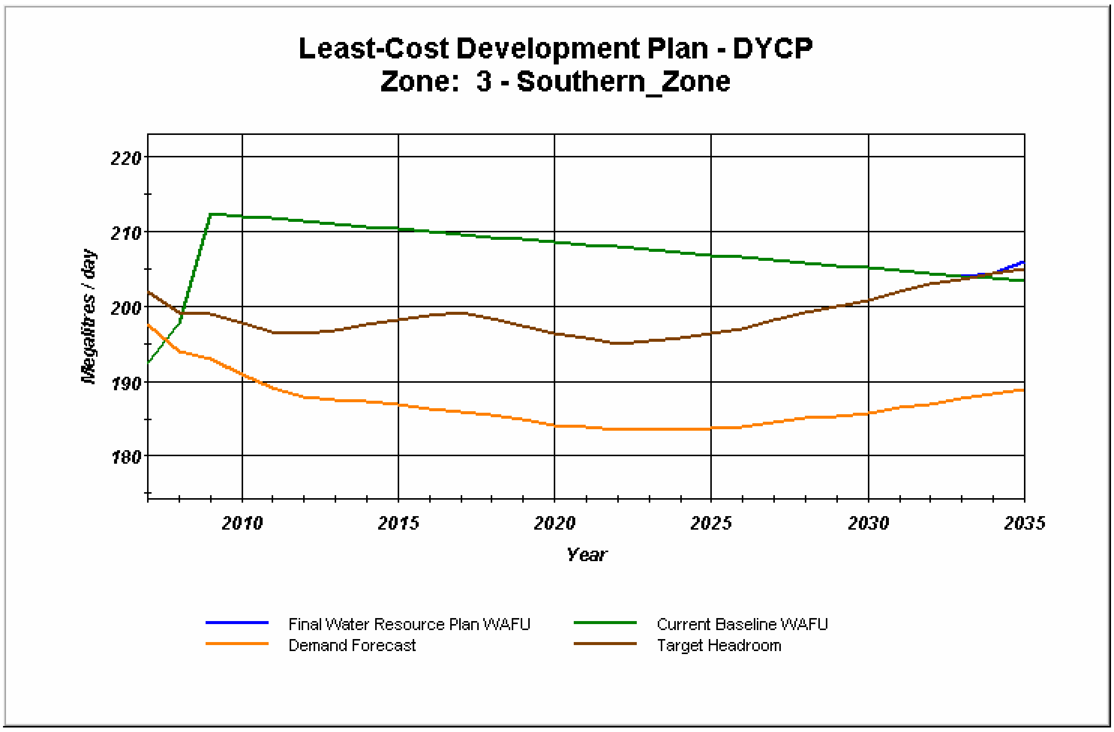


Table 10.6.3b : Net Present Value of costs for selected schemes – Scenario 3

Option ID	Option Name	Average Yield (Ml/d)	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
612	ROYD Artificial Recharge	-0.7	£ 454,428	£ 11,206	£ 54,517	£ 520,152
Group 2c	Options(604,428,185,155,569,169)	1.48	£ 185,645	£ 85,298	-£ 19,351	£ 251,592
604	Communal Greywater reuse	0.23	£ 30,593	£ -	-£ 7,434	£ 23,159
428	Leakage Control - New Detection Technologies	0.32	£ 39,687	£ -	£ -	£ 39,687
185	Commercial Water Audits	0.08	£ 21,320	£ -	-£ 8,747	£ 12,573
155	ARMI & THAX Source Optimisation	0.06	£ 8,499	£ 4,252	£ -	£ 12,752
569	Targeted Water Efficiency promotion -Housing Associations	0.04	£ 11,883	£ -	-£ 1,546	£ 10,337
169	STAN Licence	0.75	£ 73,662	£ 81,046	£ -	£ 154,707
31	ARKS/BUGR Transfer Maximising ARKN	13.5	£ 752,701	£ 1,145,333	£ 398,773	£ 2,296,807
ZONE: 1	**ALL OPTIONS**	**14.28**	**£ 1,392,774**	**£ 1,241,836**	**£ 433,940**	**£ 3,068,550**
Group 1c	Options(428,185,567,569,604,573)	0.61	£ 108,459	£ -	-£ 26,246	£ 82,213
428	Leakage Control - New Detection Technologies	0.17	£ 16,985	£ -	£ -	£ 16,985
185	Commercial Water Audits	0.04	£ 9,124	£ -	-£ 3,704	£ 5,421
567	Community water efficiency scheme	0.29	£ 49,661	£ -	-£ 12,825	£ 36,836
569	Targeted Water Efficiency promotion -Housing Associations	0.02	£ 5,086	£ -	-£ 655	£ 4,431
604	Communal Greywater reuse	0.04	£ 13,093	£ -	-£ 3,299	£ 9,794
573	Hose gun triggers (targeted DMAs)	0.05	£ 14,509	£ -	-£ 2,442	£ 12,067
560	LADY Optimisation	1.05	£ 927,294	£ 474,266	£ 11,063	£ 1,412,623
ZONE: 3	**ALL OPTIONS**	**1.66**	**£ 1,035,753**	**£ 474,266**	**-£ 15,182**	**£ 1,494,836**
	Total	**15.94**	**£ 2,428,527**	**£ 1,716,102**	**£ 418,757**	**£ 4,563,386**

10.6.4 Low total leakage reduction

Under this scenario our continuation of investment at current levels to reduce leakage at our current rate of 2 Ml/d per year either fails to deliver anticipated savings or is not approved by Ofwat

Savings associated with supply pipe leakage arising from our metering programme are achieved however total leakage will not reduce by the 30 Ml/d forecast over the 25 year planning period.

The impact of this scenario on our preferred solution is that no additional schemes are required and there remains a small surplus at the end of the Planning period in 2035, as the following graph shows.

Figure 10.6.4a : Supply and demand balance, Annual Average, All Zones

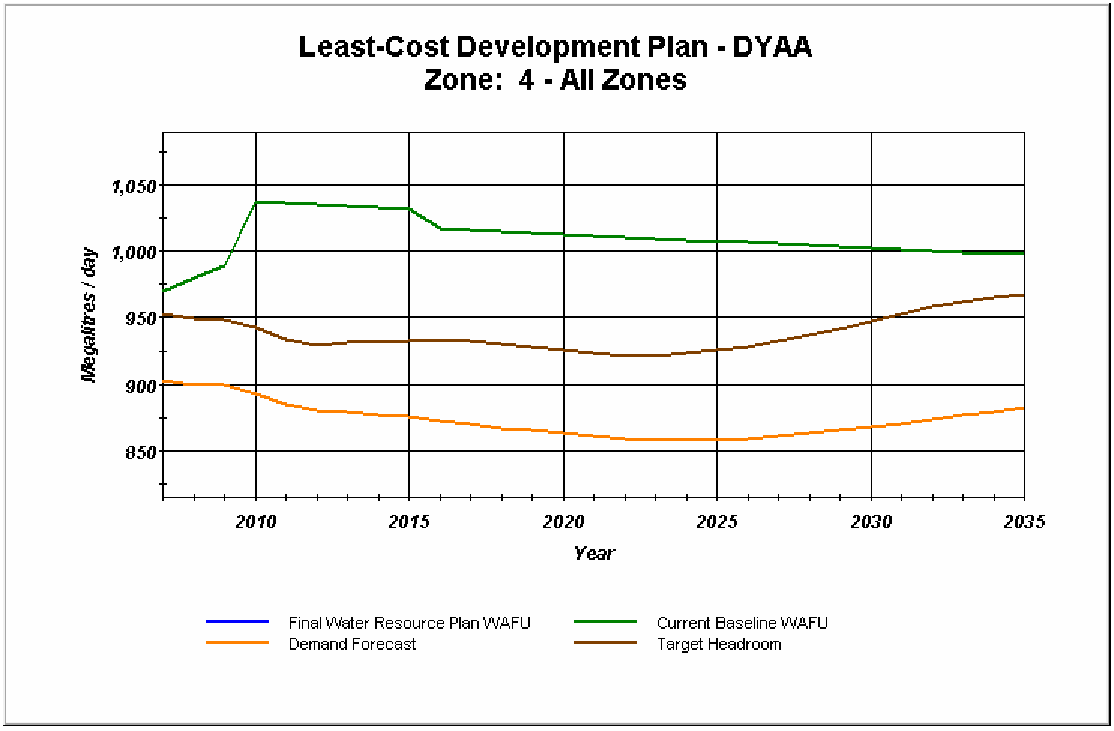
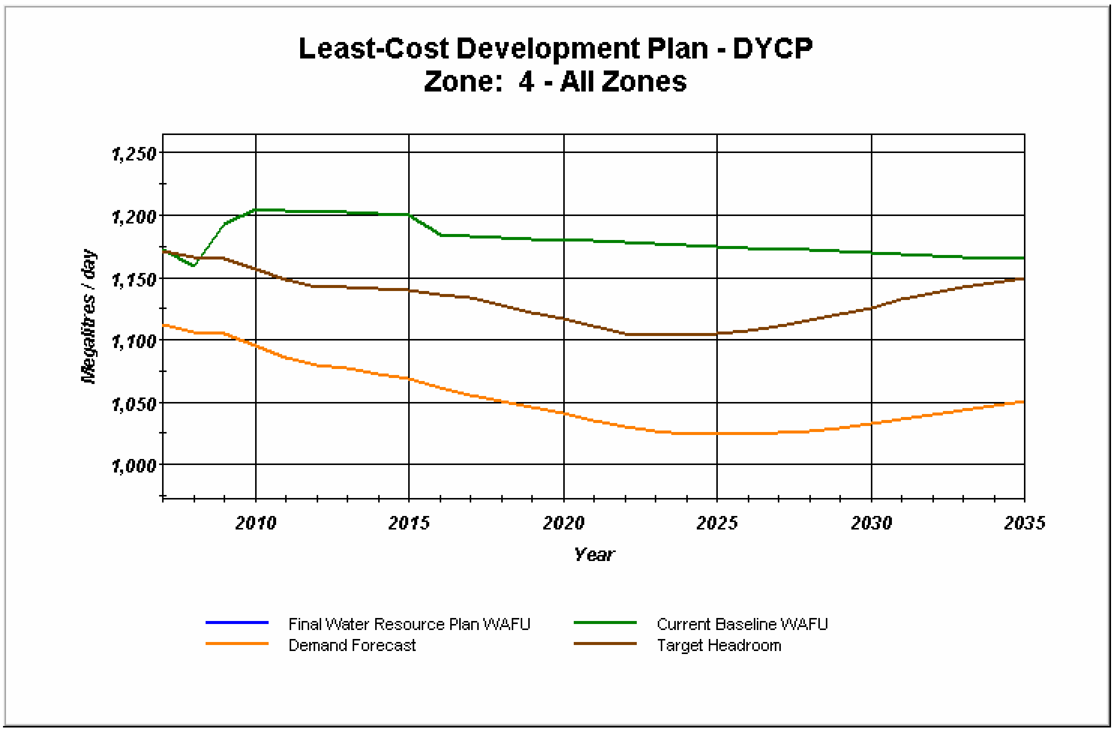


Figure 10.6.4b : Supply and demand balance, Critical Period, All Zones



10.6.5 Optant only demand reductions

One of the key uncertainties is the effect of metering on demand. Our programme assumes a saving of 12.5% of consumption and a saving of between 30 and 15 litres per property per day of supply pipe leakage on metering. Modelling a reversion to Optant metering only but at our Change of Occupier metering rate effectively provides a scenario where these savings do not accrue.As a result of this scenario no deficits occur in our water resources zones.

