ESSEX & SUFFOLK WATER

Final water resources management plan

2010 - 2035

Essex & Suffolk Water

January 2010

NORTHUMBRIAN WATER LIMITED

FINAL WATER RESOURCES MANAGEMENT PLAN

2010 - 2035

Essex & Suffolk Water

Authorised ………………………… Date 20th January 2010

John Devall

Approved ………………………… Date 20th January 2010

Martin Lunn

January 2010

Exclusions on the grounds of National Security

Essex & Suffolk Water has not excluded any information from this plan on the grounds that the information would be contrary to the interests of national security.

Under Section 37B(10)(b) of the Water Industry Act 1991, as amended by the Water Act 2003 ("the Act"), the Secretary of State can direct the company to exclude any information from the published Plan on the grounds that it appears to him that its publication would be contrary to the interests of national security.

We were not directed to exclude any information from the published Plan.

DOCUMENT CONTROL SHEET

Report Title :	Water Resources Management Plan 2010 -2035	
Release Date :	January 2010	Report Status : Final
Report Author(s) :	Martin Lunn, Paul Saynor, Clare Ridgewell, Sarah Newbury, Liz Price, William Robinson, Liz Scott, Jenny Abel, Tom Andrewartha, Megan Rogers, Sue Burch, Liz Wright, Dennis Dellow	
Related Reports	Essex & Suffolk Water Final Drought Plan, October 2007	
Distribution List :	**Internal :** Applicable Management & Affected Depts **External :** • Ofwat • Environment Agency • Secretary of State (c/o Defra) • Regional Development Agencies in the area covered by the Plan. • Elected Regional Assembly in area of the plan. • Local authorities in the area of the plan. • The Broads Authority. • Natural England • The Historic Buildings and Monuments Commission for England. • Navigation authorities in the area of the plan. • Thames Water Utilities • Anglian Water Services • The Consumer Council for Water	

Essex & Suffolk Water is a trading division of Northumbrian Water Limited which is a group company of Northumbrian Water Group

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SUMMARY OF PLAN

This Final Water Resource Management Plan has been produced in accordance with statutory requirements and follows the Environment Agency's Guidance document. All of the components of demand and supply have been reviewed for this plan and the majority reworked using specific guidance or Industry best practice methodologies.

The plan has been constructed to ensure that we are working towards the water resource/demand management strategy contained within the Essex & Suffolk Water's Strategic Direction Statement, produced as part of the Periodic Review, and titled "Looking to the Future". Under Availability of Water the Strategic Direction Statement contains the following:

Area	Intermediate Goal	Long Term Aspiration
Sufficiency of water supplies	Continue to provide sufficient water in the face of population growth and climate change. A key aspect being delivery of the Abberton scheme by 2014.	Continue to provide sufficient water
Frequency of hosepipe bans	1 in 20 years	Continue with 1 in 20 years.
Leakage from pipes	Manage at long term sustainable economic level	Continue to manage at the long term sustainable economic level
Saving water	Actively promote reductions in water use and wastage.	Continue to actively promote reductions in water use and wastage.
Metering in our Essex area	Achieve as near to universal metering as practicable by 2020	Continue to meter as many properties as practicable.
Metering in our Suffolk area	Achieve as near to universal metering as practicable by around 2030	Continue to meter as many properties as practicable.

Because similar methodologies were followed to those used for the Water Resource Plan 2004 (WRP04) this plan is seen more as an evolution of our previous plans. The largest changes since WRP04 come about as a result of

allowing for the effects of climate change on our resources and demands and changes to deployable output from recent river flow naturalisations.
In accordance with statutory requirements, the plan has been consulted upon during 2008 and the plan revised, where appropriate, as a result of the consultation.

Changes from Draft Plan

The Sections of the Plan that have been altered are those where a consultee has commented on the original plan, and we have agreed with their comment and altered that section according to our Statement of Consultation Response. All sections that consultees did not comment upon, or where, for the reasons given in the response document, we did not agree to changing, have been left as the original draft.

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APPENDIX

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Reproduced Experian Report: Household and population estimations and projections methodological guide and Reproduced Demographic Decisions report: Illegal immigrant and short term migrant population estimates.

Appendix B
Water Efficiency Options Cost Information & Analysis (including carbon accounting).

1. OVERVIEW

1.1. Introduction

This document is the Water Resources Management Plan (WRMP) for the southern operating area of Northumbrian Water Limited, trading locally as Essex & Suffolk Water (ESW). This WRMP forms part of Northumbrian Water's Business Plan for the 2009 periodic review of price limits, covering the period from 1 April 2010 to 31 March 2015 (otherwise known as AMP5).

For the first time WRMPs have become documents produced as part of a statutory process, as reflected in the Water Resources Management Plan Regulations, 2007. As such there is much greater emphasis on public consultation and ESW welcomed the comments on this WRMP received from interested orgainsations during consultation. Section 1.4 includes details of how the consultation process was carried out.

This Plan has also been the subject of a Strategic Environmental Assessment (SEA). The SEA is an important parallel process in the consideration of water resources management options and is the subject of a separate report, the key elements of which are summarised in Chapter 9 of this WRMP.

The Essex and Suffolk supply areas are located within some of the driest areas of the country and as such face particular challenges including general lack of new intrinsic water resources, growing demand, and uncertainty from climate change.

ESW fully embraces the concept of the 'twin track approach' to maintaining water supplies through a combination of demand management and water supply schemes and initiatives. ESW prides itself on its track record on demand management and in delivering innovative water supply solutions such as effluent recycling. The Company has amongst the lowest levels of leakage in the UK and is an acknowledged industry leader in water efficiency and water conservation. Additionally ESW is fully committed to achieving the maximum possible level of domestic meter penetration within an appropriate timescale.

Despite all the rigorous work on demand management, the last two periodic reviews have recognised that a major water resource scheme is required in the Essex resource zone to meet the growing demand for water. At the last review the Abberton Scheme was identified as being the appropriate option for ESW to pursue. This WRMP therefore sets out to reaffirm and justify the need for this scheme.

It was also recognised at the last review that a supply deficit in the Suffolk Northern/Central resource zone in the medium term would require development of additional supplies in addition to demand management. New groundwater development in the North Lowestoft area was identified as a potential option. This WRMP re-evaluates the need and timing of such an option.

1.2. Regulatory Framework

This statutory plan has been produced with reference to the following guidance:

- Water Resources Planning Guideline, Environment Agency, 2007
- The Water Resources Management Plan Regulations 2007
- The Water Resources Management Plan Direction 2007
- The Water Resources Management Plan (No. 2) Direction 2007
- The Water Resources Management Plan (No. 2) (Amendment) Direction, 2007
- The Water Resources Management Plan Direction (England) 2008
- Explanatory Memorandum to Water Resources Management Plan Regulations 2007 No. 727, Defra 2007
- Letter from Defra's Mike Walker to Regulatory Directors of Statutory Water Undertakers in England dated 3 May 2007.
- Company Guidance Information Requirements; Part B5 – Maintaining the Supply/Demand Balance, Ofwat 2007
- Letter from the Secretary Of State, Defra allowing publication of the Final WRMP dated 18th December 2009.

Additional detailed guidance/methodologies on specific aspects of the plan are referenced in relevant sections of this document.

1.3. Consultation

Prior to production of this document ESW was required under Section 37A (8) of the Water Industry Act 1991 to consult with the Secretary of State (Defra), the Environment Agency, Ofwat and (where appropriate) neighbouring water undertakers. A summary of these consultations is given below:

Secretary of State/ Defra
• Letter sent to Defra's Mike Walker dated May 2007 seeking views on what should be included in the water resources management plan. • Letter response from Defra's Mike Walker dated 22 June 2007.
Environment Agency
• Letter sent to the Environment Agency's Regional Director Paul Woodcock on 9 May 2007 asking for preliminary views on the water resources management plan. • Letter responses from the Agency's Regional Director Paul Woodcock dated 22 May 2007 and 18 June 2007. • Open letter from Chief Executive of the Environment Agency Barbara Young to water company Managing Directors dated 11 July 2007. • Regular meetings with the Environment Agency's Water Resources Planning function.
Ofwat

• Letter sent to Ofwat's Helen Twelves dated 9 May 2007 seeking views on what should be included in the water resources management plan. • Letter response from Ofwat's Helen Twelves dated 1 June 2007.
Other Water Undertakers
• Letter sent to Thames Water Utilities Dave Cook seeking views on what should be considered within the water resources management plan. • Letter response from Thames Water's Chris Lambert dated 8 June 2007. • Wider discussion with other eastern region water companies at regular Anglian Region Water Companies/Environment Agency liaison group meetings.

In accordance with the Water Resources Management Plan Regulations 2007 statutory consultees on the original consultation draft of this document were as follows:

- Ofwat
- Environment Agency
- Secretary of State (c/o Defra)
- Any Regional Development Agencies in the area covered by the Plan.
- Any elected Regional Assembly in area of the plan.
- All local authorities in the area of the plan.
- The Broads Authority.
- Natural England
- The Historic Buildings and Monuments Commission for England.
- Any navigation authority in the area of the plan.
- Thames Water Utilities
- Anglian Water Services
- The Consumer Council for Water

In addition ESW welcomed comments and representations from the wider community, including customers and other interest groups.

The consultation period on the Draft Water Resources Management Plan covered a twelve week period, commencing on 2 May 2008 and finishing on 25 July 2008. This period coincided with publication of the original draft plan on the Company's website at www.eswater.co.uk.

On 30 January 2009, ESW published a 'Statement of Response to Consultation' detailing the consideration it has given to all the representations received. This document was sent to all the individuals and organisations who made representation and is additionally available on the Company's website. Defra considered this statement and on the 3rd August 2009 requested further detail on some aspects of the Plan. This was produced in the 8 week timescale and the additional information sent to Defra and posted on the company's website.
On the 18th December 2009 the company received a letter from the Secretary of State, Defra giving permission to publish the Final WRMP.