Figure 10.6.5a : Supply and demand balance, Annual Average, All Zones

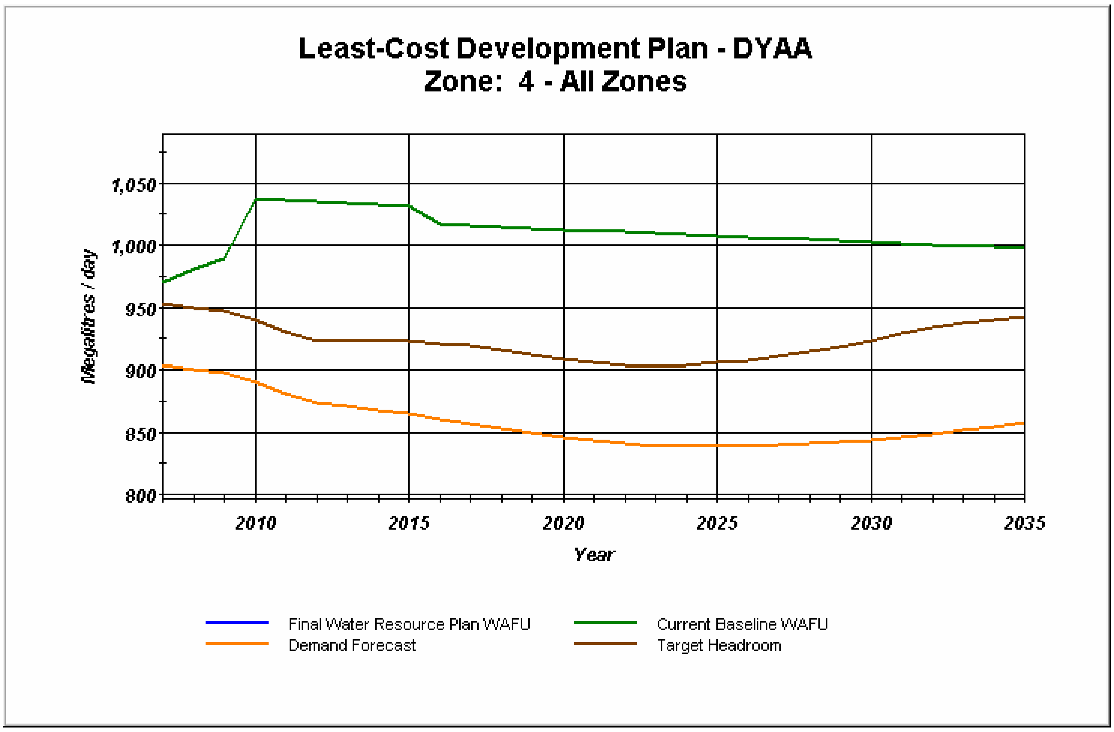
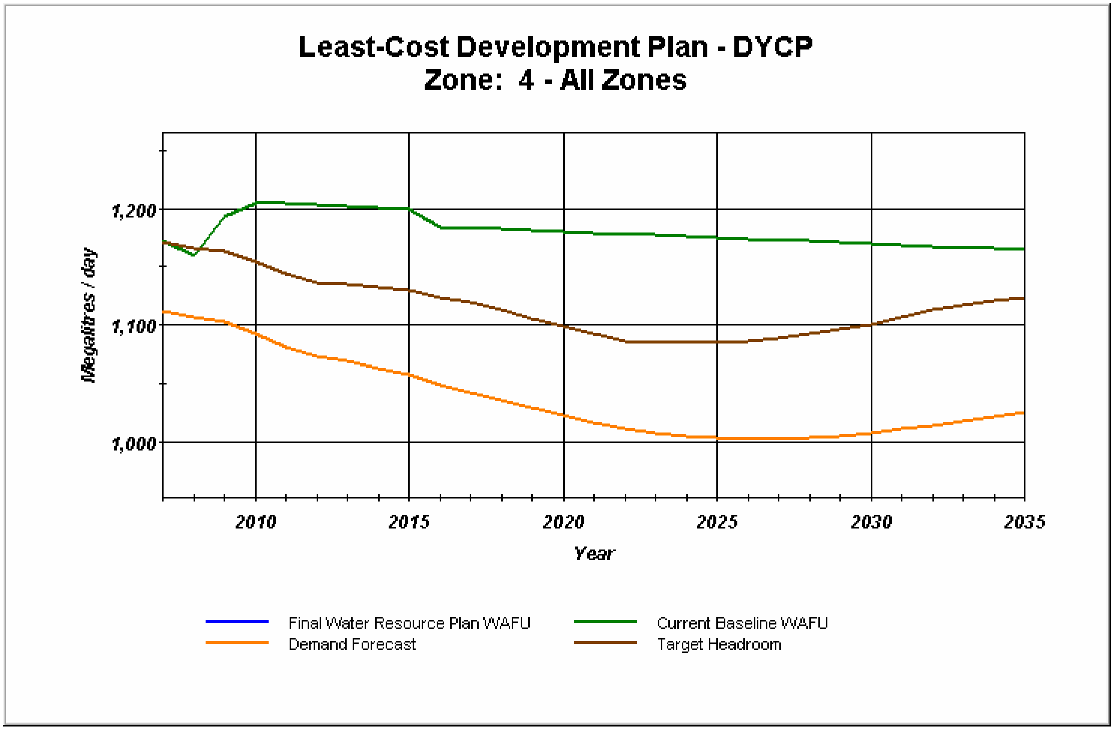


Figure 10.6.5b : Supply and demand balance, Critical Period, All Zones



10.6.6 Low supply pipe leakage savings

Under this scenario savings from supply pipe leakage fail to materialise.

In our demand forecasts we assume that there is a differential between metered and unmetered supply pipe leakage of 30 litres per property per day. Where properties are metered at the property boundary, supply pipe leakage tends to be identified and repaired sooner than would otherwise be the case. The differential is based upon industry information available however it may not be applicable to the TVW area to the same extent.

Under this scenario no overall deficit occurs at the end of the planning period in our water resources zones.

Figure 10.6.6a : Supply and demand balance, Annual Average, All Zones

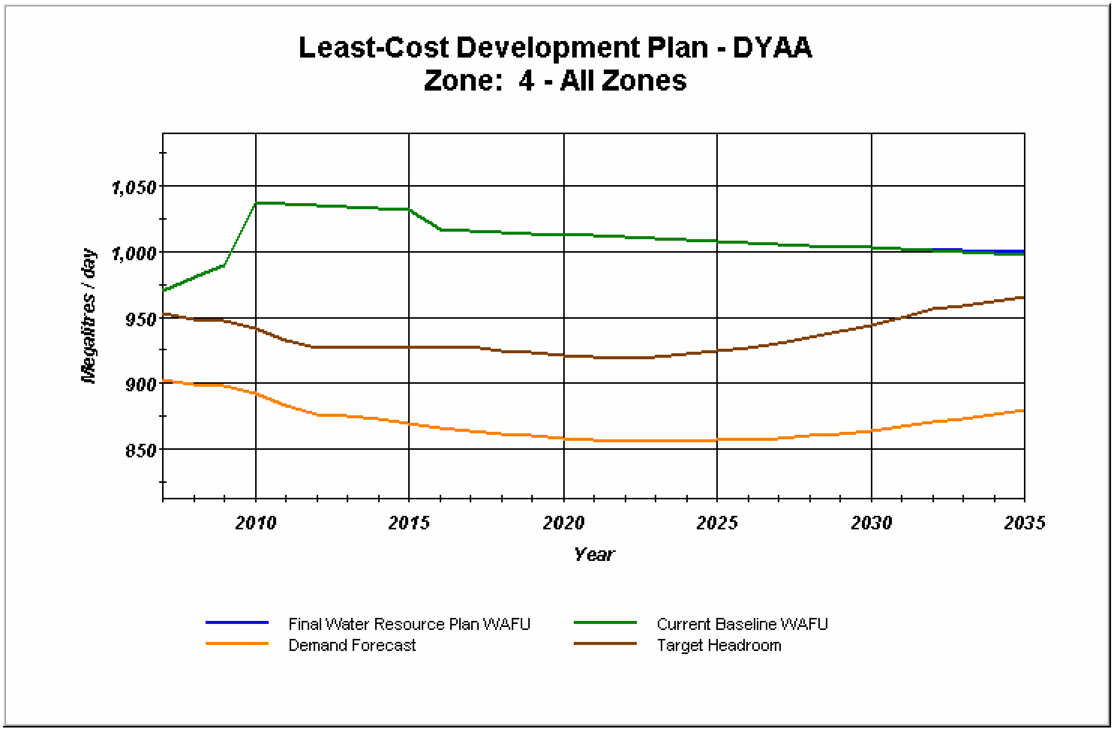
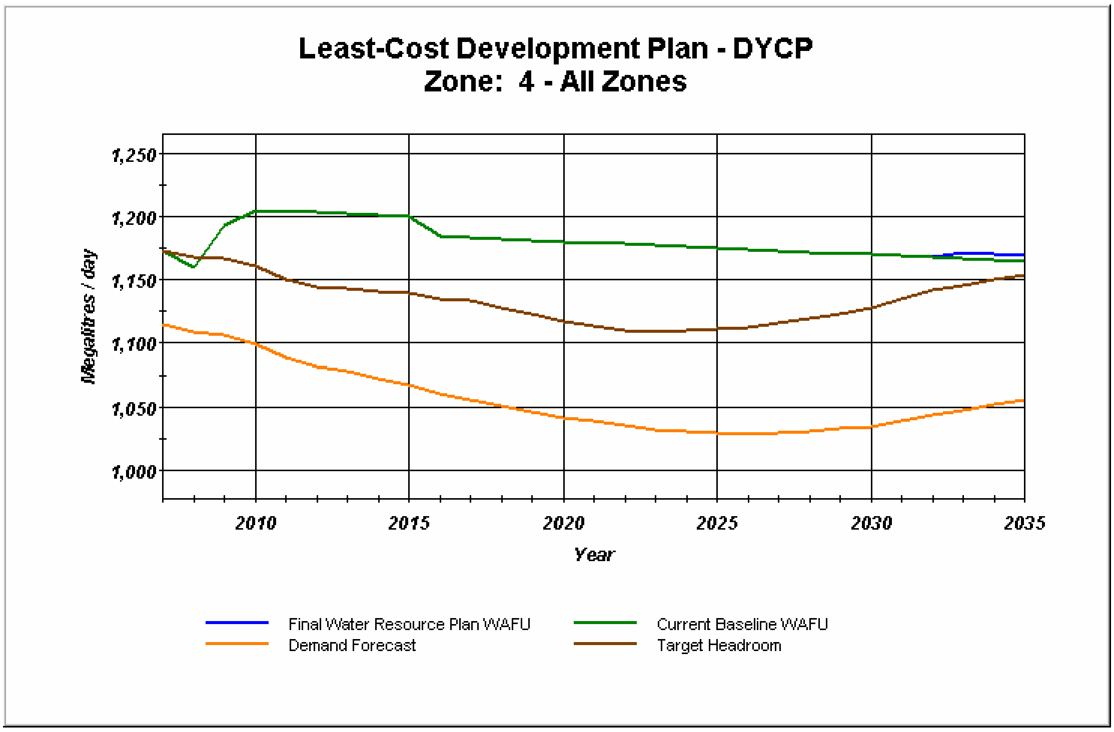


Figure 10.6.6b : Supply and demand balance, Critical Period, All Zones



10.6.7 Combination of reduced demand and leakage savings

This scenario is a combination of the previous two.

Table 10.6.7a : Total Capex of selected schemes – Scenario 7

Zone No	Zone Name	Implementation Year	Option ID	Option Name	Total Capex
1	Northern_Zone	2031/32	169	STAN Licence	£ 170,001
1	Northern_Zone	2032/33	33	ROYD Number 4 Borehole	£ 375,551
1	Northern_Zone	2034/35	Group 3c	Options(155,569,185,604,571,573,607)	£ 387,439
1	Northern_Zone	2034/35	155	ARMI & THAX Source Optimisation	£ 19,615
1	Northern_Zone	2034/35	569	Targeted Water Efficiency promotion -Housing Associations	£ 27,425
1	Northern_Zone	2034/35	185	Commercial Water Audits	£ 49,204
1	Northern_Zone	2034/35	604	Communal Greywater reuse	£ 64,530
1	Northern_Zone	2034/35	571	Dual Flush valve failures investigations	£ 75,826
1	Northern_Zone	2034/35	573	Hose gun triggers (targeted DMAs)	£ 78,242
1	Northern_Zone	2034/35	607	Large User - Water Efficiency retrofiting	£ 72,596
1	Northern_Zone	2035/36	612	ROYD Artificial Recharge	£ 856,807
1	**Northern_Zone**	**2035/36**	**ZONE: 1**	**ALL OPTIONS**	**£ 1,789,798**
				Total	**£ 1,789,798**