1.4. Additional Matters to be Addressed

The Water Resources Management Plan Direction 2007 and Water Resources Management Plan (No. 2) Direction 2007 identify additional matters to be addressed in water resources management plans. These matters are summarised in the following table which indicates the sections within this document in which these matters are described:

Matters to be Raised in WRMP	Addressed in ESW WRMP
Outline of frequency of imposition of prohibitions or restrictions on customer use in relation to: - Section 76 - Section 74(2)b of the Water Resources Act 1991 and - Section 75 of the Water Resources Act 1991	Section 2.11
Indication of appraisal methodologies used in choosing the measures intended to be taken for the purposes set out in Section 37A(2) and the reasons for choosing these measures.	Chapters 3, 4, 5, 6, 7 & 9
The emissions of greenhouse gases which are likely to arise as a result of each measure identified in accordance with section 37A(3) (b)	Sections 9.11.6 and 9.15
How the supply and demand forecasts contained in the WRMP have taken into account the implications of climate change.	Chapter 6
How future household demand has been estimated over the planning period, including the assumptions made in relation to population and housing numbers.	Chapter 4
An estimate of the increase in the number of domestic premises in the area over the planning period in respect of which it will be required to fix charges by reference to the volume of water supplied to those premises under section 144A.	Chapter 4
Ditto above but assuming that the secretary of state determines that whole or part of the water undertakers supply area is an area of serious water stress.	Chapter 4 and Section 5.2
An estimate of the increase in the number of domestic premises in its area (excluding those above) over the planning period in respect of which section 144B(2) will not apply because the conditions referred to in section 144B(1)(c) are not satisfied and in respect of which it will fix charges by reference to volume of water supplied to those premises.	Chapter 4
Full details of the likely effect of what is forecasted pursuant to metering strategy on demand for water in its area.	Chapter 4 and Section 5.2

The estimated cost to the water undertaker in relation to the installation and operation of water meters to meet its forecasts and a comparison of that cost with other measures which it might take to manage demand or increase supplies of water.	Section 5.2 and Chapter 9
A programme for the implementation of what is forecasted in relation to metering strategy.	Section 5.2

2. BACKGROUND INFORMATION

2.1. Planning Period

In accordance with the Environment Agency's updated Water Resources Planning Guideline (WRPG, Environment Agency 2008a) ESW is planning ahead until 2034/2035 in its Water Resources Management Plan (WRMP). The company used 2007/2008 as the base year for the Plan.

Ofwat also required water companies to use 2007/2008 as the base year for the periodic review business plan submission.

2.2. Resource Zones

Essex & Suffolk Water (ESW) has geographically separate supply areas, known as the Essex supply area and Suffolk supply area respectively, as indicated in Figure 1. Water is supplied to approximately 1.4 million customers in the Essex supply area and 0.3 million customers in the Suffolk supply area.

For the purposes of water resources planning, reliable supply demand balances are determined at resource zone level. A resource zone is defined as 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.

In the case of ESW, four resource zones have been delineated, one in Essex (the Essex resource zone) and three in Suffolk known as the Hartismere, Blyth and Northern/Central resource zones. Schematic diagrams of the resource zones and associated infrastructure are indicated in Figures 2 and 3 for Essex and Suffolk respectively.

None of ESW's resource zones have changed from those last reported to the Environment Agency, although ESW has discussed with the Agency the possibility of eventually amalgamating the three Suffolk zones into a single resource zone. Considerations around this proposal are summarised later in this chapter.

The resource zones used for water resources planning purposes are described as follows:

2.3. Essex Resource Zone

The Essex resource zone (Figure 2) is bounded by the Thames Estuary in the south and the Essex coastline as far north as Salcott in the east. The zone stretches as far north as Silver End and as far west as the London Boroughs of

Redbridge, Barking and Havering. The zone includes the towns of Southend-on-Sea, Chelmsford, Witham, Brentwood, Billericay, Basildon, Grays, Dagenham and Romford.

The intrinsic water resources include the Essex rivers Chelmer, Blackwater, Stour and Roman River which support pumped storage reservoirs at Hanningfield and Abberton, and treatment works at Langford, Langham, Hanningfield and Layer. The remaining water sourced from inside the Essex resource zone (approximately 3% of total water supplied in the zone) is derived from groundwater via Chalk well and adit sources in the south and south west of the zone at Linford, Stifford, Dagenham and Roding, each with on-site treatment.

Water transferred into the Essex supply area from outside the area comes from two main sources; the Chigwell raw water bulk supply from Thames Water Utilities, and the Ely Ouse to Essex Transfer Scheme (EOETS).

A steady 20% of water supplied in Essex is provided via a raw water bulk transfer provided by Thames Water Utilities from the Lea Valley reservoirs. The raw water is pumped directly to ESW's treatment works at Chigwell for treatment and then into supply.

In a dry year, up to a third of the water supplied in Essex is derived from the Ely Ouse to Essex Transfer Scheme (EOETS) which transfers water from Denver in Norfolk via pipelines and pumping stations to the headwaters of the River Stour and the River Pant/Blackwater as indicated in Figure 1. The EOETS is owned and operated by the Environment Agency.

In dry years the contribution from the EOETS combined with the Chigwell bulk supply equate to over half the water supplied within the Essex supply area.

Additionally in dry periods the Agency may operate its river support schemes, particular when transfers via Denver are limited or not possible. The two schemes with potential to support river flows in Essex are the Great Ouse Groundwater Scheme (GOGS) and the Stour Augmentation Groundwater Scheme (SAGS).

The Essex rivers and their associated intakes, the pumped storage reservoirs at Abberton and Hanningfield and associated raw water transfer pipes, pumping stations and treatment works are collectively known as the 'Essex System'. This reflects the nature of the supply network in Essex which is a highly integrated one, with a large degree of flexibility for moving water around the zone to where it is required.

The currently preferred mode of operation of the Essex treatment works during the summer is for Langham, Langford, Layer and Chigwell to provide a

reasonably constant baseload, with output from Hanningfield varying to make up the excess.
At the end of 2003, ESW completed works to construct an innovative effluent recycling scheme at Langford, near Maldon. The scheme intercepts effluent from Chelmsford Sewage Treatment Works (STW) and treats it to a very high standard at a purpose built state-of-the-art treatment plant at Langford within the site area of ESW's existing water treatment works. Once treated the water is pumped 3km upstream into the River Chelmer where it augments the natural river flows and is available for re-abstraction via existing intakes supporting both Langford Water Treatment Works (WTW) and storage into Hanningfield Reservoir. The scheme can potentially provide an additional 30 Ml/d on average, of water for use within the Essex system during dry periods.

2.4. Suffolk Blyth Resource Zone

The Blyth resource zone of Suffolk is bounded by the Suffolk coastline in the east stretching from Aldeburgh in the south to Walberswick in the north. The zone stretches as far west as Earl Soham, and as far north as Chediston. The zone includes the towns and villages of Saxmundham, Leiston, Framlingham, Peasenhall and the southern side of Halesworth. Similarly to Hartismere, the zone is predominantly rural in nature.

All the water supplied within the Blyth resource zone is sourced from groundwater via Chalk sources at Walpole, Benhall, Saxmundham, Parham and Little Glemham, and Crag sources at Coldfair Green and Leiston. Raw water at each of these sites is treated on site with the exception of Little Glemham and Leiston, which are effectively satellite boreholes treated at Benhall WTW and Coldfair Green WTW respectively.

2.5. Suffolk Hartismere Resource Zone

The Hartismere resource zone of Suffolk (Figure 3) is bounded to the north by the River Waveney, from its source at Redgrave in the west to Mendham in the east. The zone stretches as far west as Rickinghall and Wyverstone Street, and as far south as Mendlesham Green and Aspall. The zone includes the town of Eye situated on the River Dove, a major tributary of the River Waveney. The zone is predominantly rural in nature and is characterised by arable farming.

All the water supplied within the Hartismere resource zone is sourced from groundwater via Chalk boreholes at Wortham, Rickinghall, Eye, Mendlesham and Syleham, and Crag sources at Bedingfield, Syleham and Bleach Green. Raw water from each of these sites is treated on site with the exception of Wortham and Bleach Green, which are satellite boreholes treated at Redgrave WTW and Syleham WTW respectively. It should be noted that Bleach Green is geographically located within the Northern/Central resource zone but wholly supplies raw water to the Hartismere resource zone (effectively a raw water import).

The Hartismere zone was particularly affected by the 1995 -1997 drought. As a result a large number of improvements were made in the zone, including new groundwater sources at Bedingfield and Bleach Green and network improvements to enable water to be more easily transferred around the zone.

2.6. Suffolk Northern/Central Resource Zone

The Northern/Central zone of Suffolk is bounded by the River Waveney and River Bure to the west, and the Suffolk coastline from Southwold to Winterton-on-Sea in the east. The zone includes the towns of Lowestoft, Great Yarmouth, north Halesworth, Bungay and Beccles. Demand in the zone is heavily influenced by the large population centres in Lowestoft and Great Yarmouth. The transient holiday population in Great Yarmouth during the summer, and the annual pea harvest in late June/early July have a notable seasonal affect on demand.

Approximately 70% of the water supplied in the Northern/Central resource zone is sourced from surface water, with a smaller proportion of 30% being sourced from groundwater in the south of the zone.

Surface water is provided via four sources; namely the River Waveney at Shipmeadow, the River Bure at Belaugh, and groundwater fed lakes at Ormesby Broad and Lound Ponds/Fritton Lake. Water from the Waveney is treated at Barsham River WTW, water from the Bure and Ormesby Broad is treated at Ormesby WTW, and water from Lound Ponds/Fritton Lake is treated at Lound WTW.

A smaller component of raw water from groundwater can be sourced from remote Chalk boreholes at Juby Farm and Grange Farm near Belaugh in the north of the zone, which are treated at Ormesby WTW. Larger quantities of groundwater produced in the south of the zone are sourced from Chalk boreholes at Halesworth, Holton, Barsham, Barsham Hall, Shipmeadow, Puddingmoor (Beccles), and Crag and Gravel wells at Southwold Alder Carr and Broome respectively. The Barsham, Barsham Hall, Shipmeadow and Puddingmoor sources are treated at Barsham groundwater WTW, whilst all other sources have associated treatment works on site.

The resource zone is named to reflect the fact that historically it effectively operated as two sub-zones; the Northern zone and the Central zone, although it is no longer appropriate to consider these as separate resource zones. The Northern zone contains Ormesby WTW and Lound WTW, whilst the Central zone contains Barsham WTW and all the groundwater sources except Juby and Grange Farm.

2.7. Connectivity Between Suffolk Resource Zones

The possibility of amalgamating the three Suffolk zones into a single resource zone was explored in discussions with the Environment Agency. ESW saw benefit in the proposal for the following reasons:

- The approach would remove the need to divide the robust Suffolk area demand related data into the three zones, thereby removing any associated data inaccuracy at sub-zone level.
- In practical terms, drought restrictions would always be enforced supply zone wide in Suffolk rather than at resource zone level, in order to avoid confusion amongst customers. Therefore all Suffolk area customers would, in reality face the same risk of restrictions on their use of water
- There is already some, albeit small interconnectivity between the zones; namely Walpole (in Blyth) feeding South Halesworth (in Northern/Central), Cratfield booster (in Hartismere) potentially supporting supplies in Blyth, and raw water from the Northern/Central zone at Bleach Green regularly supplying Syleham WTW (in Hartismere).
- The Agency's concern regarding hidden localised hotspots would not materialise as ESW has existing processes under its security of supply drivers to identify and address such issues. There are numerous examples of where such issues have been identified and addressed in a timely manner.

The Environment Agency did not accept ESW's proposal and due to lack of time to debate the issue more thoroughly, it was jointly decided to continue using the three Suffolk water resource zones for this periodic review. The option will however be reviewed again, prior to production of the next Water Resources Management Plan.

2.8. Scenarios

The 'dry year' is the fundamental basis of the demand forecast for the Company's Water Resource Management Plan. The Company has included the following planning scenarios in the Water Resources Plan:

- Dry year annual average daily demand forecast (baseline).
- Dry year annual average daily demand forecast (final plan).
- Normal year annual average daily demand forecast (baseline).

ESW's approach has been to build a significant base-load of demand constraining measures into the demand forecasts from the outset. This is due to the susceptibility of many of the resource zones to drought (as illustrated in the 1990's), and the limited number of options to address potential supply deficiencies in the future. This is also a requirement of Ofwat's water efficiency targets as explained further in Chapter 5. The Company considers this a prudent measure, since there is an overwhelming need to incorporate demand management at the heart of its water resource planning strategy.

The Company's assumptions regarding the impacts of climate change on both water available for use and demand are described in Chapter 6.

Operational experience has indicated that critical period scenarios such as those based on average day peak week (ADPW) are not appropriate for the Essex and Suffolk resource zones as none of the Company's resource zones are significantly peak constrained from a water resources perspective. In the case of the Essex resource zone peaks can usually be absorbed due to the integrated nature of the supply network and the storage provided by the two large pumped storage reservoirs. Similarly in the Suffolk Northern/Central zone the flexibility over utilisation of the three main surface water works at Lound, Barsham and Ormesby provides a buffer to impacts from peak demands.

Subsequent to the 1995 - 1997 drought, significant investment was made in network improvements and enhancement of security of supply within the groundwater fed zones of Hartismere and Blyth. This effectively removed any residual peak/critical period concerns, and hence no ADPW or similar peak scenarios are presented in this Plan.

2.9. Reconciliation of Data

ESW has used the maximum likelihood estimation method (MLE) to reconcile the water balance at resource zone level in order to minimise the uncertainty in base year estimates. MLE provides a good framework to reconcile the water balance to ensure the sum of the estimated components equates to distribution input. The standard method for MLE is provided in a UKWIR/NRA report (UKWIR/NRA,1995).

Details of the base year figures are provided in section 4.2.

2.10. Sensitivity Testing

In developing this WRMP, ESW has made a number of assumptions. The Agency has highlighted the importance of including a description of the sensitivity of the plan to these assumptions.

The Agency's Water Resources Planning Guideline (2008a) indicates that as a minimum the sensitivity analysis should consider:

(1) The sensitivity of the supply demand balance to data uncertainty
(2) The sensitivity of the proposed actions in the plan to assumptions or changes in the supply demand balance.

Item (1) is considered in detail within the calculation of headroom uncertainty and hence an assessment of sensitivity for each resource zone has been included in Section 7.4 within the chapter on Target Headroom.

Item (2) is essentially dealt with within the assessment of water resources management options and development of the final solution scenario for the supply demand balance. This is particularly the case in the Essex resource zone, where sensitivity in option selection has been considered within the Intermediate EBSD framework. This element of sensitivity is therefore described in Chapter 9.

Additionally sensitivity to indicative sustainability reductions is described in section 8.7.

2.11. Company Policies including Level of Service

Levels of service are expressed in terms of expectations about the frequency of restrictions on use during dry years, and set out the standard of service that customers can expect to receive from their water company. The 'planned' levels of service for ESW customers are indicated as follows;

Appeal for restraint	1 in 10 years
Hosepipe ban	1 in 20 years
Restriction on non-essential use	1 in 50 years
Rota Cuts	never

The planned level of service for the frequency of hosepipe bans has been changed for this periodic review. The frequency has been increased from 1 in 25 years (last Water Resources Plan) to 1 in 20 years (this Water Resources Management Plan). The other levels of service remain unaltered. The planned level of service has been changed to better reflect the reality of return periods in the Essex and Suffolk supply areas and to take account of the fact that both areas are located in what have recently been defined by the Agency as areas of serious water stress.

ESW customer research has showed that whilst there was no desire amongst customers to pay more for increasing the return period from 1 in 20 years to 1 in 50, the small cost benefit of having an increased frequency at 1 in 15 years was not seen as beneficial. In reality there is virtually no difference in resources required for 1 in 20 or 1 in 25 years and any differences between the two options are too small to show up given the nature of all of the uncertainties surrounding demand / supply forecasting.

In terms of actual levels of service, this can only be determined retrospectively and through consideration of return periods. The following table indicates the dates on which appeals for restraint and restrictions have been implemented within the Essex and Suffolk supply areas since 1976.

	Appeals for Restraint	Hosepipe Ban	Non Essential Use Restrictions	Rota Cuts
1976 drought				
Essex	Yes	Yes	No	No
Suffolk	Yes	Yes	No	No
1990/92 drought				
Essex	Yes	Yes	No	No
Suffolk	Yes	Yes	No	No
1995/97 drought				
Essex	Yes	Yes	No	No
Suffolk	Yes	Yes	No	No
2006 drought				
Essex	Yes	No	No	No
Suffolk	Yes	No	No	No

It should be recognised that restrictions in Suffolk (ie. hosepipe bans) have always been applied across the whole supply area and not in selected resource zones.

Essex

ESW has undertaken a modelling assessment to determine the frequency of hosepipe bans in Essex in terms of the historic naturalised flow time series available in the water resource planning model, *Aquator*. Total reservoir storage volumes were estimated using the dry year demand forecast for the 2007/08 base year and the naturalised flow time series from 1933-1996. Daily storage volumes for the two Essex Reservoirs, Abberton and Hanningfield, were exported from the model and total reservoir storage was compared to the annual combined control curve for the implementation of hosepipe bans (the 1 in 20 year return period). The number of days in which reservoir storage was below the control curve was calculated and used to determine the actual level of service the Essex system would be operated to under the sample flow conditions and demand forecast. The level of service was determined as 1 in 15 years.

These results indicate that ESW is not currently able to meet the ‘planned’ levels of service, as would be expected in a resource zone with a supply deficit. Moreover, the modelling work does not take into account the operational procedures that are used to mitigate against reservoir storage dropping to the drought action control curve level. For example, in 2003 the Environment Agency and ESW managed transfers from the Ely Ouse to Essex transfer scheme outside of the normal operational control curves, to ensure that reservoir stocks were maintained as long as possible. This was done as a result of taking into account the flow conditions being experienced at the time and the forecast weather conditions for the following months. As a result of this action the start of reservoir drawdown was delayed and there was no need to implement a hosepipe ban during the summer months. It is therefore likely that through such operational management ESW would be able to maintain its planned levels of service for a short period under the current dry year demand forecast, although security of supply would not be maintained through an extended drought. However, as demand increases over the planning horizon, in a zone already in deficit, it is likely that these levels of service would be compromised further if no new water resources management options (whether customer, distribution, production and/or resource orientated) were implemented.

Suffolk

In the groundwater supplied resource zones of Hartismere and Blyth, there is no mechanism by which to equate levels of service with groundwater levels. Therefore ESW has done an assessment based on an analysis of historic rainfall in the surface water dominated Northern/Central resource zone. The information on actual levels of service in terms of the implementation of restrictions, indicates that there is a correlation between the Essex and Suffolk supply areas, in that the same levels of appeals for restraint and restrictions have been implemented in each of the supply areas during the same drought years considered. To quantify this, a statistical analysis was carried out on the rainfall records for Barsham in Suffolk and Hanningfield in Essex to determine the statistical significance of the relationship between rainfall in Suffolk and that in Essex. This assessment gave a correlation co-efficient of 0.75 for the monthly average rainfall data from 1983-2008. A further assessment was carried out on the drought years 1995-1997. This gave a correlation co-efficient of 0.86. These results suggest that there is a strong similarity between the levels of rainfall in Essex and the levels of rainfall in Suffolk. This supports the view that actual levels of service achieved in Suffolk would be the same or very similar to those achieved in Essex, based on historic experience of the implementation of restrictions in both of these areas and the similarities in their rainfall record.

2.12. Details of Competitors in Each Resource Zone

With respect to the Water Act 2003 amendment of the Water Industry Act 1991 extending opportunities for competition within England and Wales, there are currently no other water supply licensees (either under retail or combined licences) operating within any of the ESW resource zones.

The only similar area of competition however is Anglian Water Services (AWS) inset appointment to supply Buxted Chickens at Flixton, near Bungay, which was secured in 1997. Buxted Chickens is located within ESW's Northern/Central resource zone and was supplied water by ESW prior to the inset appointment. The supply arrangement between Buxted Chickens and AWS continues to the present day.

2.13. Linkages with Drought Plan

This document is supported by the Company's Drought Plan (ESW, 2007a). The Drought Plan considers what measures can be implemented in the short term to address temporary shortages of water resources during drought conditions. By contrast this WRMP focuses on how demand is predicted to rise over the next 25 years and what resource options will be required to meet longer term increases in demand and the company's target headroom requirement.

Drought Planning is essentially a prepared response to developing sustained dry weather (drought) conditions that have the potential to detrimentally affect public water supplies. Drought conditions are usually manifested in the form of:

- reduced raw water availability (e.g. low river flows, low reservoir storage, low groundwater levels) and/or

- increased demand (e.g. due to increased drinking, garden watering, showering etc in dry weather).

There are direct linkages between longer term water resources planning and drought planning in terms of the calculation of all elements relating to the Supply Demand balance, which can be assumed to be consistent.

By contrast, water resources planning is the regulatory process used to determine how water companies intend to maintain the balance between water supply and demand over the long term (usually a 25 year period), and is commonly carried out at resource zone level. An important aspect of this process is the 'Supply Demand Balance' which is essentially a comparison of both forecast raw water availability (supply), against forecast demand. The forecasts are worst case in the sense that dry weather demands are measured against source yields defined by previous drought periods. Any deficits in the 'Supply Demand Balance' can be addressed by a combination of reducing demand (e.g. through leakage reduction, metering, water efficiency) and increasing supply (e.g. developing new sources of water).

3. WATER SUPPLY

3.1. Deployable Output

Deployable output for surface water systems is defined as:

"the constant rate of supply that can be maintained from the water resources system except during periods of restriction within the following constraints :

- *given level of service*
- *the historic period for which data is available or could be derived*
- *supply without storage entering the emergency storage zone*
- *supply within the defined physical capacities of the existing system adopted for the simulation*
- *source operation in accordance with licence, or, for specified scenarios, a drought order or permit."*

(Environment Agency, 1998a)

Deployable output for groundwater sources is defined as:

"the output of a commissioned source or group of sources or of bulk supply as constrained by the environment, licence (if applicable), pumping plant and/or well/aquifer properties, raw water mains and/or aquifers, transfer and/or output mains, treatment and water quality."