Figure 10.6.7a : Supply and demand balance, Annual Average, Northern Zone

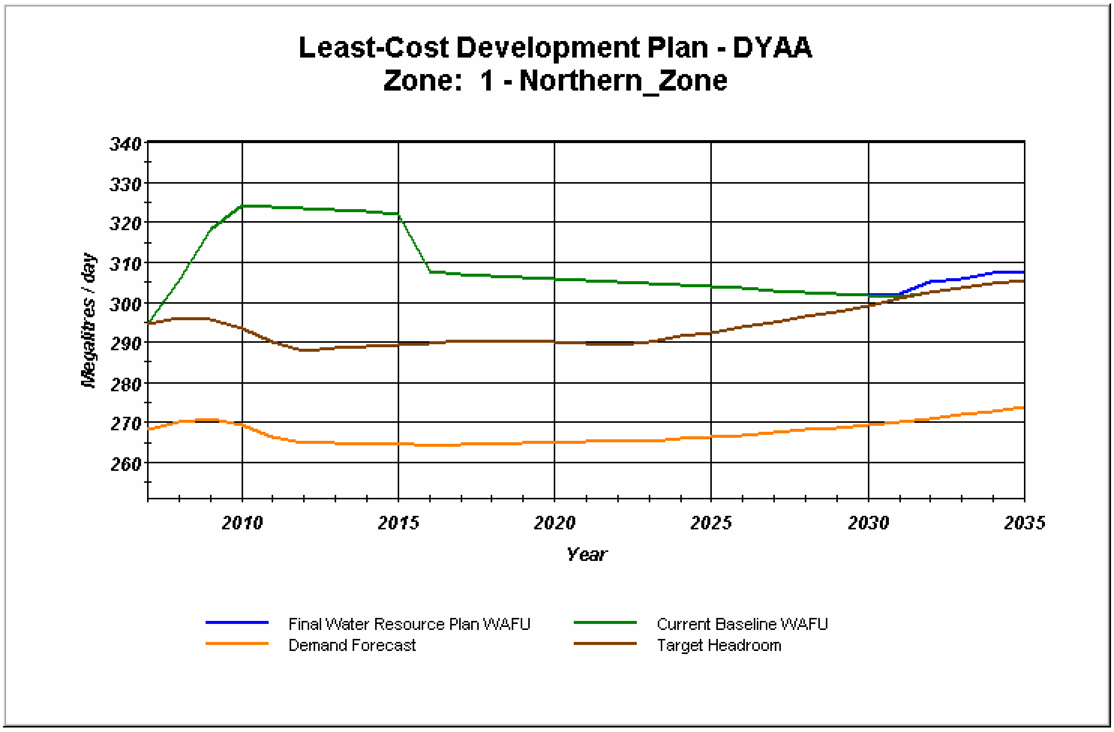


Figure 10.6.7b : Supply and demand balance, Critical Period, Northern Zone

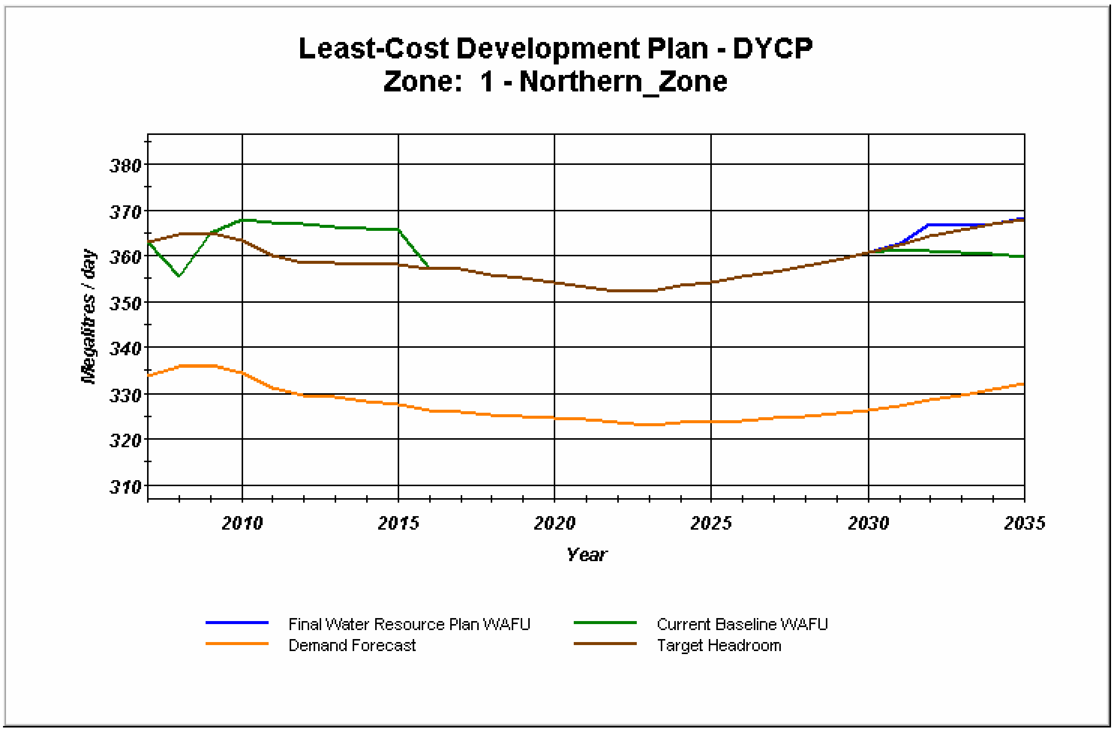


Table 10.6.7b : Net Present Value of costs for selected schemes – Scenario 7

Option ID	Option Name	Average Yield (Ml/d)	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
169	STAN Licence	0.75	£ 67,454	£ 61,160	£ -	£ 128,614
33	ROYD Number 4 Borehole	1.6	£ 227,184	£ 378,766	£ 44,656	£ 650,605
Group 3c	Options(155,569,185,604,571,573,607)	0.63	£ 136,826	£ 2,054	-£ 29,095	£ 109,785
155	ARMI & THAX Source Optimisation	0.06	£ 6,820	£ 2,054	£ -	£ 8,874
569	Targeted Water Efficiency promotion -Housing Associations	0.04	£ 9,536	£ -	-£ 1,274	£ 8,262
185	Commercial Water Audits	0.08	£ 17,108	£ -	-£ 7,206	£ 9,902
604	Communal Greywater reuse	0.23	£ 24,550	£ -	-£ 6,186	£ 18,363
571	Dual Flush valve failures investigations	0.01	£ 26,365	£ -	-£ 4,115	£ 22,250
573	Hose gun triggers (targeted DMAs)	0.09	£ 27,205	£ -	-£ 4,752	£ 22,453
607	Large User - Water Efficiency retrofiting	0.12	£ 25,242	£ -	-£ 2,245	£ 22,997
612	ROYD Artificial Recharge	-0.7	£ 327,089	£ 7,632	£ 38,360	£ 373,082
ZONE: 1	**ALL OPTIONS**	**2.28**	**£ 758,554**	**£ 449,612**	**£ 53,921**	**£ 1,262,086**
	Total	**2.28**	**£ 758,554**	**£ 449,612**	**£ 53,921**	**£ 1,262,086**

10.6.8 Defra 130 PCC by 2030

We have outlined the impact and cost of schemes that would be required to reduce our measured population Per Capita Consumption to 130 litres per person per day in Section 3.6 of our Plan. The impact of this investment on our supply demand balance is shown in the graphs below. We forecast that our surplus at critical period and annual average demand conditions will increase by *Ml/d and *Ml/d respectively. The additional Capex to achieve a PCC is estimated to £565 millions. The NPV Capex and Opex of this investment assuming the investment profile indicated in the table below is £313 million.

Table 10.6.8 : Total Cost of selected schemes – Scenario 8

Year	CAPEX		OPEX		Total
	Microcomponent	AMR	Water Saved (m3/yr)	Water Saved (£)	
2010	£21,904,762	£0	-834,857	-£56,353	£21,848,409
2011	£21,904,762	£0	-1,669,714	-£112,706	£21,792,056
2012	£21,904,762	£0	-2,504,571	-£169,059	£21,735,703
2013	£21,904,762	£0	-3,339,429	-£225,411	£21,679,350
2014	£21,904,762	£0	-4,174,286	-£281,764	£21,622,998
2015	£21,904,762	£0	-5,009,143	-£338,117	£21,566,645
2016	£21,904,762	£0	-5,844,000	-£394,470	£21,510,292
2017	£21,904,762	£0	-6,678,857	-£450,823	£21,453,939
2018	£21,904,762	£0	-7,513,714	-£507,176	£21,397,586
2019	£21,904,762	£0	-8,348,571	-£563,529	£21,341,233
2020	£21,904,762	£0	-9,183,429	-£619,881	£21,284,880
2021	£21,904,762	£0	-10,018,286	-£676,234	£21,228,528
2022	£21,904,762	£0	-10,853,143	-£732,587	£21,172,175
2023	£21,904,762	£0	-11,688,000	-£788,940	£21,115,822
2024	£21,904,762	£0	-12,522,857	-£845,293	£21,059,469
2025	£21,904,762	£0	-13,357,714	-£901,646	£21,003,116
2026	£21,904,762	£21,000,000	-15,507,471	-£1,046,754	£41,858,008
2027	£21,904,762	£21,000,000	-17,657,229	-£1,191,863	£41,712,899
2028	£21,904,762	£21,000,000	-19,806,986	-£1,336,972	£41,567,790
2029	£21,904,762	£21,000,000	-21,956,743	-£1,482,080	£41,422,682
2030	£21,904,762	£21,000,000	-24,106,500	-£1,627,189	£41,277,573
2031	£0	£0	-24,106,500	-£1,627,189	-£1,627,189
2032	£0	£0	-24,106,500	-£1,627,189	-£1,627,189
2033	£0	£0	-24,106,500	-£1,627,189	-£1,627,189
2034	£0	£0	-24,106,500	-£1,627,189	-£1,627,189
2035	£0	£0	-24,106,500	-£1,627,189	-£1,627,189
NPV	£282,808,511	£39,897,302		-£9,443,249	£313,262,564

Figure 10.6.8a : Supply and demand balance, Annual Average, All Zones

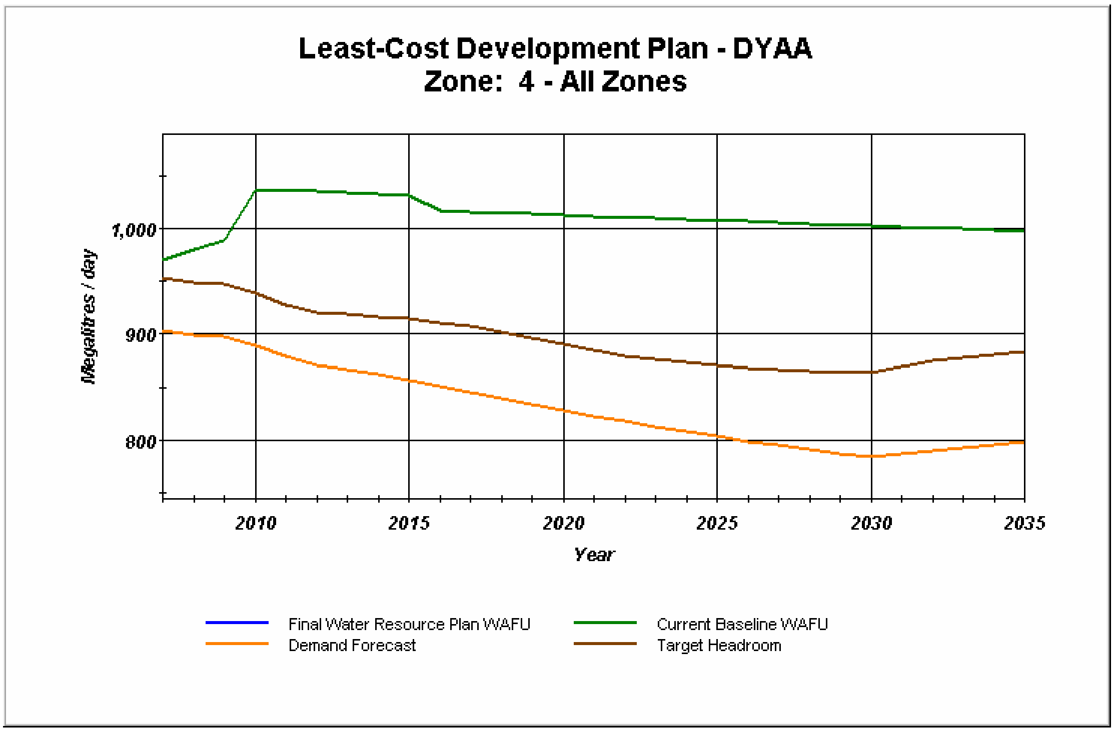
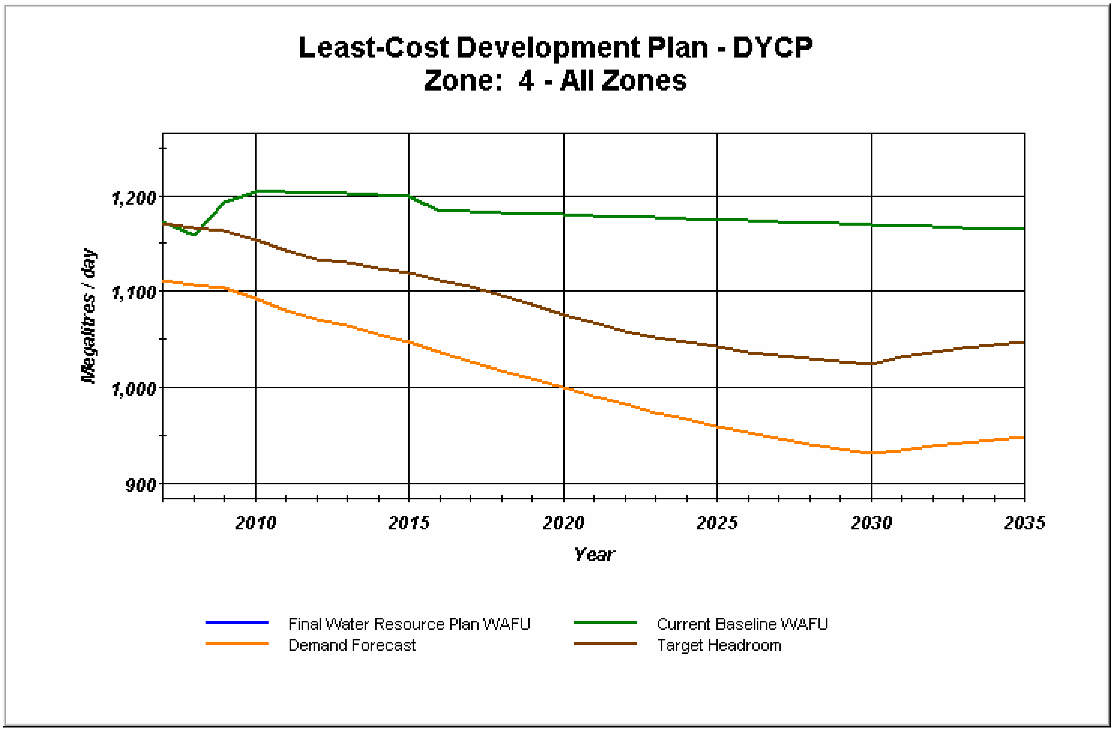


Figure 10.6.8b : Supply and demand balance, Critical Period, All Zones



10.6.9 Water Framework Directive

The Preliminary Cost Effectiveness Analysis (PCEA) work undertaken for Ofwat attempted to put some “ball park” figures to the potential licence reductions that could occur as a result of the Water Framework Directive. For Veolia Water Central this estimate was that we could lose up to 20% of our abstraction licences (and therefore our water available for use to supply) and the cost of replacement may be over £1 billion which we considered to be disproportionate.

We await the river basin management plans and the Environment Agency’s intentions with respect to over licensed and over abstracted catchments. Meanwhile however we have attempted to model the effect of a reduction of 20% of our deployable output as a result of the Water Framework Directive.

The effect is so large that our modelling is not able to resolve ensuing supply demand deficit however by combining achievement of Defra 130 PCC target and a WFD scenario we are able to provide an estimate of the alternate schemes selected by the least cost model.

However, this indicative cost ignores the financial impact of the costs of stranded assets which our customers have already paid for and which cannot be utilised to abstract treat and supply water.

Also omitted are the costs of redesigning our distribution supply network away from local sources towards more bulk transfers and the necessary infrastructure investment that we would have to make in order to maintain levels of service currently enjoyed by our customers.

We estimate these to be £2 million per mega litre of licence lost or £900 million at peak demand. These costs have been added to those identified from our least cost optimisation model and the Defra 130 PCC scenario (£ 565 million) to provide the total costs of schemes required under this WFD scenario.

Total Capex costs are estimated to be £1.6 billion.