(UKWIR, 1995a)

3.1.1. Essex Resource Zone Deployable Output

The deployable output of the Essex resource zone as a whole has three separate components which are:

- the Essex System (including Langford Recycling Scheme)
- groundwater sources; and
- the Chigwell bulk supply

The determination of the first two elements is indicated in the following section. The assumptions for the Chigwell bulk supply are detailed in Section 3.4.1.

3.1.2. Essex System Deployable Output

Approach

The deployable output of the Essex system is calculated using a sophisticated windows-based water resources system model known as Aquator.

Aquator is based in Microsoft Access and through its use of Microsoft Visual Basic (MS-VB) programming, water resource model components are able to have their behaviour defined explicitly using macros.

Aquator models a water resource system by combining a multi-pass calculation of how water is to be distributed within a system together with the operating rules built into each component in the model. This approach attempts to optimise the allocation of water by allowing demands to first reserve and then take water. The reservation of water by all demands before any one demand actually takes water allows a sharing algorithm to make decisions based on predefined rules. These rules can be replaced or modified by the user to simulate the requirements of the water resource system being modelled.

Aquator models water resource allocation on a daily basis and has the ability to carry out historic yield calculations for a water resource system. This method of calculation is known as the 'English & Welsh Method'. The method involves running the model over the critical drought period in order to identify the optimum yield of the system, i.e. the maximum demand that can be continually met throughout the critical drought period. Aquator identifies the optimum yield by carrying out model runs between two user defined system demands and using a binary chop method to identify the optimum demand that can be met by the water resource system over the critical drought period.

Model Development since the last Periodic Review

The Aquator model used to calculate the PR09 Essex Resource Zone deployable output has been developed from the model recently used for the Abberton Scheme environmental assessment work. This model includes a number of major improvements over that used for the 2004 periodic review, and was audited by the Environment Agency in July 2007 (Atkins, 2007a). Subsequent to this audit, the model has been updated further to incorporate additional programming and adjusted parameter values to better represent components of the existing Essex System. The following sections describe all the model improvements made since the last periodic review.

Prior to the 2007 audit of the model, the two major changes were:

1. Replacement of the gauged flow sequence at Denver with a naturalised flow sequence and associated abstraction and discharge profiles to denaturalise the flow.

2. Incorporation of reservoir control curves to control the operation of the Ely Ouse to Essex Transfer Scheme (EOETS).

Denver Naturalised Flow Record

It was identified by both ESW and the Environment Agency that the development of a naturalised flow record for Denver would improve the accuracy of the Essex System model in Aquator and would be necessary to ensure the best available information was used to carry out the assessments required to support the Abberton Scheme proposals. A jointly funded project was therefore implemented by the Environment Agency and ESW to commission the work required to carry out the naturalisation of the Denver gauged flow record. The results of the flow naturalisation study were finalised and reported in January 2006 (Entec, 2006). The naturalised flow record was incorporated into the Aquator model of the Essex System with the associated abstraction and discharge sequence monthly profiles derived for 1996, in line with the other abstraction and discharge sequences used in the model.

EOETS Reservoir Control Curves

In order to make the model more representative of reality, visual basic programming was carried out to enable control curves to be applied to the Essex Reservoirs and used as triggers for making water available for abstraction from Denver. The control curves used in the baseline Essex System are representative of the control curves in the EOETS operational manual used by the Environment Agency to identify when transfers from Denver are required.

After the 2007 audit of the model the following model developments were made:

1. Refinement of the representation of the Denver Complex.

2. Inclusion of a reservoir control curve to control the operation of the Stour Augmentation Groundwater Scheme (SAGS) boreholes.

3. Adjustment to Langford Recycling Scheme output.

4. Incorporation of updated demand profile

5. Inclusion of applicable process losses

These developments are described as follows:

Refinement of the Representation of the Denver Complex

Work has been carried out on the Essex System model to better represent the Denver Complex. This has included the representation of the Cut Off Channel (CoC) and the Flood Relief Channel (FRC) at Denver as reservoirs. In addition, the sluices at the Denver Complex are also now represented in the model, providing links from the River Ely Ouse to the CoC and the FRC. These changes have enabled the movement of water around the Denver Complex to be modelled in a way that better represents reality.

Stour Augmentation Groundwater Scheme Reservoir Control Curve

In response to recommendations made by the Environment Agency and Atkins in the 2007 audit of the model, assessments have now been carried out incorporating the SAGS boreholes into the baseline deployable output (DO) calculation.

Visual basic programming has been used to enable a control curve on Abberton Reservoir to be linked to the operation of the SAGS boreholes. When reservoir storage falls below the level of the control curve the SAGS boreholes are switched on to support the river Stour and the Essex System demand. The control curve used in the baseline Essex System is representative of that used in reality by the Environment Agency to determine the operation of the SAGS boreholes.

Adjustment to Langford Recycling Scheme Output

In the AMP4 model the Langford Recycling Scheme output was based on the output that the scheme was anticipated to be able to achieve, but very little operational experience was available at the time to confirm the value. Now that several years of operational data has been obtained, a review was carried out and a more representative output figure of 20 Ml/d was determined. This value has been incorporated into the Essex System baseline model in Aquator. The details of the review carried out are available on request.

Incorporation of Updated Demand Profile

In response to recommendations by the Environment Agency and Atkins in their 2007 audit of the Aquator model, an assessment was carried out to derive an updated demand profile for the Essex System, based on the latest available information on demand. The details of the assessment carried out are also available on request.

Inclusion of Applicable Process Losses

A change to the Water Resource Planning Guidance has resulted in the requirement to account for process losses from water treatment works within the deployable output calculation. A review of the treatment works processes within the Essex System identified that only Langford water treatment works has process water that is completely lost and not returned to source water for potential re-abstraction. The losses associated with the treatment processes at Langford were therefore included directly in the Aquator model, defined as a percentage of treated water.

Model Assumptions

In reviewing the Essex System model baseline assumptions, the following elements were identified as requiring additional explanation as to how they have been accounted for:

The Great Ouse Groundwater Scheme

The Environment Agency own and operate two groundwater schemes for the purposes of river augmentation to support water supplied in the Essex supply area during dry periods. These are known as the Great Ouse Groundwater Scheme (GOGS), and the Stour Augmentation Groundwater Scheme (SAGS). These boreholes utilise borehole sources for river augmentation and in the case of GOGS can support transfers via the EOETS into the Essex supply area during summer low flow periods. The SAGS boreholes can directly support flows in the River Stour from which ESW abstracts.

At the Environment Agency's recommendation, ESW has now included the SAGS boreholes as a source of water available for use in the baseline deployable output calculation, subject to the reservoir control curve restrictions on the operation of the boreholes. There is a clear operational policy and associated trigger level for the use of these boreholes, enabling representative rules to be applied to the Aquator model to allow a realistic assessment of their likely use.

The GOGS boreholes however, have not been included in the Essex System baseline as there is some uncertainty around the future of these sources and no clear Agency operational rules to define the specific circumstances under which the boreholes are used. For these reasons ESW did not consider it viable to include the GOGS boreholes in the baseline deployable output. In addition, it is recognised that some of the GOGS borehole sites have been the subject of Review of Consent investigations and there are potential environmental effects associated with the operation of the scheme, resulting in further uncertainties.

The GOGS boreholes have however, been considered as an additional source of water available as a drought action to be taken during conditions of prolonged low flows in the rivers when there is insufficient support from the EOETS and SAGS. The GOGS boreholes have therefore been included as an additional source of water for the purposes of the Levels of Service assessment.

Langham Boreholes

ESW own and operate a group of boreholes at Langham Water Treatment Works (WTW) currently licensed for emergency use only (licence no. 8/36/158/*G/0092). Emergency use is defined in the abstraction licence as drought, frost, poor water quality in the River Stour affecting treatment, or other unpreventable cause or accident.

The emergency use conditions mean that it is not feasible to incorporate the use of the Langham boreholes into the Essex Resource Zone deployable output model. There are a number of reasons for this, the most notable being that the modelling for deployable output does not take into account water quality issues in the river and assumes that all water in the river is available for treatment. In reality there are times when all or part of the river water is replaced by borehole water under the reasons identified under the licence conditions, but this does not create any additional yield as the WTW is not increasing its output as a result of the borehole operation. Therefore, if the boreholes were included in the deployable output calculation it could potentially result in the double counting of available water and an artificially high yield.

The use of the Langham boreholes is currently indicated in the ESW Drought Plan, 2007 as a source of water available under drought conditions. The boreholes have therefore been included as an additional source of water for the purposes of the Levels of Service assessment.

Reservoir Emergency Storage

Guidance on calculating deployable output for surface water systems as provided in the Environment Agency document “Review of Water Company Yields, March 1998” implies that emergency storage (of typically 30 days) should be allowed for when deriving the deployable output of a resource zone. However, for the purposes of the Essex system ESW determined that this was not appropriate. The reasoning, as explained in the last periodic review is summarised as follows;

1. The reservoirs in the Essex Resource Zone are pumped storage reservoirs that, unlike impounding reservoirs, receive water first abstracted from several rivers, some of which are supported via the EOETS. Use of emergency storage is more applicable to impounding reservoirs than pumped storage reservoirs and if used for the Essex reservoirs would significantly reduce the yield, thereby accounting for an unrealistic risk (see point 2).

2. Incorporation of a 30-day emergency storage level in the reservoir would reduce the Essex System DO by 20%. This is based on the fact that the 1934 drought (the design drought) is four months in duration, from July to early November. Including an allowance for 30 day’s emergency storage

would effectively extend the drought by one month. The 1934 drought is approximately a one in one-hundred-year event, so incorporating an arbitrary safety measure such as a 30 day emergency storage to extend the security of supply for the Essex System with limited demand restrictions does not seem justified when additional sources of supply are available through drought actions.

3. Work carried out and reported in October 2000 on reservoir control rules used an in-depth analytical approach based on yield assessment using a probability matrix. This work allowed a 30 day emergency storage based on the baseline deployable output of the Essex Resource Zone. This work illustrated that there was little risk of the reservoirs drawing down below the estimated 30-day emergency storage level during historic yield simulations which incorporate the likely drought actions that would be implemented under such circumstances.