Table 10.6.9a : Total Capex of selected schemes, Northern Zone - Scenario 9

Zone No	Zone Name	Implementation Year	Option ID	Option Name	Total Capex
1	Northern_Zone	2023/24	31	HWFS/ARKR Transfer Upgrade	£ 1,070,872
1	Northern_Zone	2024/25	33	ROYD Number 4 Borehole	£ 375,551
1	Northern_Zone	2025/26	23	ANGL Extension	£ 15,624,230
1	Northern_Zone	2029/30	169	STAN Licence	£ 170,001
1	Northern_Zone	2030/31	Group 5c	Options(604,428,185,567,155,603,607,569,573,388,636,330,4)	£ 2,069,924
1	Northern_Zone	2030/31	604	Communal Greywater reuse	£ 64,530
1	Northern_Zone	2030/31	428	Leakage Control - New Detection Technologies	£ 91,592
1	Northern_Zone	2030/31	185	Commercial Water Audits	£ 49,204
1	Northern_Zone	2030/31	567	Community water efficiency scheme	£ 267,799
1	Northern_Zone	2030/31	155	ARMI & THAX Source Optimisation	£ 19,615
1	Northern_Zone	2030/31	603	Communal rainwater reuse	£ 138,739
1	Northern_Zone	2030/31	607	Large User - Water Efficiency retrofiting	£ 72,596
1	Northern_Zone	2030/31	569	Targeted Water Efficiency promotion -Housing Associations	£ 27,425
1	Northern_Zone	2030/31	573	Hose gun triggers (targeted DMAs)	£ 78,242
1	Northern_Zone	2030/31	388	New Cistern Displacement Devices	£ 280,253
1	Northern_Zone	2030/31	636	Leakage reduction - Pressure management	£ 186,923
1	Northern_Zone	2030/31	330	WE projects for SMEs	£ 412,991
1	Northern_Zone	2030/31	4	NEWP and WEND maximisation	£ 380,013
1	Northern_Zone	2031/32	Group 6c	Options(112,134,612,261,250)	£ 7,984,316
1	Northern_Zone	2031/32	112	LOND Peak Licence Scheme	£ 443,769
1	Northern_Zone	2031/32	134	VAUXI Groundwater	£ 1,723,972
1	Northern_Zone	2031/32	612	ROYD Artificial Recharge	£ 856,807
1	Northern_Zone	2031/32	261	Tap re-washering	£ 842,760
1	Northern_Zone	2031/32	250	Water Saving Devices - Customer subsidy for purchasing	£ 4,117,007
1	Northern_Zone	2032/33	Group 7c	Options(548,105,26,533c1)	£ 5,556,876
1	Northern_Zone	2032/33	548	HART Borehole - Replacement for PORT	£ 572,648
1	Northern_Zone	2032/33	105	HADHI New Borehole	£ 910,048
1	Northern_Zone	2032/33	26	SPRF - maximise average group licence	£ 1,438,371
1	Northern_Zone	2032/33	533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	£ 2,635,810
1	Northern_Zone	2033/34	Group 8c	Options(533c2,160,385,635,528,470)	£ 5,535,201
1	Northern_Zone	2033/34	533c2	Compulsory metering (AMR) - 15yr Prog - Phase 2	£ 2,635,810
1	Northern_Zone	2033/34	160	HEMP Source Optimisation	£ 586,712
1	Northern_Zone	2033/34	385	Retrofit Dual Flush Mechanism	£ 451,709
1	Northern_Zone	2033/34	635	Leakage reduction - District Metering	£ 380,077
1	Northern_Zone	2033/34	528	Leakage reduction - Speed of Repair	£ -
1	Northern_Zone	2033/34	470	SCHO Relocation	£ 1,480,893
1	Northern_Zone	2034/35	Group 9c	Options(572,531,511,608,571,533c3)	£ 7,112,095
1	Northern_Zone	2034/35	572	Retrofit aerated shower head	£ 241,180
1	Northern_Zone	2034/35	531	Left Over Commercials (metering of)	£ 570,069
1	Northern_Zone	2034/35	511	RUNGS Peak Licence	£ 1,251,045
1	Northern_Zone	2034/35	608	RUNL (Treatment)	£ 2,338,164
1	Northern_Zone	2034/35	571	Dual Flush valve failures investigations	£ 75,826
1	Northern_Zone	2034/35	533c3	Compulsory metering (AMR) - 15yr Prog - Phase 3	£ 2,635,810
1	Northern_Zone	2035/36	Group 10c	Options(130,559,161)	£ 8,754,076
1	Northern_Zone	2035/36	130	RUNL (Chalk) Optimisation	£ 770,140
1	Northern_Zone	2035/36	559	Treated Water Storage	£ 5,095,296
1	Northern_Zone	2035/36	161	LOWE Bulk Import Increase	£ 2,888,640
1	**Northern_Zone**	**2035/36**	**ZONE: 1**	**ALL OPTIONS**	**£ 54,253,142**

Table 10.6.9b : Total Capex of selected schemes, Central Zone - Scenario 9

Zone No	Zone Name	Implementation Year	Option ID	Option Name	Total Capex
2	Central_Zone	2025/26	87	SHAK Source Optimisation	£ 567,155
2	Central_Zone	2026/27	28	ABIN	£ 1,025,118
2	Central_Zone	2027/28	615	WHEA Peak Licence Scheme	£ 339,281
2	Central_Zone	2028/29	24	ICKE Treatment Recommissioning	£ 2,401,678
2	Central_Zone	2029/30	Group 5c	Options(607,428,185,567,604,388,573,636,624,566)	£ 7,414,651
2	Central_Zone	2029/30	607	Large User - Water Efficiency retrofiting	£ 130,673
2	Central_Zone	2029/30	428	Leakage Control - New Detection Technologies	£ 164,866
2	Central_Zone	2029/30	185	Commercial Water Audits	£ 88,567
2	Central_Zone	2029/30	567	Community water efficiency scheme	£ 482,038
2	Central_Zone	2029/30	604	Communal Greywater reuse	£ 116,154
2	Central_Zone	2029/30	388	New Cistern Displacement Devices	£ 504,456
2	Central_Zone	2029/30	573	Hose gun triggers (targeted DMAs)	£ 140,836
2	Central_Zone	2029/30	636	Leakage reduction - Pressure management	£ 336,462
2	Central_Zone	2029/30	624	BWB - Slough Arm	£ 1,111,482
2	Central_Zone	2029/30	566	NORM - Detailed Review of Process	£ 4,339,116
2	Central_Zone	2030/31	464	POOR Treatment Scheme	£ 3,121,582
2	Central_Zone	2031/32	47	LANE 160	£ 7,725,077
2	Central_Zone	2032/33	618	HILF Option A1 (b)	£ 9,818,248
2	Central_Zone	2033/34	76	BUGR/PREP	£ 396,272
2	Central_Zone	2034/35	533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	£ 4,744,457
2	Central_Zone	2035/36	Group 11b	Options(330,571,385,572,66,635,531,48,261,426,249,528,67,65,250)	£ 22,500,646
2	Central_Zone	2035/36	330	WE projects for SMEs	£ 743,384
2	Central_Zone	2035/36	571	Dual Flush valve failures investigations	£ 136,487
2	Central_Zone	2035/36	385	Retrofit Dual Flush Mechanism	£ 813,077
2	Central_Zone	2035/36	572	Retrofit aerated shower head	£ 434,125
2	Central_Zone	2035/36	66	GERR Source optimisation	£ 403,913
2	Central_Zone	2035/36	635	Leakage reduction - District Metering	£ 684,138
2	Central_Zone	2035/36	531	Left Over Commercials (metering of)	£ 1,026,124
2	Central_Zone	2035/36	48	THEG Peak Licence - Watford Fields Treatment	£ 4,952,541
2	Central_Zone	2035/36	261	Tap re-washering	£ 1,516,969
2	Central_Zone	2035/36	426	Leakage reduction - Service Reservoir	£ 560,769
2	Central_Zone	2035/36	249	Water Saving Devices - Voucher Scheme	£ 836,307
2	Central_Zone	2035/36	528	Leakage reduction - Speed of Repair	£ -
2	Central_Zone	2035/36	67	HUGH Source Optimisation	£ 1,103,321
2	Central_Zone	2035/36	65	DENH/UXBR New Source	£ 1,878,877
2	Central_Zone	2035/36	250	Water Saving Devices - Customer subsidy for purchasing	£ 7,410,613
2	**Central_Zone**	**2035/36**	**ZONE: 2**	**ALL OPTIONS**	**£ 60,054,165**

Table 10.6.9c : Total Capex of selected schemes, Southern Zone and total for all zones - Scenario 9

Zone No	Zone Name	Implementation Year	Option ID	Option Name	Total Capex
3	Southern_Zone	2026/27	533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	£ 1,405,765
3	Southern_Zone	2027/28	533c2	Compulsory metering (AMR) - 15yr Prog - Phase 2	£ 1,405,765
3	Southern_Zone	2028/29	533c3	Compulsory metering (AMR) - 15yr Prog - Phase 3	£ 1,405,765
3	Southern_Zone	2029/30	560	Lady Mead Optimisation	£ 2,469,392
3	Southern_Zone	2030/31	250	Water Saving Devices - Customer subsidy for purchasing	£ 2,195,737
3	Southern_Zone	2031/32	654	KEMP WRSE Option	£ 7,265,371
3	Southern_Zone	2032/33	388	New Cistern Displacement Devices	£ 149,468
3	Southern_Zone	2033/34	567	Community water efficiency scheme	£ 142,826
3	Southern_Zone	2034/35	249	Water Saving Devices - Voucher Scheme	£ 247,795
3	Southern_Zone	2035/36	261	Tap re-washering	£ 449,472
3	Southern_Zone	2036/37	330	WE projects for SMEs	£ 220,262
3	Southern_Zone	2037/38	636	Leakage reduction - Pressure management	£ 99,692
3	Southern_Zone	2038/39	5	HORS Source Recommissioning	£ 442,897
3	Southern_Zone	2039/40	528	Leakage reduction - Speed of Repair	£ -
3	Southern_Zone	2040/41	428	Leakage Control - New Detection Technologies	£ 48,849
3	Southern_Zone	2041/42	573	Hose gun triggers (targeted DMAs)	£ 41,729
3	Southern_Zone	2042/43	635	Leakage reduction - District Metering	£ 202,708
3	Southern_Zone	2043/44	620	Large User - Rainwater harvesting	£ 61,484
3	Southern_Zone	2044/45	603	Communal rainwater reuse	£ 73,994
3	Southern_Zone	2045/46	185	Commercial Water Audits	£ 26,242
3	Southern_Zone	2046/47	385	Retrofit Dual Flush Mechanism	£ 240,912
3	Southern_Zone	2047/48	569	Targeted Water Efficiency promotion -Housing Associations	£ 14,627
3	Southern_Zone	2048/49	426	Leakage reduction - Service Reservoir	£ 166,154
3	Southern_Zone	2049/50	271	Leakage reduction - Communication Pipes	£ 8,402,080
3	Southern_Zone	2050/51	531	Left Over Commercials (metering of)	£ 304,037
3	Southern_Zone	2051/52	572	Retrofit aerated shower head	£ 128,630
3	Southern_Zone	2052/53	571	Dual Flush valve failures investigations	£ 40,440
3	Southern_Zone	2053/54	637	Leakage reduction by 1 Ml/d	£ 5,281
3	Southern_Zone	2054/55	427	Leakage reduction - Global Supply Pipes	£ 10,360,444
3	Southern_Zone	2055/56	532	Left Over Domestics (metering of)	£ 20,800,000
3	Southern_Zone	2056/57	638	Leakage reduction by 2 Ml/d	£ 11,652
3	Southern_Zone	2057/58	270	Leakage reduction - Distribution Main Renewals	£ 15,413,066
3	Southern_Zone	2058/59	639	Leakage reduction by 3 Ml/d	£ 11,844
3	Southern_Zone	2059/60	640	Leakage reduction by 4 Ml/d	£ 12,059
3	Southern_Zone	2060/61	641	Leakage reduction by 5 Ml/d	£ 12,301
3	Southern_Zone	2061/62	642	Leakage reduction by 6 Ml/d	£ 12,577
3	Southern_Zone	2062/63	643	Leakage reduction by 7 Ml/d	£ 12,894
3	Southern_Zone	2063/64	644	Leakage reduction by 8 Ml/d	£ 13,259
3	Southern_Zone	2064/65	645	Leakage reduction by 9 Ml/d	£ 13,688
3	Southern_Zone	2065/66	646	Leakage reduction by 10 Ml/d	£ 14,204
3	**Southern_Zone**	**2065/66**	**ZONE: 3**	**ALL OPTIONS**	**£ 74,345,365**
				Total ALL ZONES	**£ 188,652,673**