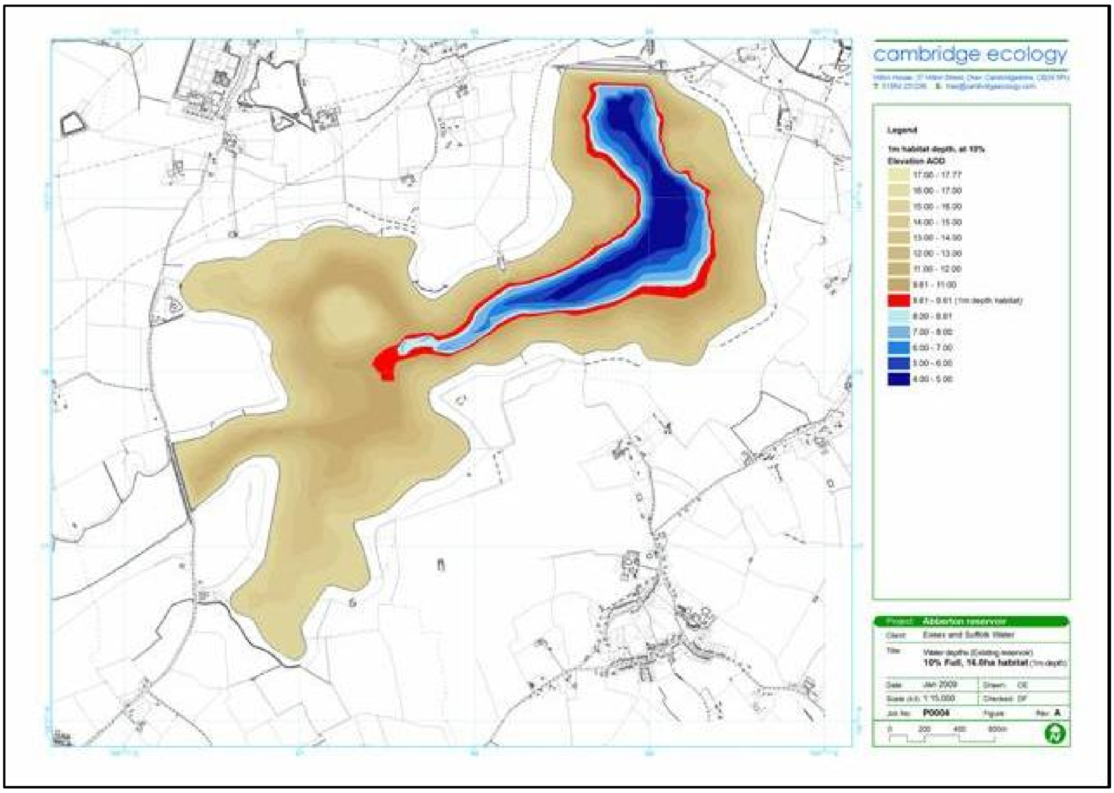
4. The work carried out to assess ESW's compliance with the levels of service illustrated the yield that can be achieved in the worst historic drought when the reservoirs are drawn down to the 30-day emergency storage level (based on 30-days demand at deployable output) and all the drought actions have been implemented according to the levels of service control curves. The approach to confirming levels of service therefore effectively overrides the need to include emergency storage in the deployable output calculation.

Reservoir Dead Storage

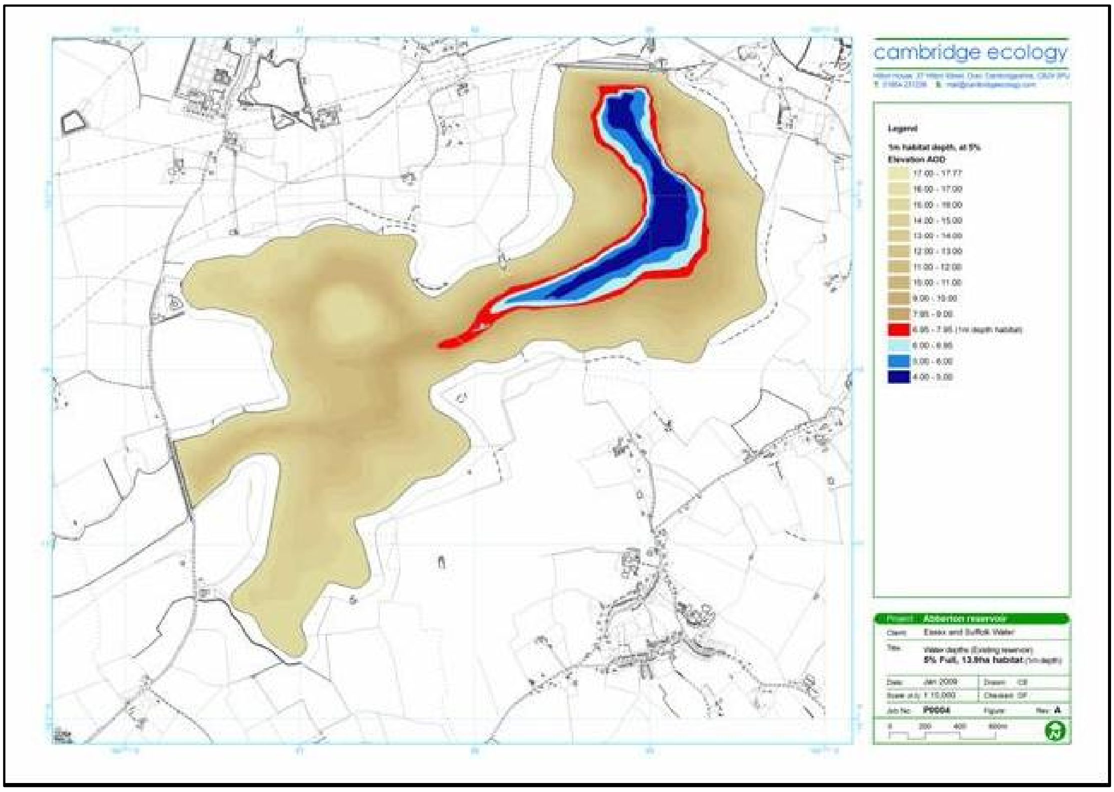
Dead storage is based on the water that is unable to be used towards the bottom of a reservoir. This can be either because it is unable to be abstracted from the reservoir due to the water level being below the lowest draw-off point in the reservoir, or because it is of unsuitable water quality.

At Abberton Reservoir dead storage has been determined as 10%. This represents the minimum operational draw-off level plus an allowance for uncertainty due to siltation and water quality. A graphical representation of this is provided on the following page. This illustrates that the water levels at 10% storage are very low and that at 5% storage it would not be possible to abstract water from the reservoir due to the water depth being estimated to be only between 1 and 2 metres.

At Hanningfield reservoir dead storage is also deemed to be 10%. This is based on operational requirements linked to water quality and the locations on the reservoir where water can be abstracted. The lowest draw off point at the Outlet Tower is at 49m AOD. This equates to 9073Ml or 34.79% reservoir storage. Below this level, water would only be able to be abstracted from the Valve Tower. For 50% of the year there would be a risk that water quality at the Valve Tower would reduce the water available for abstraction and without an alternative abstraction point it would not be possible to continue supply from the



Abberton Reservoir water level at 10% storage volume



Abberton Reservoir water level at 5% storage volume

reservoir. Based on the known drawdown and refill pattern of Hanningfield Reservoir, it is likely that a low storage scenario would be at its worst in October to November time, immediately before the start of the refill season. Therefore there is a chance that water could become un-usable during these months. Based on the increased risk associated with only having one abstraction point, dead storage can be estimated at approximately 10% of total reservoir storage as an equivalent volume that may become un-usable below the 34.79% value.

The assumption used in ESW's water resources system model (Aquator) is therefore that there is 10% dead storage in both Abberton and Hanningfield reservoirs. ESW considers that the 10% assumption is a reasonable estimate and indeed it is highly debatable whether meaningful abstraction could be achieved if the reservoirs did drop to that level. When considered in the context of 30-day emergency storage, dead storage is added to the volume represented by the 30-day emergency storage because it is not able to be abstracted from the reservoir and therefore can not be considered as available for supply.

Essex System Deployable Output Scenarios

ESW has developed a number of deployable output scenarios reflecting the need to represent a range of climate change scenarios, as recommended in the WRPG (Environment Agency, 2007a). This work is described in this section, with the variation in supply due to climate change being covered in Chapter 6.

Guidance has been provided in the Environment Agency's WRPG (Environment Agency, 2008a) relating to the assessment of the effects of climate change on baseline deployable output. The methodology enables the likely effects of climate change on the deployable output of a resource zone to be accounted for across the planning horizon and also provides guidance on how to account for the uncertainty associated with climate change within the headroom assessment.

The recommended methodology requires a number of scenarios to be assessed to derive a baseline deployable output value for the Essex System and the associated climate change effects. The scenarios assessed all assumed that the SAGS boreholes were available subject to the operational control curve and are indicated as follows:

1. Baseline –The naturalised flow record in the Aquator model has no factors applied to it, therefore providing a deployable output value based on historic flow records only with no effect of climate change.

2. Baseline Climate Change Mid – The naturalised flow record has had the Mid climate change scenario monthly flow factors for 2025 applied to it using the climate change sequence profile function in Aquator.

3. Baseline Climate Change Wet – As above, but the Wet climate change scenario monthly flow factors for 2025 have been applied to the naturalised flow record.

4. Baseline Climate Change Dry – As the Mid scenario but the Dry climate change scenario monthly flow factors for 2025 have been applied to the naturalised flow record.

ESW has presented the baseline scenario in order to provide clarity on the effect the climate change factors have on the baseline deployable output. The scenarios were set up in a model named PR09 – Baseline 2/12/2007. The results of the scenarios assessed are presented in the table below.

Scenario	Year	Deployable Output (Ml/d)
Baseline (with SAGS)	2007 – 2035	298
Baseline Climate Change Mid (with SAGS)	2025	290
Baseline Climate Change Wet (with SAGS)	2025	321
Baseline Climate Change Dry (with SAGS)	2025	259

The deployable output values for the climate change scenarios are the anticipated values for 2025. In order to incorporate this information into the whole planning horizon it was necessary to interpolate between 2007 and 2040 for the scenarios where climate change factors were applied. This was carried out in accordance with the Environment Agency's guidance (Environment Agency, 2008a)

The use of the model to determine marginal yields for some of the potential water resource management options in the Essex resource zone is outlined in Chapter 9 on Options Appraisal.

3.1.3. Essex System Compliance with Levels of Service

As previously highlighted ESW has adopted a Level of Service of 1 in 10 years for appeals for restraint, 1 in 20 years for a hosepipe ban, 1 in 50 years for restrictions on non-essential use, and 'never' for rota cuts. An assessment was carried out to determine compliance with these Levels of Service and the yield that can be achieved when the Essex System is operated to meet these Levels of Service.

The definition of deployable output explicitly excludes any consideration of restrictions on water use, however ESW has, following discussions with the Environment Agency, developed a supply forecast incorporating Levels of Service restrictions.

Methodology

The model used for determining the Essex System deployable output was copied and renamed for the purposes of the levels of service assessment.

The Levels of Service indicated above are represented by the implementation of specific actions and an associated increase in supply or decrease in demand caused by each action, as outlined in the table overleaf

The methodology used to assess ESW compliance with Levels of Service was based on a probabilistic approach, using the historic annual series of daily naturalised river flow data available in Aquator (1933-1996), to create a set of reservoir control curves that reflect each of the levels of service.

The baseline control curve was developed by carrying out a model run for each year of record (May to April, 1933/34 to 1995/96) using the baseline parameter set and the Essex System baseline deployable output demand figure (298Ml/d). The combined daily reservoir volumes for each year of record were exported into an Excel spreadsheet and used to calculate the 1 in 5 year probability (80 percentile) control curve, below which the use of the ESW Langham emergency boreholes should be implemented.

Frequency of Level of Service	Action	Estimated demand reduction	Estimated supply increase
1 in 5 years	Langham emergency boreholes brought online		+22.7Ml/d
1 in 10 years	Appeal for constraint (PR campaign)	-7% (May to October)	
1 in 20 years	Hosepipe ban	-3% (May to October accumulative with previous action)	
1 in 50 years	Non-essential use ban Denver drought order GOGS river support boreholes	-2% (May to October accumulative with previous actions)	 +8Ml/d +28.73 Ml/d (July to October only)

The 1 in 10 year control curve was developed by re-running the model for the parts of those years when the combined daily reservoir volumes dropped below the 1 in 5 year control curve. The 'state set capture' function in Aquator was used to capture the model component states on the day the reservoir volumes drop below the 1 in 5 year control curve. The model was then run for the remainder of the year from this date with the Langham boreholes switched on, using the model component states captured as the starting conditions, thus simulating the action that would have been carried out when the first (1 in 5 year) control curve was crossed. The resulting combined daily reservoir volumes for each year of record were recorded in the Excel spreadsheet and used to calculate the 1 on 10 year probability (90 percentile) control curve, below which the appeal for constraint (PR campaign) action should be implemented.

This method was repeated in a similar manner to develop the 1 in 20 year control curve and the 1 in 50 year control curve.

The actions implemented for the 1 in 20 year control curve initially resulted in the curve crossing above the 1 in 10 year control curve for 25 days from October through to November. A correction assumption was therefore applied to this part of the control curve to ensure that the curves cannot cross. If the difference between the 1 in 10 year control curve and the 1 in 20 year control curve was less than 1000Ml during the 25 day period identified, then the 1 in 20 year control curve was adjusted to ensure it was 1000Ml below the 1 in 10 year control curve.

The control curves derived from this methodology do not account for the need to have a maximum control curve level on the reservoirs, above which normal operation is always assumed. The control curves derived were therefore adjusted to reflect the maximum fill volume used by the Environment Agency for the Ely Ouse to Essex Transfer Scheme control curves. This maximum fill volume ensures there is adequate storage availability above the control curves to enable water to be put in storage as a result of sudden storm events.

Once the Levels of Service control curves had been derived using the methodology outlined above, Aquator model runs were carried out to calculate the maximum demand that could be met by the Essex System when operated to the proposed levels of service. Calculations were carried out for two scenarios;

1. accounting for a 30-day emergency storage allowance at the Essex System deployable output value of 298Ml/d remaining in the reservoirs, and

2. drawing the reservoirs down to the 10% dead storage volume.

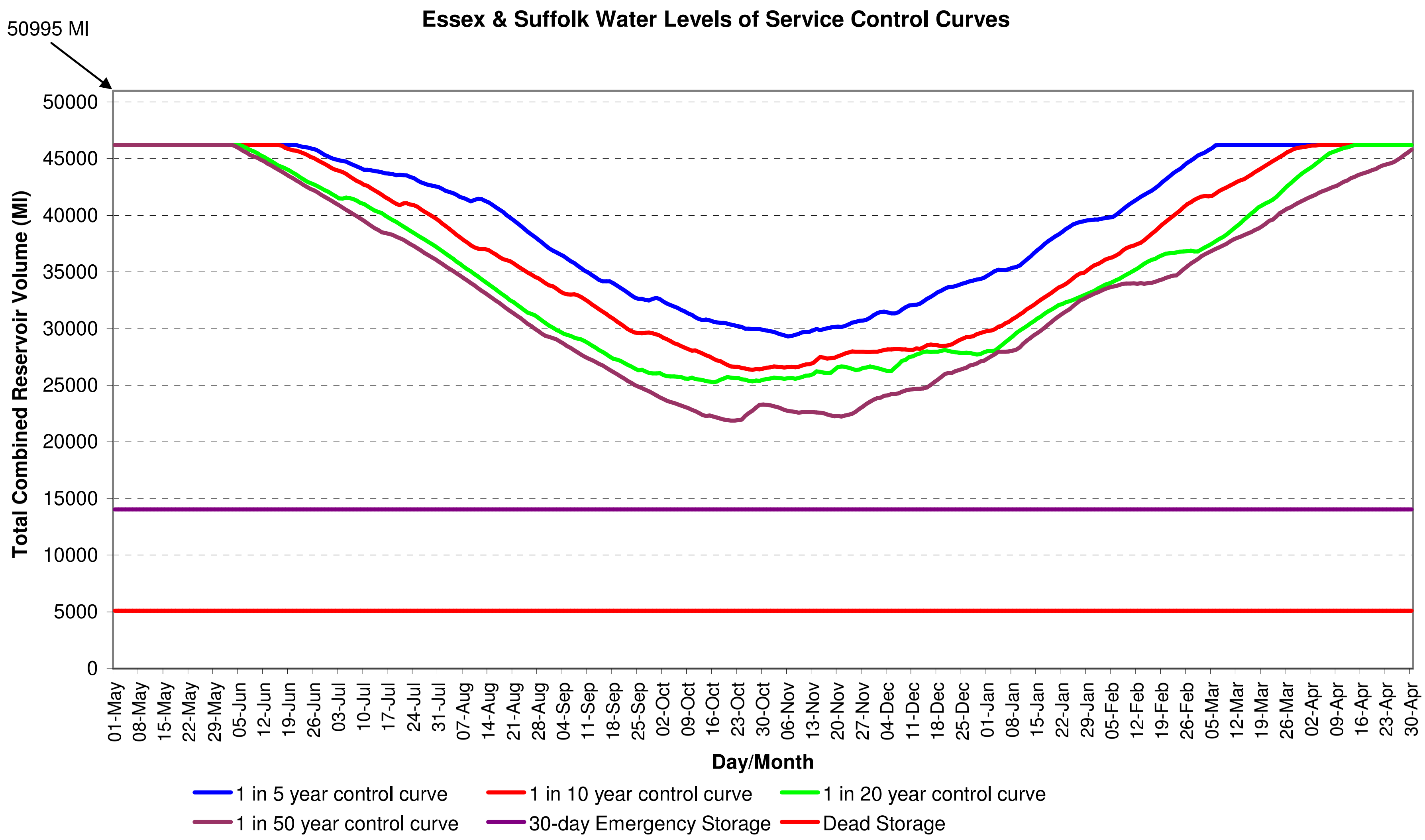
The results of the control curve assessment and the demand assessment are presented below.

Results

The results of the Levels of Service assessment are presented in the graphs overleaf. A set of control curves for each of the levels of service drought actions assessed is presented in the first graph. In the second graph the reservoir drawdown and refill sequences resulting from the assessment of the maximum demand achievable under the two scenarios are presented.

The results show that an average demand of 298Ml/d (the baseline deployable output demand) can be met when the Essex System is operated to its defined levels of service, and the reservoirs are drawn down to a 30-day emergency storage level. When the reservoirs are drawn down to the 10% dead storage level, and operated to the same levels of service, an average demand of 350Ml/d can be met throughout the design drought years.

This assessment demonstrates that, based on the historic river flow record available for the Essex Rivers, the Essex system baseline deployable output complies with ESW's proposed levels of service. The demand assessment illustrates the demand that could be met during the worst historic drought on record, when all the drought actions would have been implemented.


Essex & Suffolk Water Levels of Service Control Curves
50995 Ml
Total Combined Reservoir Volume (Ml)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
01-May
08-May
15-May
22-May
29-May
05-Jun
12-Jun
19-Jun
26-Jun
03-Jul
10-Jul
17-Jul
24-Jul
31-Jul
07-Aug
14-Aug
21-Aug
28-Aug
04-Sep
11-Sep
18-Sep
25-Sep
02-Oct
09-Oct
16-Oct
23-Oct
30-Oct
06-Nov
13-Nov
20-Nov
27-Nov
04-Dec
11-Dec
18-Dec
25-Dec
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
05-Feb
12-Feb
19-Feb
26-Feb
05-Mar
12-Mar
19-Mar
26-Mar
02-Apr
09-Apr
16-Apr
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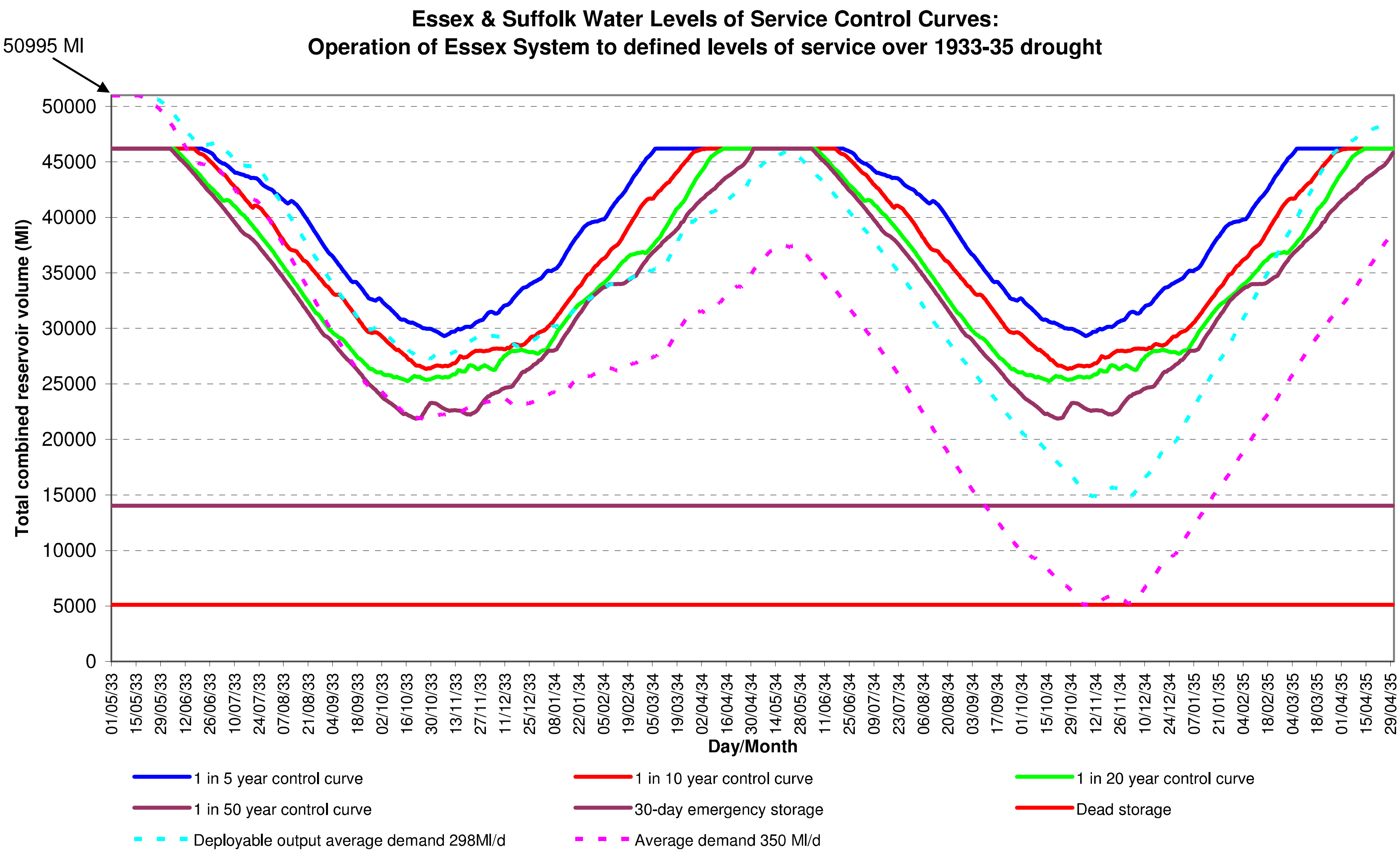
30-Apr
Day/Month
1 in 5 year control curve
1 in 10 year control curve
1 in 20 year control curve
1 in 50 year control curve
30-day Emergency Storage
Dead Storage