Figure 10.6.9a : Supply and demand balance, Annual Average, Northern Zone

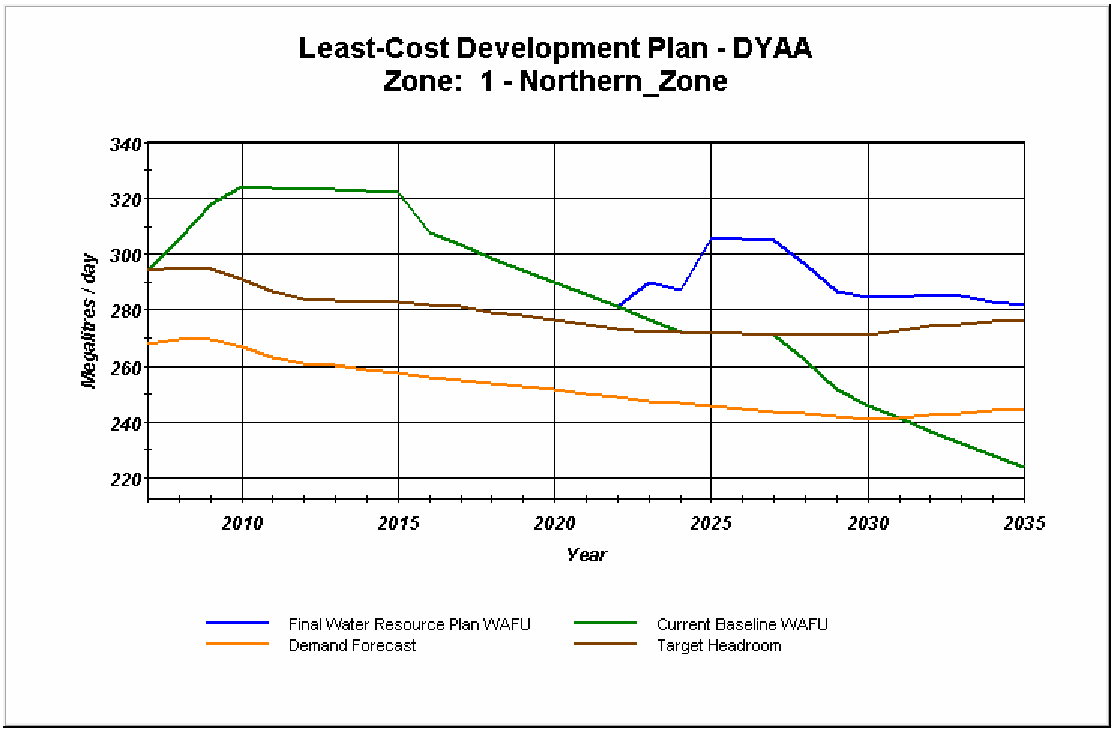


Figure 10.6.9b : Supply and demand balance, Critical Period, Northern Zone

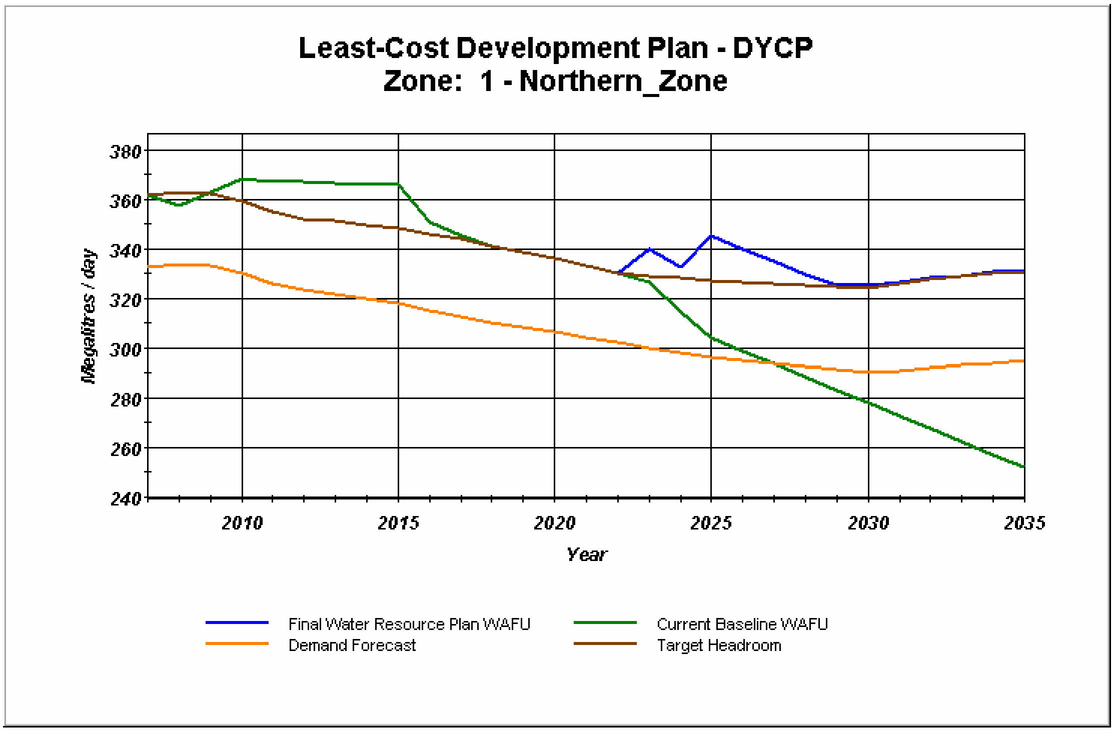


Figure 10.6.9c : Supply and demand balance, Annual Average, Central Zone

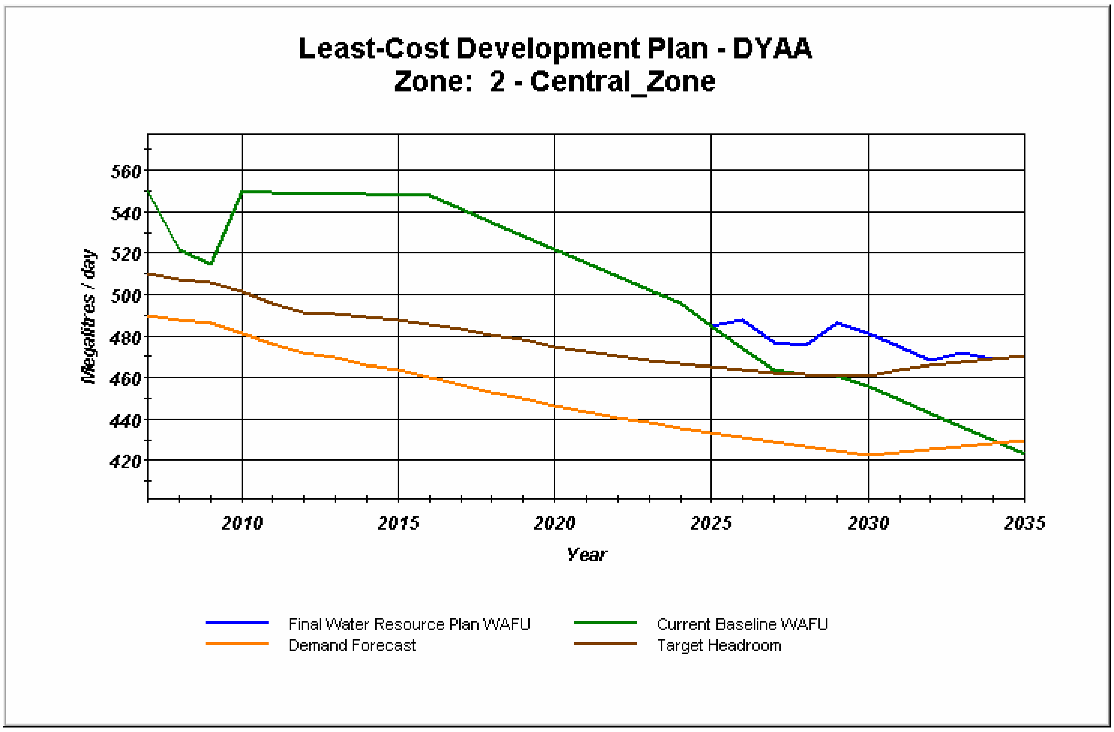


Figure 10.6.9d : Supply and demand balance, Critical Period, Central Zone

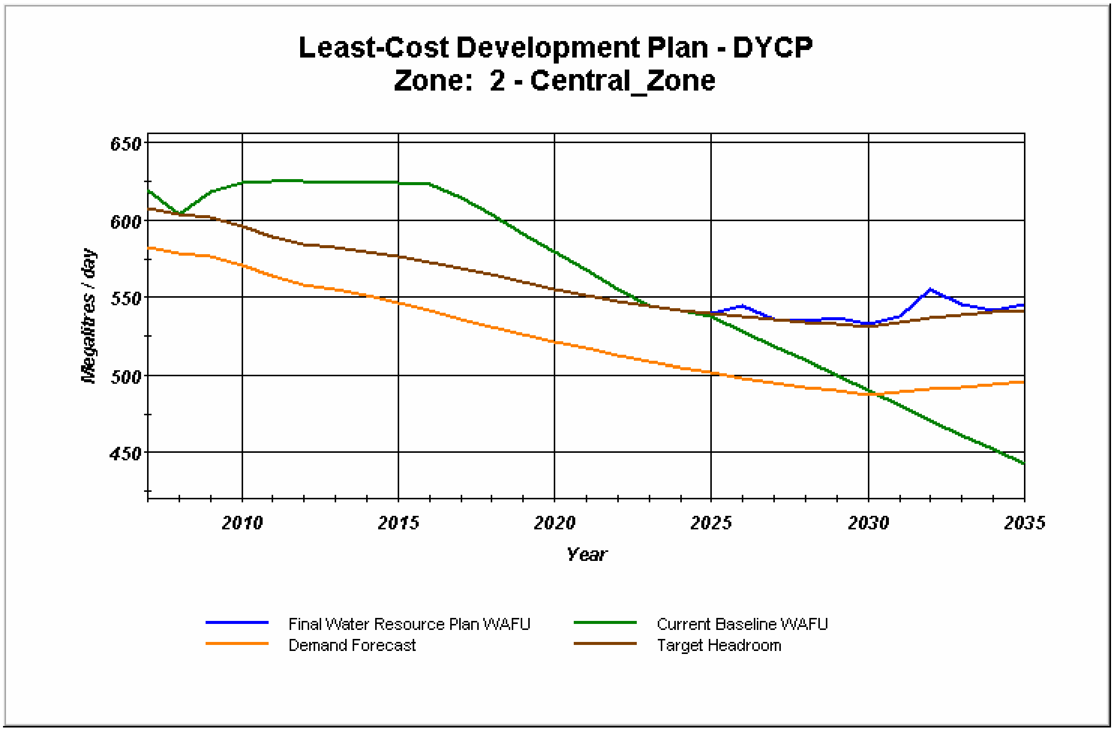


Figure 10.6.9e : Supply and demand balance, Annual Average, Southern Zone

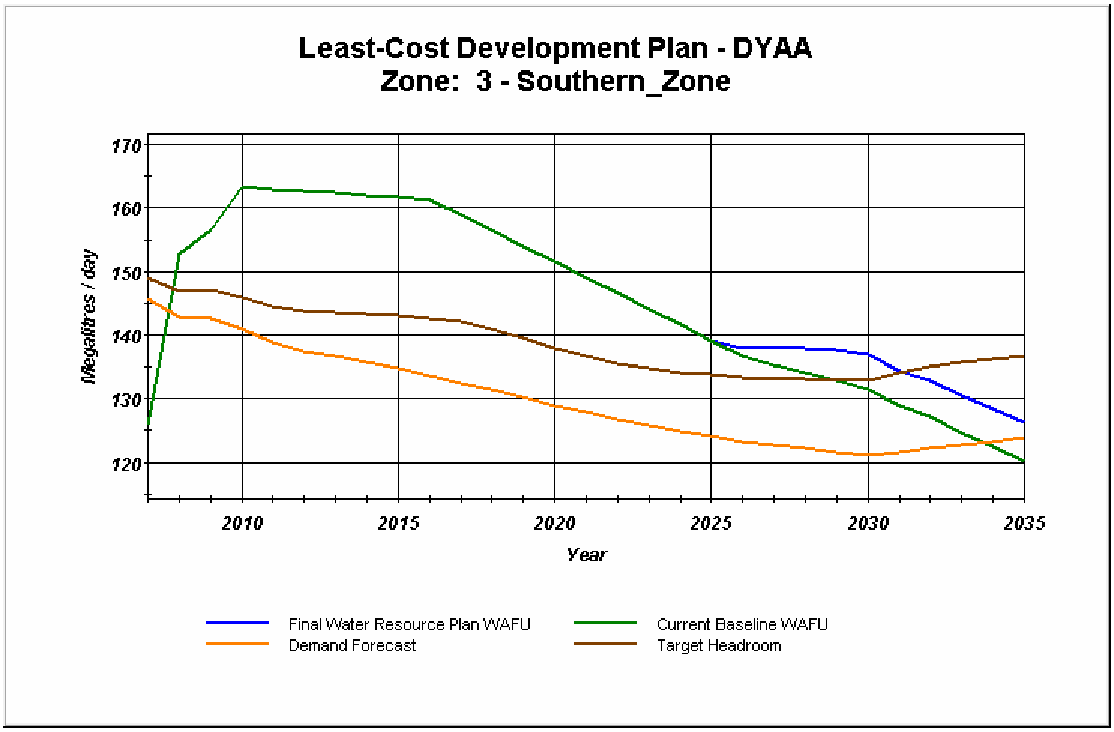


Figure 10.6.9f : Supply and demand balance, Critical Period, Southern Zone

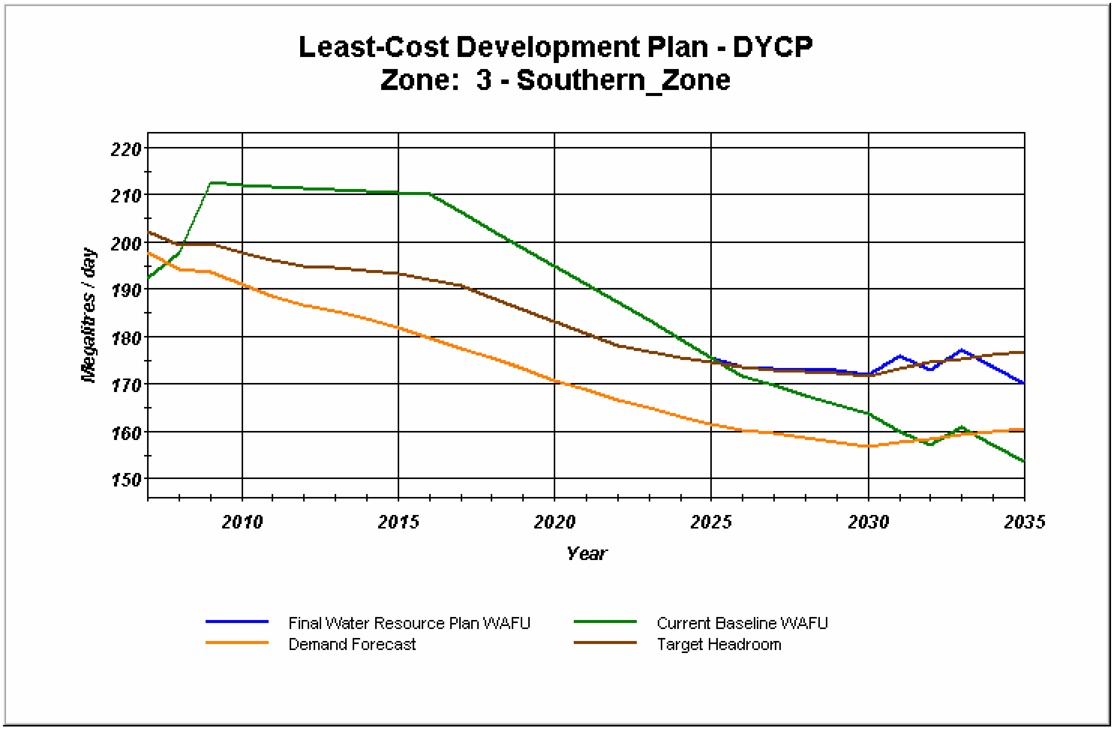


Table 10.6.9d : Net Present Value of costs for selected schemes, Northern Zone – Scenario 9

Option ID	Option Name - Northern Zone	Average Yield (Ml/d)	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
31	ARKS/BUGR Transfer Maximising ARKN	13.5	£ 1,095,874	£ 1,825,428	£ 512,624	£ 3,433,926
33	ROYD Number 4 Borehole	1.6	£ 341,948	£ 588,357	£ 59,855	£ 990,159
23	ANGL Extension	18.9	£ 9,545,981	£ 12,521,030	£ 36,420	£ 22,103,430
169	STAN Licence	0.75	£ 73,662	£ 71,291	£ -	£ 144,953
Group 5c	Options(604,428,185,567,155,603,607,569,573,388,636,330,4)	4.15	£ 1,033,645	£ 234,984	£ 586,543	£ 1,855,172
604	Communal Greywater reuse	0.23	£ 29,276	£ -	-£ 7,172	£ 22,104
428	Leakage Control - New Detection Technologies	0.32	£ 37,978	£ -	£ -	£ 37,978
185	Commercial Water Audits	0.08	£ 20,402	£ -	-£ 8,424	£ 11,978
567	Community water efficiency scheme	0.54	£ 111,041	£ -	-£ 29,171	£ 81,870
155	ARMI & THAX Source Optimisation	0.06	£ 8,133	£ 2,983	£ -	£ 11,117
603	Communal rainwater reuse	0.27	£ 62,943	£ -	-£ 8,475	£ 54,468
607	Large User - Water Efficiency retrofiting	0.12	£ 30,101	£ -	-£ 2,624	£ 27,477
569	Targeted Water Efficiency promotion -Housing Associations	0.04	£ 11,372	£ -	-£ 1,489	£ 9,883
573	Hose gun triggers (targeted DMAs)	0.09	£ 32,443	£ -	-£ 5,555	£ 26,888
388	New Cistern Displacement Devices	0.35	£ 116,205	£ -	-£ 19	£ 116,186
636	Leakage reduction - Pressure management	0.21	£ 77,506	£ 27,173	£ -	£ 104,679
330	WE projects for SMEs	0.26	£ 171,244	£ -	-£ 23,626	£ 147,618
4	NEWP and WEND maximisation	1.58	£ 325,001	£ 204,828	£ 673,223	£ 1,203,051
Group 6c	Options(112,134,612,261,250)	4.38	£ 3,842,611	£ 1,709,665	£ 210,625	£ 5,762,902
112	LOND Peak Licence Scheme	0.76	£ 312,044	£ 234,694	£ 53,836	£ 600,574
134	VAUXI Groundwater	2.7	£ 1,164,380	£ 1,467,861	£ 113,806	£ 2,746,047
612	ROYD Artificial Recharge	-0.7	£ 398,214	£ 7,110	£ 46,998	£ 452,322
261	Tap re-washering	0.3	£ 334,397	£ -	-£ 11,653	£ 322,744
250	Water Saving Devices - Customer subsidy for purchasing	1.32	£ 1,633,577	£ -	£ -	£ 1,633,577
Group 7c	Options(548,105,26,533c1)	5.16	£ 6,367,484	-£ 378,845	£ 1,222,299	£ 7,210,938
548	HART Borehole - Replacement for PORT	0.48	£ 413,257	£ 189,589	£ 7,392	£ 610,237
105	HADHI New Borehole	1.51	£ 566,645	£ 170,914	£ 1,163,032	£ 1,900,591
26	SPRF - maximise average group licence	0.86	£ 796,297	£ 277,960	£ 108,355	£ 1,182,612
533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	2.31	£ 4,591,284	-£ 1,017,307	-£ 51,510	£ 3,522,468
Group 8c	Options(533c2,160,385,635,528,470)	4.11	£ 5,901,689	£ 958,093	£ 75,238	£ 6,935,020
533c2	Compulsory metering (AMR) - 15yr Prog - Phase 2	2.31	£ 4,393,574	-£ 965,019	-£ 50,190	£ 3,378,365
160	HEMP Source Optimisation	0.51	£ 461,462	£ 334,284	£ 34,694	£ 830,439
385	Retrofit Dual Flush Mechanism	0.09	£ 164,129	£ -	-£ 3,781	£ 160,347
635	Leakage reduction - District Metering	0.14	£ 138,101	£ 23,210	£ 97,670	£ 258,982
528	Leakage reduction - Speed of Repair	0.45	£ -	£ 990,322	-£ 11,592	£ 978,730
470	SCHO Relocation	0.61	£ 744,424	£ 575,296	£ 14,011	£ 1,333,732
Group 9c	Options(572,531,511,608,571,533c3)	2.46	£ 6,904,723	-£ 474,990	£ 43,649	£ 6,473,382
572	Retrofit aerated shower head	0.04	£ 83,859	£ -	-£ 1,252	£ 82,607
531	Left Over Commercials (metering of)	0.1	£ 202,675	£ 40,975	-£ 1,830	£ 241,820
511	RUNGS Peak Licence	0	£ 855,296	£ 81,121	£ 22,612	£ 959,030
608	RUNL (Treatment)	0	£ 1,532,151	£ 297,572	£ 82,037	£ 1,911,759
571	Dual Flush valve failures investigations	0.01	£ 26,365	£ -	-£ 4,115	£ 22,250
533c3	Compulsory metering (AMR) - 15yr Prog - Phase 3	2.31	£ 4,204,377	-£ 894,658	-£ 48,834	£ 3,260,885
Group 10c	Options(130,559,161)	3.07	£ 3,542,496	£ 1,688,355	£ 40,130	£ 5,270,981
130	RUNL (Chalk) Optimisation	1.72	£ 488,145	£ 221,053	£ 78,439	£ 787,637
559	Treated Water Storage	0	£ 1,854,966	£ 5,354	-£ 90,871	£ 1,769,449
161	LOWE Bulk Import Increase	1.35	£ 1,199,385	£ 1,461,949	£ 42,731	£ 2,704,064
ZONE: 1	**ALL OPTIONS**	**58.08**	**£ 38,650,110**	**£ 18,743,370**	**£ 2,787,384**	**£ 60,180,870**

Table 10.6.9e : Net Present Value of costs for selected schemes, Central Zone – Scenario 9

Option ID	Option Name - Central Zone	Average Yield (Ml/d)	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
87	SHAK Source Optimisation	0	£ 593,825	£ 68,368	£ 14,687	£ 676,879
28	HWFS/ARKR Transfer Upgrade	13.5	£ 991,563	£ 3,267,333	£ 461,460	£ 4,720,355
615	WHEA Peak Licence Scheme	0	£ 369,232	£ 65,672	£ 17,409	£ 452,313
24	ICKE Treatment Recommissioning	0	£ 2,250,740	£ 211,286	£ 196,700	£ 2,658,726
Group 5c	Options(607,428,185,567,604,388,573,636,624,566)	11.37	£ 4,834,190	£ 923,014	£ 85,340	£ 5,842,543
607	Large User - Water Efficiency retrofiting	0.07	£ 56,621	£ -	-£ 52,545	£ 4,076
428	Leakage Control - New Detection Technologies	0.57	£ 71,437	£ -	£ -	£ 71,437
185	Commercial Water Audits	0.15	£ 41,989	£ -	-£ 10,027	£ 31,962
567	Community water efficiency scheme	0.97	£ 208,868	£ -	£ -	£ 208,868
604	Communal Greywater reuse	0.12	£ 55,068	£ -	-£ 13,885	£ 41,183
388	New Cistern Displacement Devices	0.62	£ 218,582	£ -	-£ 8,034	£ 210,547
573	Hose gun triggers (targeted DMAs)	0.16	£ 61,025	£ -	-£ 35	£ 60,990
636	Leakage reduction - Pressure management	0.37	£ 145,789	£ 51,415	£ -	£ 197,205
624	BWB - Slough Arm	2.04	£ 674,667	£ 379,256	£ 61,442	£ 1,115,366
566	NORM - Detailed Review of Process	6.3	£ 3,300,144	£ 492,342	£ 104,148	£ 3,896,634
464	POOR Treatment Scheme	0	£ 2,508,972	£ 176,075	£ 88,157	£ 2,773,205
47	LANE 160	0	£ 5,712,828	£ 1,367,837	£ 1,072,433	£ 8,153,098
618	HILF Option A1 (b)	0	£ 5,829,373	£ 506,634	£ 551,935	£ 6,887,943
76	BUGR/PREP	10.13	£ 245,118	£ 166,013	£ 237,119	£ 648,250
533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	4.16	£ 7,567,878	-£ 1,655,130	-£ 87,901	£ 5,824,847
Group 11b	Options(330,571,385,572,66,635,531,48,261,426,249,528,67,65,250)	7.98	£ 9,410,588	£ 2,689,792	£ 2,284,850	£ 14,385,230
330	WE projects for SMEs	0.46	£ 247,347	£ -	-£ 623	£ 246,724
571	Dual Flush valve failures investigations	0.01	£ 45,413	£ -	-£ 33,662	£ 11,751
385	Retrofit Dual Flush Mechanism	0.17	£ 270,536	£ -	-£ 12,003	£ 258,532
572	Retrofit aerated shower head	0.06	£ 144,447	£ -	-£ 6,055	£ 138,392
66	GERR Source optimisation	0.69	£ 321,451	£ 106,194	£ 7,484	£ 435,129
635	Leakage reduction - District Metering	0.24	£ 227,634	£ 37,519	£ 149,345	£ 414,498
531	Left Over Commercials (metering of)	0.18	£ 349,105	£ 72,468	-£ 3,207	£ 418,366
48	THEG Peak Licence - Watford Fields Treatment	0	£ 2,700,307	£ 195,864	£ 1,527,728	£ 4,423,899
261	Tap re-washering	0.53	£ 504,742	£ -	-£ 3,739	£ 501,003
426	Leakage reduction - Service Reservoir	0.05	£ 186,585	£ -	£ 4	£ 186,589
249	Water Saving Devices - Voucher Scheme	0.04	£ 278,265	£ -	-£ 2,088	£ 276,177
528	Leakage reduction - Speed of Repair	0.81	£ -	£ 1,603,001	-£ 18,552	£ 1,584,449
67	HUGH Source Optimisation	0.61	£ 730,341	£ 242,855	£ 406,764	£ 1,379,960
65	DENH/UXBR New Source	1.75	£ 938,679	£ 431,891	£ 268,600	£ 1,639,170
250	Water Saving Devices - Customer subsidy for purchasing	2.38	£ 2,465,738	£ -	-£ 7,915	£ 2,457,823
ZONE: 2	**ALL OPTIONS**	**47.14**	**£ 40,314,300**	**£ 7,786,893**	**£ 4,922,190**	**£ 53,023,390**

Table 10.6.9e : Net Present Value of costs for selected schemes, Southern Zone and total for All Zones – Scenario 9

Option ID	Option Name - Southern Zone	Average Yield (Ml/d)	NPV CAPEX	NPV OPEX	NPV Env. Social	NPV COST
533c1	Compulsory metering (AMR) - 15yr Prog - Phase 1	1.23	£ 3,188,825	-£ 739,277	-£ 31,801	£ 2,417,747
533c2	Compulsory metering (AMR) - 15yr Prog - Phase 2	1.23	£ 3,051,507	-£ 702,239	-£ 31,199	£ 2,318,069
533c3	Compulsory metering (AMR) - 15yr Prog - Phase 3	1.23	£ 2,920,102	-£ 668,649	-£ 30,568	£ 2,220,885
560	Lady Mead Optimisation	1.05	£ 1,207,577	£ 702,724	£ 14,407	£ 1,924,709
250	Water Saving Devices - Customer subsidy for purchasing	0.71	£ 910,447	£ -	£ -	£ 910,447
654	KEMP WRSE Option	0	£ 3,014,480	£ 2,371,520	£ -	£ 5,386,000
388	New Cistern Displacement Devices	0.18	£ 56,753	£ -	-£ 9	£ 56,744
567	Community water efficiency scheme	0.29	£ 51,896	£ -	-£ 13,347	£ 38,549
249	Water Saving Devices - Voucher Scheme	0.01	£ 86,159	£ -	-£ 1,962	£ 84,197
261	Tap re-washering	0.16	£ 149,553	£ -	-£ 5,128	£ 144,425
330	WE projects for SMEs	0.14	£ 70,132	£ -	-£ 9,571	£ 60,561
636	Leakage reduction - Pressure management	0.11	£ 30,375	£ 9,979	£ -	£ 40,354
5	HORS Source Recommissioning	0.26	£ 251,041	£ 100,155	£ 37,889	£ 389,085
528	Leakage reduction - Speed of Repair	0.24	£ -	£ 381,110	-£ 4,639	£ 376,471
428	Leakage Control - New Detection Technologies	0.17	£ 13,043	£ -	£ -	£ 13,043
573	Hose gun triggers (targeted DMAs)	0.05	£ 10,662	£ -	-£ 1,809	£ 8,853
635	Leakage reduction - District Metering	0.07	£ 49,562	£ 7,439	£ 32,515	£ 89,515
620	Large User - Rainwater harvesting	0	£ 14,912	£ 388,526	-£ 130	£ 403,308
603	Communal rainwater reuse	0.04	£ 18,127	£ -	-£ 2,585	£ 15,541
185	Commercial Water Audits	0.04	£ 5,623	£ -	-£ 2,264	£ 3,359
385	Retrofit Dual Flush Mechanism	0.05	£ 49,394	£ -	-£ 1,084	£ 48,310
569	Targeted Water Efficiency promotion -Housing Associations	0.02	£ 2,870	£ -	-£ 361	£ 2,509
426	Leakage reduction - Service Reservoir	0.01	£ 31,195	£ -	£ 1	£ 31,196
271	Leakage reduction - Communication Pipes	0.66	£ 1,509,564	£ -	£ 53,967	£ 1,563,531
531	Left Over Commercials (metering of)	0.05	£ 53,449	£ 8,477	-£ 510	£ 61,415
572	Retrofit aerated shower head	0.02	£ 21,163	£ -	-£ 276	£ 20,887
571	Dual Flush valve failures investigations	0	£ 6,367	£ -	-£ 873	£ 5,494
637	Leakage reduction by 1 Ml/d	0.07	£ 796	£ 894,589	£ -	£ 895,385
427	Leakage reduction - Global Supply Pipes	0.22	£ 1,493,694	£ -	£ 541,776	£ 2,035,470
532	Left Over Domestics (metering of)	1.05	£ 2,934,226	£ 56,744	£ 17,453	£ 3,008,423
638	Leakage reduction by 2 Ml/d	0.14	£ 1,538	£ 966,481	£ -	£ 968,020
270	Leakage reduction - Distribution Main Renewals	0.15	£ 1,947,258	£ -	£ 19,899	£ 1,967,157
639	Leakage reduction by 3 Ml/d	0.14	£ 1,432	£ 878,160	£ -	£ 879,592
640	Leakage reduction by 4 Ml/d	0.14	£ 1,395	£ 871,933	£ -	£ 873,328
641	Leakage reduction by 5 Ml/d	0.14	£ 1,362	£ 867,051	£ -	£ 868,413
642	Leakage reduction by 6 Ml/d	0.14	£ 1,332	£ 863,350	£ -	£ 864,683
643	Leakage reduction by 7 Ml/d	0.14	£ 1,307	£ 860,510	£ -	£ 861,817
644	Leakage reduction by 8 Ml/d	0.14	£ 1,286	£ 842,802	£ -	£ 844,089
645	Leakage reduction by 9 Ml/d	0.14	£ 1,271	£ 838,567	£ -	£ 839,838
646	Leakage reduction by 10 Ml/d	0.14	£ 1,262	£ 831,585	£ -	£ 832,847
ZONE: 3	**ALL OPTIONS**	**10.77**	**£ 23,902,170**	**£ 10,714,210**	**£ 599,570**	**£ 35,215,950**
	Total - ALL ZONES	**115.99**	**£ 102,866,580**	**£ 37,244,473**	**£ 8,309,144**	**£ 148,420,210**