Essex & Suffolk Water Levels of Service Control Curves:
Operation of Essex System to defined levels of service over 1933-35 drought
50995 Ml
Total combined reservoir volume (Ml)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
01/05/33
15/05/33
29/05/33
12/06/33
26/06/33
10/07/33
24/07/33
07/08/33
21/08/33
04/09/33
18/09/33
02/10/33
16/10/33
30/10/33
13/11/33
27/11/33
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25/12/33
08/01/34
22/01/34
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05/03/34
19/03/34
02/04/34
16/04/34
30/04/34
14/05/34
28/05/34
11/06/34
25/06/34
09/07/34
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10/12/34
24/12/34
07/01/35
21/01/35
04/02/35
18/02/35
04/03/35
18/03/35
01/04/35
15/04/35
29/04/35
Day/Month
1 in 5 year control curve
1 in 10 year control curve
1 in 20 year control curve
1 in 50 year control curve
30-day emergency storage
Dead storage
Deployable output average demand 298Ml/d
Average demand 350 Ml/d

The Excel spreadsheet containing the output from the Aquator model used for this assessment, consisting of combined daily reservoir volume results for each year of record for each control curve, is available to regulators on request.

3.1.4. Essex Groundwater Source Deployable Output

Deployable outputs for the Essex groundwater sources at Linford, Stifford, Dagenham, Roding, and Ball Lane have been determined using the standard UKWIR methodology entitled "A Methodology for the Determination of Outputs for Groundwater Sources" (UKWIR, 1995a).

This methodology accounts for the determination of deployable outputs for both average and peak demand conditions, and is based on utilising either analytical test pumping data and/or operational data from drought periods in the form of water level/output data to assess source performance. A graph of this information on a water level-output plot can then be utilised to determine a lower bounding 'drought curve' for the source. The drought curve can then be compared with key water-level and output constraints such as licence limits, pump output, WTW capacity, deepest advisable pumping water level, pump intake depth, in order to determine deployable output. The deployable output is defined as the point at which the drought curve intersects the most restricting water-level or output constraint.

The deployable output determination for the average demand condition ideally utilises average monthly source output and monthly lowest pumping water levels in drought years. In the event of analytical step pumping test data being used, where necessary this is extrapolated to 200 days in order to estimate the likely drawdowns that would occur over longer periods of time than those typically encountered during step test pumping.

Deployable outputs for the peak demand condition are determined using output in the average day peak week (ADPW) of a drought year plus the output in each of the two weeks either side of the peak week. In each case the deepest pumping water level of the particular week concerned is used in the analysis. In the event of analytical step pumping test data being used, where necessary this is extrapolated to 7 days in order to estimate the likely drawdowns that would occur over a peak week rather than those typically encountered over a few hours during step test pumping.

During the last periodic review the deployable output calculations for the Essex groundwater sources were reviewed and refined in the light of improved information. The results of this work were detailed in a report entitled Selected Groundwater Deployable Output Assessments (ESW, 2003). A similar exercise has been undertaken as part of the current periodic review.

As a result of the most recent work only one of the groundwater sources at Stifford has had a recalculated deployable output. This is largely due to a recent complete refurbishment of the sourceworks including new treatment structures and a new submersible pump. The output of the new submersible pump has been sized to avoid dewatering of the adit system at this source which is a demonstrated risk (observed during a comprehensive period of test pumping in 2002). As such the new pump output is a constraint on both average and peak deployable output. Accordingly the revised deployable output is 3.4 Ml/d for both average and peak demand scenarios. This compares with a previous average deployable output figure of 3.68 Ml/d.

The following table summarises the groundwater deployable output figures determined for the Essex resource zone:

Source	Average DO (Ml/d)	Peak DO (Ml/d)
Linford	5.28	5.95
Stifford	3.40	3.40
Roding	5.40	5.45
Dagenham	4.80	5.91

3.1.5. Suffolk Resources Zones Deployable Output

Groundwater Sources

Prior to this periodic review the definition of groundwater source deployable output was undertaken using the UKWIR methodology of 1995, entitled "A Methodology for the Determination of Outputs for Groundwater Sources". The basis of this methodology has already been summarised in the previous section on 'Essex Groundwater Source Deployable Output'.

The output of these assessments is available within the output from two studies:

- Suffolk Groundwater Management Study, Phase Two Final Report, Volumes 1 to 5 (Mott MacDonald, 1997)
- AMP4 Periodic Review, Selected Groundwater Deployable Output Assessments (ESW, 2003)

A review was undertaken to establish the following:

(1) Whether the water level/output signatures obtained from the ESW groundwater sourceworks during the 2006 drought fell outside the envelope generated during the previous assessments (these being principally defined using data from the 1991/92 and 1995/97 drought periods)

(2) Whether any of the potential constraints on groundwater DO (e.g. pump capacity, WTW capacity etc) have changed since the last review undertaken as part of PR04. The Production teams at ESW were contacted to assist in this review.

As a result of this review it was identified that in the case of item (1) above none of the 2006 drought data was more constraining that the data used for the previous assessments of DO.

Following overall assessment two of the groundwater sources at Puddingmoor and Broome, located in ESW's Northern/Central resource zone have experienced reductions in deployable output described as follows:

- Puddingmoor – Pump and switch gear constraints on output have reduced the average demand DO from 2.15 Ml/d to 1.90 Ml/d.

- Broome – The yields for the Broome well field are known to have declined since new sources were constructed less than ten years ago. The decline is almost certainly due to the aggressive nature of the local groundwater which is high in iron and manganese. The well screens of these sources are known to be susceptible to fouling and encrustation which reduces the capacity for effective recharge into the wells during pumping. Observations have indicated that this constraint has effectively reduced the average DO from 2.36 Ml/d to 1.98 Ml/d. ESW is currently investigating the long term sustainability of remedial techniques to address this issue.

The DO for all the other groundwater sources in Suffolk remains unchanged.

Surface Water Sources

River Bure at Belaugh and Ormesby Broad

Abstraction from the River Bure, Ormesby Broad, and groundwater Chalk sources at Juby Farm and Grange Farm (in the Bure valley) is covered within a joint abstraction licence, which allows a total annual quantity of 10,000 Ml to be abstracted. Ignoring what is an insignificant contribution from the groundwater sources, the bulk of the abstraction comes from the River Bure and Ormesby Broad, with close to the total 10,000 Ml limit being abstracted every year.

The deployable output figures used for the River Bure and Ormesby Broad in the last two periodic reviews remain unchanged, and are summarised as follows:

Source	Average DO Ml/d	Peak DO Ml/d
Bure at Belaugh	17.80	27.27
Bure at Horning*	0.00	0.00
Ormesby Broad	8.59	10.70
Juby Farm	0.54	6.80
Grange Farm	0.47	6.80
Bure/Ormesby Total	27.40	51.57

* Horning intake effectively abandoned in 1989 due to water quality issues

All the 10,000 Ml licensed quantity was abstracted in each of the drought years from 1995 to 1997. This provides confidence that the combined average deployable output figures for the Bure and Ormesby Broad (which equate to the equivalent annual licensed quantity of 27.4 Ml/d) are robust. In view of this no major hydrological working of the reliable yield is deemed to be required. However since Ormesby Broad and the Bure abstractions are being investigated under the AMP3 and AMP4 Environment Programmes respectively, it is likely that additional information which will support the deployable output figures may come out of these assessments.

River Waveney at Shipmeadow

During the last periodic review the deployable output for the River Waveney abstraction at Shipmeadow was reassessed for ESW by consultants Black & Veatch, with the results presented in a report (Black & Veatch, 2003). However, this assessment did not take into account the likely effects of climate change on the source and the output was not in a suitable format to be used to implement such an assessment. ESW therefore have developed a water resource system model of the River Waveney abstraction and associated infrastructure using the water resource modelling software, *Aquator*. Technical details of the *Aquator* modelling approach are provided in section 3.1.2 of this document under 'Approach'. This model enables a baseline deployable output (DO) to be calculated using naturalised flow data, as well as enabling the effects of climate change on DO to be assessed.

The Environment Agency developed a naturalised flow record for the River Waveney at Ellingham Mill gauging station in 2004. The flow naturalisation covered the period from 1970 – 2002. This data was provided to ESW by the Agency for use in the development of a Waveney model in *Aquator*.

Key factors in the deployable output determination for the Waveney can be summarised as follows:

(1) The Ellingham Mill gauging station is the closest gauging station upstream of ESW's Shipmeadow abstraction and importantly is used as the basis for limiting ESW abstraction from the Waveney when flows drop below certain gauged flow trigger levels at Ellingham. The Company's latest Drought Plan (ESW, 2007a) contains details of these trigger levels.