10.7 Water Efficiency Uncertainties

The table below outlines the risks and uncertainties associated with water efficiency options considered for the least cost plan. We will continue to improve the reliability, sustainability and repreatability of demand management options in line with the developments in the evidence base for our next plan.

Project ID	Scheme title	Veolia category	Description of scheme	Description of benefits	Benefits at average	Benefits at peak	Confidence in benefits	Description of risks and uncertainties	Full utilisation AISC (p/m3)
185	Water Audits – Commercials	Water efficiency	Commercial water audits to advise businesses how to use water more efficiently in manufacturing processes and everyday use.	5% reduction in water use expected following water efficiency audits.	0.53Ml/d	0.53Ml/d	Medium	All options presume that savings will be sustained in perpetuity once generated.A particular uncertainty arises as the ongoing costs of maintenance are not included. This is an area of great uncertainty in the evidence base.	11.8
249	Water saving devices - Voucher Scheme	Water efficiency	Scheme to offer VWC customers vouchers towards discounting the price of new water efficient devices (washing machines and dishwashers).	Customers will replace old inefficient devices with modern efficient devices. Saving water each time they are used in the home.	0.31 Ml/d	0.31Ml/d	Good savings figures taken from Waterwise and The Environment Agency.	Savings may double count the demand forecast which already includes for replacement of white goods.	799.2
250	Water saving devices - Customer subsidy for purchasing water saving devices	Water efficiency	Offer discounts or money off vouchers to customers of VWC towards the purchase of water efficient devices, such as taps, Ecobeta dual toilet flush, aerated shower heads etc.	Customers can replace inefficient devices at a discounted price, making water saving around the home more attractive and more cost effective for home owners. Actual Water savings will depend on the number of devices installed	unknown	Unknown	High	Risk of not undertaking - may fail to fulfil statutory duty.Uncertainty of working with a manufacturer or supplier to support discounted products.	107.0

Project ID	Scheme title	Veolia category	Description of scheme	Description of benefits	Benefits at average	Benefits at peak	Confidence in benefits	Description of risks and uncertainties	Full utilisation AISC (p/m3)
261	Re-washering taps	Water efficiency	Subsidised tap rewashing service, including home visit and installation by plumber.	4000 to 5000 litres saved per tap re-washered (Ofwat best practice register). Assumed that every house that takes up the offer has one dripping tap and would target 80300 houses. 0.99 Ml/d.	0.99Ml/d	0.99Ml/d	High, based on OFWAT figures.	BAsed on industry evidence and our own evidence both take up rates and costs are uncertain.	94.0
330	WE Project for SME's	Water efficiency	The scheme will target small and medium sized businesses and look at ways in which they can become more water efficient.	Savings based on 5% uptake rate by non-household sectors.	1.62Ml/d	1.62Ml/d	Medium	Uncertainty of up take rate and cost benefit of industry data.	60.6
385	Retro fit dual flush mechanism	Water efficiency	A project to promote the use of retro fit dual flush systems within the home, through giving away a number of devices. (2000 per year over 5 years).	31 litre/property/day (Based on Ofwat good practice guide)	0.31Ml/d	0.31Ml/d	Good - savings taken from OFWAT	Uncertainty - rate of household uptake. Potential double counts with demand forecast	167.3
388	New cistern displacement devices	Water efficiency	Install Hippos at 50 metered houses - (by plumber) in order to be able top monitor the exact water saving achieved by their installation and update figures. The project will target the continued role out of hippos	18-36l /CDD/day. Targeting 125000 households would save 3.375Ml/d	3.34 Ml/d	3.34Ml/d	Based on mid range figure from Ofwat good practice register. Number of households suitable for hippo use is assumed.	Failure to fulfil statutory duty.Dependent on Householders being receptive to CDD installation. Duration of benefits.	27.8

Project ID	Scheme title	Veolia category	Description of scheme	Description of benefits	Benefits at average	Benefits at peak	Confidence in benefits	Description of risks and uncertainties	Full utilisation AISC (p/m3)
567	Community water efficiency scheme.	Water efficiency	Based on the out comes of the Neighbourhood water efficiency project results to help quantify savings and behavioural changes from changes made to water use.	Education, awareness and water savings via the creation of a community water saving ethic.	2Ml/d	2Ml/d	Benefits stated based on Waterwise proposal, assuming a similar target area to the original Neighbourhood project (2007 to 2010). So therefore high confidence level.	Risks associated with the project - Highly dependent on public participation.	28.2
569	Housing Associations - Targeted water efficiency promotion	Water efficiency	Working with housing associations to promote water efficiency to residents.	Targeting the message of water efficiency in the home to an audience who may be currently falling out side the scope of current messages. The water savings would depend on the number of changes that housing associations and their tenant's choose to implement	Unknown	Unknown	High	P project is reliant on the cooperation of housing associations and their tenants. There are benefits in associated energy savins	28.2
571	Dual flush valve failures - Investigation	Water efficiency	Investigate the incidents of dual flush valve failures as the cause of increased consumption. Promote the self testing of dual flush toilet valve function through the use of dye tablets which would be sent out handed out to customers	Evidence from Bournemouth suggest between 5-10% of increased (high) consumption may be caused by dual flush valve failures.	5-10% decrease in consumption where valves have failed.	5-10% decrease in consumption where valves have failed.	High - based on Bournemouth Water study results.	Failure rates and damaged valves passing large qualities of water.	1219.1

Project ID	Scheme title	Veolia category	Description of scheme	Description of benefits	Benefits at average	Benefits at peak	Confidence in benefits	Description of risks and uncertainties	Full utilisation AISC (p/m3)
572	Aerated shower retrofit	Water efficiency	Retrofit low flow aerated shower heads.	Average saving 28% or 3.2litres/min	0.13 Ml/d	0.13 Ml/d	Benefits, water saving taken from United Utilities study results. Therefore confidence is high.	Will require members of the public to agree to change their shower head.	237.2
573	Hose gun trigger - Targeted DMA	Water efficiency	Target high consumption DMA's and distribute and promote the use of trigger guns for use on hose pipes.	3000 - 4000 litres/gun/year saving possible (Ofwat good practice register). With additional flow restriction assumed that 6000 litres/gun/year saving would be achievable.	0.33 M/Ld	Greater than 0.33 Ml/d	High - figures taken from Ofwat best practice register.	Duration of benefits is uncertain	23.4
603	Communal rainwater reuse	Water reuse	Speculative scheme to fit rainwater recycling systems (with dual network) in new housing developments, at a community scale. After basic disinfection, the rainwater could be used for toilet flushing, clothes washing and outdoor use. The installation of a recycling system could be promoted through different water incentives: capital cost subsidizing, block tariff…Care taken to ensure public acceptability.	Opportunity cost of the potable water saved (approximately 40.5 m3/household/y) Role in flood protection (by harvesting the rainwater)	40.5m3/hhd/y Best case scenario190,000 m3/y (0.52Mld)	40.5m3/hhd/y Best case scenario190,000 m3/y (0.52Mld)	Depends on the willingness of people to fit the system	- uptake - the people have to actually use the system once it is fitted - risk of cross connection pollution and health risks	20.8
604	Communal grey water reuse	Demand management	Speculative scheme to fit grey water recycling systems (with dual network) in new housing	Opportunity cost of the water saved	Best case scenario: 160,000	Best case scenario: 160,000	High uncertainty. Depends on the customer's	- customers willingness to fit and use the system -risk of cross-connections	11.4

Project ID	Scheme title	Veolia category	Description of scheme	Description of benefits	Benefits at average	Benefits at peak	Confidence in benefits	Description of risks and uncertainties	Full utilisation AISC (p/m3)
			developments, at a community scale. After treatment, the grey water could be used for toilet flushing and outdoor use. The installation of a recycling system could be promoted through different water incentives: capital cost subsidizing, block tariff. Care taken to ensure public acceptability.		m3/y (0.44Mld)	m3/y (0.44Mld)	willingness to fit and use the system		
607	Large user - Water Efficiency retrofitting	Reuse	Extensive retrofitting measures to be installed in the different parts of Luton airport: Terminal building, Hotels and Offices. Study required to establish the detailed design and detailed cost. Cost Benefits for Luton Airport would be of £58,000/year (calculated with current figure of £0.83/m3). VWC would commission an external body to implement this project.	Opportunity cost of the water saved Less effluent discharge fees	65,900m3/ year = 0.18Mld	65,900m3/ year = 0.18Mld	High - but depends on the extent of the retrofitting programme	Dependent on Luton Airport acceptance and willingness to pay for this project.	24.4
620	Large user - rainwater harvesting	Reuse	Implementation of rainwater harvesting system in Terminal and Hangar Buildings. Installation of rainwater tanks on roofs, storage tank - desinfection of water for toilets flushing only. Study required to establish the detailed design: collect precise data about the roof types and the rainfall, measure the rainwater quality in terms of faecal micro-organisms and chemical components, check the cost analysis with other case	Opportunity cost of the water saved Less effluent discharge fees	11,300m3/ year = 0.03Mld	11,300m3/ year = 0.03Mld	Medium	Dependent on Luton Airport acceptance and willingness to pay for this project.	271.3

Project ID	Scheme title	Veolia category	Description of scheme	Description of benefits	Benefits at average	Benefits at peak	Confidence in benefits	Description of risks and uncertainties	Full utilisation AISC (p/m3)
			studies coming from EA and BSRIA. Cost Benefits for Luton Airport would be of £9,293/year (calculated with current figure of £0.83/m3). VWC would commission an external body to implement this project.						
133	Stevenage STW	Reuse	If a new sewage treatment works was to be built, SE of Stevenage, effluent returns to the Upper Beane would ensure year round base flow, mitigating the impact of abstractions on river flows. High quality effluent would be required. The EA along with VWC are involved with the Rye Meads Water Cycle study. A new sewage works SE of Stevenage is unlikely to be the preferred solution.	Would allow Whitehall to remain operational and improve flows in the Beane and River Lee. High possibility of increasing output from Hertford sources.	5Mld	5Mld	High	Uncertainties over how such a scheme would be developed due to VWC not having sewage undertaking.	527.8

10.8 Glossary of Terms

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
ACORN	A classification of Residential Neighbourhoods (ACORN) is a socio-demographic classification of neighbourhoods published by CACI Ltd. The system is based on the assumption that people who live in similar neighbourhoods are likely to have similar behavioural and consumption habits.
ALF	Alleviation of Low Flow. Predecessor to the Restoring Sustainable Abstraction (RSA) Programme looking at the impact of public water supply abstraction on low river flows.
Allowable Outage	The outage (calculated from legitimate unplanned and planned events) which affects the water available for use. An outage allowance may be made for such outages.
AMP	Asset Management Plan which identifies a company's future 5 year investment strategy.
AMP2	Asset Management Plan for period 1995-2000.
AMP3	Asset Management Plan for period 2000-2005.
AMP4	Asset Management Plan for period 2005-20010.
Annual average	The total demand in a year, divided by the number of days in the year**.**
Annual billing run	Sending out yearly bills for the measured and unmeasured consumption.
Aquifer	A water bearing rock used for water supply via wells, boreholes and springs.
Available headroom	The difference (in ML/d or %) between water available for use (WAFU), including imported water, and demand at any given point in time.
Average day demand in peak week (ADPW)	One seventh of total demand in the peak week in any 12 month demand period.
\verage incremental cost AIC)	A method of calculating the net present value of additional water delivered or reduced demand.

Average incremental social costs (AISC)	A method of calculating unit benefit of new supply or demand options including social and environmental costs. This is net present value of additional water delivered or reduced demand.
Baseline Forecast	A demand forecast which reflects a company's current demand management policy but which should assume the swiftest possible achievement of the current agreed target for leakage during the forecast duration, as well as implementation of the company water efficiency plan.
CAMS	Catchment Abstraction Management Strategy. Environment Agency strategy which sets out the new licensing policy for catchments throughout England and Wales.
Capital investment	Spending by firms on capital equipment. This includes spending on machinery, equipment and buildings.
Catchment	An area from which a source takes raw water.
Catchment Protection	Policies and actions to minimise pollution within the catchment.
Carbon Footprint	The amount of carbon dioxide (tonnes) emitted as a result of actions and processes undertaken by the company.
Change of Ownership Metering	Compulsive metering of consumption following a change of occupier providing there isn't already a meter at the property.
Communication Pipe	The part of a service pipe which is vested in the water supplier.
Consumption Monitor	A sample of properties whose consumption is Monitored in order to provide information on the consumption and behaviour of properties served by a company. Applied to household and non-household customers.
COPI	Construction Outputs Price Index. The rate of inflation that applies to a basket of construction prices over a period of time.
Critical Period	The period of time during which the customer experiences the greatest risk of loss of supply.
Crystal ball ®	Commercially available software which undertakes complex statistical analysis such as Monte Carlo analysis.
Demand Management	A sample of properties whose consumption is monitored in the implementation of policies or measures which serve to control or influence the consumption or waste of water (this definition can be applied at any point along the chain of supply).
Deployable Output	The output of a commissioned source or group of sources or of a bulk supply as constrained by(if applicable): • Environment • Licence, if applicable • Pumping plant and/or well/aquifer properties

	• Raw water mains and/or aquifers • Transfer and/or output main • Treatment • Water Quality
Distribution Input	The amount of treated water entering the distribution system at the point of production.
Distribution losses	Total leakage on the distribution system minus supply pipe leakage and is made up of losses on trunk mains, service reservoirs, distribution mains and communication pipes.
Distribution System (DSOU) Operation use	Water knowingly used by a company to meet its statutory obligations particularly those relating to water quality Examples include mains flushing and air scouring.
Drought	Period of low rainfall which particularly impacts levels of ground water recharge in the winter period and river flows and demand patterns in the summer months.
Drought management Plan	Statutory plans to manage supplies during a drought period.
Drought order	An authorisation granted by the Secretary of State under drought conditions, which imposes restrictions upon the use of water and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.
Drought permit	An authorisation granted by the Environment Agency under drought conditions, which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.
Drought threshold levels	A ground water level or river flow which is used to restrict raw water available from sources.
Dry year	A year of rainfall below long term average and is characterised with high summer temperatures and high demand.
Dry year Annual Average Unrestricted daily Demand	The average amount of water supplied in a dry year made up of the level of demand, which is just equal to the maximum annual average, which can be met at anytime during the year without introduction of demand restrictions. This should be based on a continuation of current demand management policies.
Economic Level of Leakage	The level of leakage where the cost associated with reducing leakage further is higher than the cost of putting more water into supply. This can be calculated both on a short and long term basis and is calculated in Ml/d.
Environment Agency	The government agency's main statutory body with responsibility for licensing abstraction, consenting discharge in addition to advising on environmental and flood risk management policy, and setting and enforcing environmental standards in England and Wales.
Environmental Impact Assessment	Requirement under Directive 85/377 EEC (as amended by Directive 97/11/EC) to carry out an assessment of the likely significant effects of a proposed development on the environment

	before consent is granted. EIA must be carried out in accordance with the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.
Environmental Statement	This explains the environmental issues identified as being important to a particular project under consideration as well as what the environment is like now, and how it might change as a result of the project. Consideration must be given to the alternatives that have been looked at and the ways in which the significant affects the project is likely to have may be avoided, reduced or addressed.
Feasibility Studies	An investigation into the viability of a plan to meet a particular need.
Final planning demand forecast	A demand forecast, which reflects a company's preferred policy for managing demand and leakage through the planning period, after taking account of all options through full economic analysis.
Final planning scenario	A companies preferred scenario for water available for use taking into account demand and headroom. It constitutes the best estimate for planning purposes, consistent with information provided to Ofwat for the periodic review to secure water supply.
Forecasts/Plan Horizon	The end date of demand forecast or water resources plan (for example, 2035).
Groundwater	An important part of the natural water cycle present underground, within strata known as aquifers.
Group Licence	Restrictions placed on a number of licenses to constrain the total output from the group.
Habitats Directives	A collective term for Birds Directive 79/409/EEC on the conservation of wild birds and Habitats Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora.
Habitats Directives Schemes	Programmes to assess and implement works in order to mitigate the impacts of abstraction on designated sites under the Habitats Directive.
Headroom	Minimum buffer that a prudent water company should allow to cater for uncertainties in specified components of the supply-demand balance forecast.
Hydrographs	Plots of water levels against time
Leakage Control	Control of the sum of distribution losses (on trunk mains, service reservoirs, distribution mains and communication pipes) and underground supply pipe losses (between the point of delivery at a property and the point of consumption).
Local Plan	Development plan prepared by district and other local planning authorities.
Local Planning Authority	Authority with responsibility for planning regulation and development control.

Maximum likelihood estimation (MLE)	A statistical technique where a reconciliation item is distributed to the largest and least certain components of an estimate of the magnitude of a variable. The technique can be applied to a reconciliation of a water balance.
Mega litres Per Day	(Ml/d) One mega litre equals one million litres (1,000 cubic metres) per day.
Meter Optants	Properties where a meter is voluntarily installed at the request of its occupants.
Micro –component analysis	The process of a deriving estimates of future consumption based on expected changes in the individual components of customer use.
Mitigation	The alteration of proposals to address specific concerns in order to achieve environmental, social or economic improvement
Monte Carlo Analysis	A statistical evaluation technique which obtains a probabilistic approximation to the solution of a problem by using statistical sampling techniques.
Net Present Value	The difference between the discounted sum of all of the benefits arising from a project and the discounted sum of all the costs arising from the project. Put simply it is the economic value of a project, at today's prices, calculated by netting off its discounted cash flow from revenues and costs over its full life.
Non-households	Properties receiving potable supplies that are not occupied as domestic premises, for example, factories, offices and commercial premises.
Normalisation Factor	A factor applied to bring the sum of all individual probabilities of an occurrence for an event to equal one.
Normal Year	An average year of rainfall and demand patterns.
Normal year annual average daily demand	The total demand in the year with normal or average weather patterns, divided by the number of days in the year.
Operating Costs	Routine operating expenses comprising day to day (both planned and unplanned) costs, such as wages, power, materials and transport.
Outage	A temporary loss (less than 3 months) of deployable output. Outage can be as a result of power loss, pollution events and others.
PCC	(Per Capita Consumption) Amount of water consumed per person, it can be unmeasured (uPCC) or measured.
Point of abstraction	The top of a borehole for ground water abstraction; the river intake for surface water abstraction to direct supply or bank side storage; the draw – off tower for a direct supply reservoir.
Point of Consumption	The point where the supply pipe rises above ground level within the property, usually inside the stopcock or an internal meter.

Point of delivery	The point at which water is transferred from mains or pipes, which are vested in the water supplier into, pipes which are the responsibility of the customer. In practice this is usually the outside stopcock, boundary box or external meter.
Point of Production	The point where treated water enters the distribution system.
Potable Water Produced	Raw water abstracted less treatment works operational use and treatment losses.
Potable Water Exported	Potable water exports from within a defined geographical area to an area outside that defined geographical area.
Potable Water Imported	Imports of potable water from outside a defined geographical area to a defined geographical area.
"Pull" System	A system of control on pump operation based on reservoir levels.
Potential Yield (PY)	Maximum output from a source or group of sources constrained only by well and/or aquifer properties for specified conditions.
Raw Water	Water taken from rivers, ground water or reservoirs prior to treatment.
Raw water abstracted	Raw water abstracted at the point where abstraction charges are levied. It is made up of raw water retained and raw water exported.
Raw water collected	Raw water retained plus raw water imported.
Raw Water exported	Raw water exported from a specific geographical
Raw Water Imported	Raw water imported from outside of a specified geographical area.
Raw Water Losses	The net loss of water to the resource system comprised of mains/aqueduct (pressure system) losses, open channel/very low pressure system losses, and losses from break-pressure tanks and small reservoirs.
Raw water operational use	Regular washing-out of mains due to sediment build-up and poor quality of source water.
Resultant Deployable Output (RDO)	The final deployable output allowing for constraints and share of group licenses which might be different to the volume on the license.
Reconciliation item	The difference between the estimates of the magnitude of a variable and the sum of the estimates of the individual components of that variable.
Regional Planning Authority	Prepares, monitors and reviews the regional planning guidance for its region. In every English region this now the regional assembly.
Regional Spatial Strategy	Statutory regional spatial strategies will replace non-statutory regional planning guidance notes produced for each English region. Regional spatial strategies will be part of the development plan. As a consequence, they are likely to be more detailed and

	will carry much more weight in relation to determining planning applications. In London, the spatial development strategy prepared by the mayor forms the regional spatial strategy.
Resource Zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zones in which all customers experience the same risk of supply failure from a resource shortfall.
Rest Water Levels	Non pumping level of water in a borehole or well.
RSA Programme	Restoring Sustainable Abstraction Programme – Environment Agency led programme of investigations looking at the impact of public water supply abstraction on river flows.
Return Events	An event or occurrence with the tendency to reoccur.
Return Period	The assessed frequency of occurrence of a specified return event.
Risk	A measure of the probability and magnitude of an event and the consequences of its occurrences.
Retail Price Index (RPI)	A measure of the increase in price of a specified basket of goods each year related to a base year.
SAC	Special Area of Conservation – An area designated under Article 3 of the Habitats Directive for its high quality conservation status, making a contribution to the conservation of habitats and species listed in Annex I and II (amended).
Screening Tool	A sequence of decision-making techniques that incorporate different criteria on which to base a decision, rather than techniques based solely on, for example, financial analysis. Its main role is to deal with large amounts of complex information in a consistent way, which can otherwise create difficulties.
Source	A named input to a resource zone. A multiple well/spring source is a named place where water is abstracted from more than one operational well/spring.
Source Scale	Factors influencing individual source works.
Source works	Combination of boreholes, wells and springs providing water to a single treatment works.
Source Reliable Output	The outcome of a source yield assessment measured as Mega litres/day and usually linked to all peak values for specified constraints (same as those for deployable output)
Source Yield Assessment	The process of understanding the volume of water that any water source can provide during a critical period. This forms the basis of deployable output.
SPA	Special Protection Area – An area classified under Article 4 of the Birds Directive
SSSI	Site of Special Scientific Interest – An area designated under the

	Wildlife and Countryside Act for special interest by reason of any of its flora, fauna, or geological or physiographical features.
Strategic Environmental Assessment	A process designed to ensure that significant environmental effects arising from proposed plans and programmes and reasonable alternatives are identified, assessed, subjected to public participation, taken into account by decision makers, and monitored. SEA sets the framework for future assessment of development projects some of which require Environmental Impact Assessment (EIA).
Structural Water loss	Water lost from structures such as water towers, reservoirs.
Supply-demand balance	The deficit or surplus of supply against demand taking into account risk.
Supply pipe	The service pipe which is not vested in the water supplier and is normally the length of pipe between the property boundary where the water main is laid, and any terminal fitting directly connected to it and under mains pressure e.g. taps.
Supply pipe losses	The sum of underground supply pipe losses and above ground supply pipe losses.
Sustainability	Sustainability is essentially about protecting and enhancing the environment, and careful use of natural resources whilst considering today's needs and those of future generations.
Sustainability Appraisal	A process which provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal.
Sustainability criteria	A range of attributes against which to measure performance and which indicate the level of Sustainability against a project or programme proposal.
Sustainability reduction	Reductions in deployable output required by the Environment Agency to meet statutory and/or environmental requirements.
Target headroom	The threshold of minimum acceptable headroom, which would trigger the need for water management options to increase water available for use or decrease demand.
Total leakage pipe losses	The sum of distribution losses from trunk main, reservoir and underground supply pipe losses.
Treatment work losses	Includes treatment work operational use, structural water losses and any overflow water lost from structure overflows from reservoirs and drains.
Treatment work water operational use	Water used as part of the treatment process which is not taken into supply.
Underground supply pipe losses	Losses between the water supplier's pipe work and the customers tap.

UKCIP02	The Climate Impact Programme 2002 release.
UKWIR	UK Water Industry Research
Unrestricted demand	The demand for water when there are no restrictions in place for example hose pipe bans.
Void property	A property connected to the distribution network but not charged because it has no occupants.
WRMP tables	Tables used for presenting key quantitative data associated with Water Resources Management.
WAFU	**Water Available For Use.** The value calculated by deducting allowable outages and planning allowances from deployable output in a resource zone.
WATCOM	Water Consumption Monitor – a study of water consumption of unmetered consumers to evaluate how unmeasured customers utilise water.
Water Balance	A calculation of the difference between the sum of the components of water consumption and the measured Deployable Output.
Water delivered	Water delivered to the point of delivery such as the customer's tap. This includes supply pipe losses.
Water delivered billed	Water delivered less water taken unbilled. It can be split into unmeasured household, measured household, unmeasured non-household and measured non-households water delivered.
Water Framework Directive	European Legislation promoting the efficient use of water and protecting the environment from over abstraction by restoring it to a good ecological status.
Water taken	Distribution Input minus distribution losses.
Water Resource	The volume (Ml/d) of water that the company can use to meet customer demand. It can be considered on both regional and local scales.
Water Resource Zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zones in which all customers experience the same risk of supply failure from a resource shortfall.
Water Resource Management Plan	Water Companies' plans for supplying water to meet demand over a 25 year period.
Water treatment works	Plant where raw potable water is treated to a standard suitable for drinking. Note this is not dealing with sewerage.
White goods and Appliances	Household appliances that utilise water such as fridges, freezers, dishwashers, washing machines.
WRc	Water Research Centre