(2) The River Waveney deployable output is influenced by potential use of the Agency river support boreholes on the River Dove (a major tributary of the River Waveney) which are collectively known as the Waveney Augmentation Groundwater Scheme or WAGS. The scheme was constructed in the early 1970's, tested in 1977 and licensed in 1990. The original purpose of the scheme was mainly to support the ESW abstraction at Shipmeadow. The yield of the WAGS scheme was also confirmed during recent testing of the boreholes by the Agency.

Following discussions with the Agency, subsequent to the last periodic review, operating rules have been defined which set out the responsibilities, operating objectives and operating procedures for the WAGS scheme. These rules now place a more transparent requirement on the Agency to operate the WAGS boreholes during low flow periods, in order to support ESW's abstraction at Shipmeadow. This policy is in line with the supported rates for abstraction charges in respect of the River Waveney.

The WAGS boreholes were included in the *Aquator* model of the River Waveney and visual basic programming was used to define the operational conditions linking the use of the boreholes to flow availability at Ellingham Mill and the demand requirements at the ESW intake at Shipmeadow. The WAGS boreholes were therefore available as a source of supply for the River Waveney deployable output assessment.

Historic yield calculations were carried out in *Aquator* for the Waveney abstraction to determine the deployable output of the source. This modelling showed that a certain level of WAGS support would be required to maintain supplies to the Northern/Central zone from the River Waveney via Barsham water treatment works. A baseline deployable output of 13.5Ml/d was calculated using the 'English & Welsh Method' of assessment available in the *Aquator* model. This is comparable to the deployable output of 13.6Ml/d derived by Black & Veatch in the last periodic review. The figure of 13.5Ml/d was therefore adopted as the baseline deployable output of the Company's Waveney abstraction for water resource planning purposes.

Further details of the work carried out to develop the *Aquator* model of the River Waveney abstraction at Shipmeadow have been documented by ESW in the report '*Periodic Review 2009: River Waveney Water Resource Modelling & Deployable Output Calculation'* (January 2009).

Lound/Hopton Ponds and Fritton Lake

The deployable output figures used for Lound Ponds and Fritton Lake used in the last two periodic reviews remain unchanged. Deployable output figures of 8.09 Ml/d and 13.40 Ml/d were determined for the average and peak demand conditions respectively.

The annual licensed quantity for Lound and Hopton ponds is 2955 Ml, which is equivalent to an average of 8.095 Ml/d. The annual maximum quantity was approached in the drought years of 1995 and 1996 which provides confidence that the average reliable yield figure of 8.095 Ml/d is robust.

Additional quantities over the licensed quantities are occasionally made available in times of flooding of Fritton Lake, via an ongoing flood alleviation agreement with the Agency.

3.2. Reductions in Deployable Output

3.2.1. Sustainability Reductions

The Environment Agency has advised of those licences that have the potential to be affected by sustainability changes as a result of the potential outcome of the review of consents and other processes. The Agency has provided ESW with indicative and definite sustainability changes. The WRPG (November 2008) defines 'indicative' changes as those "based on the best information available following the completion of an investigation", and 'definite' changes as those "identified following completion of an appraisal to identify the proportionate licence change which meets the objectives of a site and/or a driver for action". ESW have followed the guidance which indicates that water companies should only include definite changes in their final WRMPs.

Sustainability changes were first advised in letters from the Agency dated 8 June 2007 and 21 December 2007. The last iteration was in a letter received from the Agency dated 31 October 2008 where the Agency had added some new sites that had not been previously highlighted. A summary of the sustainability changes provided by the Agency is outlined in the following table:

Designated Site	ESW Zone Potentially Affected	Definite Sustainabiity Change	Indicative Sustainability Change
Redgrave & Lopham Fens	Suffolk Hartismere	Available March 2009	Zero
Abberton Reservoir SSSI	Essex	Zero	
Stour Estuary SSSI	Essex	Zero	
Bure Broads & Marshes SSSI	Suffolk Northern/ Central	See Trinity Broads	
Geldeston Meadows SSSI (including Stanley & Alder Carrs, Aldeby)	Suffolk Northern/ Central	8.1 Ml/d	
Minsmere to Walberswick Marshes	Suffolk Blyth	Zero	
Trinity Broads SSSI (including Bure Broads & Marshes SSSI, Crostwick Marshes, Hall Farm Fen, and Burgh Common & Muckfleet Marshes)	Suffolk Northern/ Central	Available December 2009.	2.73 Ml/d
Blackwater Estuary	Essex	5 Ml/d	
Alde-Ore Estuary	Suffolk Blyth	Available March 2010	0.76 Ml/d
Lower River Stour at Cattawade	Essex	Available March 2015	5 Ml/d

Leiston-Aldeburgh SSSI	Suffolk Blyth	Available March 2009	None given.
Sizewell Marshes	Suffolk Blyth	Available March 2009	None given.
Weston Fen	Suffolk Hartismere	Available March 2009	Zero

It should be recognised that at the majority of sites the Agency are still not yet in a position to provide definitive sustainability reductions until the various review processes have been completed, and that in most cases the Agency has extended its deadlines since its letter of December 2007.

The sensitivity of the plan to indicative sustainability reductions is described in Section 8.7 of this report.

For the purpose of the WRMP and construction of the Supply Demand Balance in each resource zone the definitive sustainability changes need to be converted into sustainability reductions. In relation to the above table there are only two definite sustainability changes identified; Geldeston Meadows and the Blackwater Estuary respectively. These were converted into sustainability reductions as follows:

Geldeston Meadows

The Agency has recognised that the proposed sustainability change at this site is highly uncertain and that further assessment is required by them (subsequent to ESW's own comprehensive assessment of March 2007). Given this uncertainty and the absence of any alternative analysis, ESW has decided to adopt the Agency's sustainability change as the sustainability reduction for the purposes of the WRMP. The sustainability change of 8.1 Ml/d was determined by the Agency as being the difference in the actual abstraction from the Barsham Group of sources in 1997 (the year of modelled lowest water levels) and the equiavent of the annual licensed quantity for the same sources. ESW has independently been able to reproduce this figure. Once additional analysis becomes available from the Agency the appropriateness of the sustainability reduction will be reviewed. If this sustainability reduction were to materilaise in reality then there is currently little prospect of an available local solution to recover the water.

Blackwater Estuary

The Agency has recommended that there should be a 23.7Ml/d (measured on a 7-day rolling average) combined flow of river water and fully treated sewage effluent entering the Blackwater Estuary downstream of Beeleigh Weir. The volumes of treated effluent discharged into the Blackwater Estuary are variable depending on the season, weather conditions, and whether ESW's effluent recycling plant is operating at Langford.

The Agency assumed that these proposals would not affect the deployable output of the Essex system. ESW challenged this assumption through technical analysis and was able to demonstrate that there would be a resulting loss of deployable output.

A modelling exercise using the model of the Essex system in *Aquator* to assess the implications of the Environment Agency's proposals on the deployable output of the Essex system in the design drought (1933-34).

The modelling assessment took account of the likely effluent discharge to the estuary during a dry period, including the operation of the Langford recycling plant, and used this information to assess the effects of maintaining a 23.7Ml/d flow to estuary. The assessment showed that during periods of significantly low flows, the requirement to release 23.7Ml/d to the Blackwater estuary is likely to result in a loss of yield to the Essex system of 4Ml/d. This result is based on the assumption that during a drought, the discharge of treated effluent to the estuary would be low and in order to maintain the 23.7Ml/d combined flow to estuary, river water will be required to support the effluent flow.

3.2.2. Climate Change

Allowances for climate change effectively lead to a reduction in baseline deployable output under best estimate and dry scenarios. The uncertainty in the level of climate change to incorporate is covered within the company's headroom assessment.

A detailed explanation of the effects of climate change on supply and demand is covered in Chapter 6 of this report.

3.2.3. Process Losses

Process losses in the form of raw and treatment works operational use are included in the calculation of deployable output for the Essex Resource zone through incorporation in the Essex water resources system model Aquator. The bulk of the allowances used in the model relate to Langford WTW where 90% of treatment process losses are considered not to be returned to source. In the case of all the other Essex works (Hanningfield, Layer, Langham and Chigwell) it is assumed that all the treatment process water is returned to source.

In the case of the Suffolk resource zones, process losses are not directly included in the definition of deployable output and raw and hence an allowance for process losses has been separately defined and considered as an additional reduction in deployable output.

Process losses are defined as the sum of raw water operational use and losses, and treatment works operational use and losses. Raw water losses and operational use in Suffolk are assumed to be zero. Suffolk treatment works losses are also assumed to be zero but treatment works operational use (TWOU) is a feature of many of the works.

TWOU is defined as treatment process water i.e. the net losses that exclude water returned to source waters. ESW has recently re-estimated these process losses using the latest information on works performance, and the results have been factored into the supply calculations.

For individual works in Suffolk (apart from those where water is returned to source) TWOU averages approximately 4.4% of works output.

3.2.4. Other Reductions in Deployable Output

An additional reduction in DO has been assumed in the Northern/Central zone. This relates to the Alder Carr and Quay Lane sourceworks at Reydon, Southwold. Both sources are threatened by the current draft Blyth Strategy under which the Agency will no longer be maintaining sea defences that currently protect these assets after 2012. The local treatment works at Alder Carr supplies potable water to 2850 properties and is essential in meeting peak summer demand within the local District Metered Area (DMA).

The withdrawal of maintenance of the sea defences will means that when the nearby embankment fails, a significant area of Reydon Marshes will be inundated with sea water twice daily and will effectively become tidal salt marsh.

ESW has undertaken a Flood Resilience Assessment which has been informed by separate studies undertaken by Royal Haskoning and University of East Anglia. The main conclusions drawn were as follows:

- The Agency's Blyth Estuary flood defence embankment condition assessment concluded that the embankment has a residual life of between zero and ten years and so could therefore fail at any time;
- The Agency's preferred Blyth Estuary flood defence strategy is not to repair any defence breach after 2012;
- Royal Haskoning concluded that Alder Carr Treatment Works is currently at a significant risk of tidal flooding for a 200 year return period event. Buildings would be inundated although flood water would not directly affect any of the identified critical infrastructure. However, underground wiring and ducting could still be affected resulting in asset failure;
- University of East Anglia concluded that it would take between three and five years from embankment failure before brackish water was drawn into Alder Carr well; and that Quay Lane well is also at risk of drawing in brackish water although this could be reduced if a localised defence was constructed.
- Given the Agency's condition assessment and UEA's conclusions, if the embankment was to fail tomorrow, Alder Carr well could be unusable within three to five years;

- As customer demand cannot be met by the Barsham transfer alone, up to 2850 customers within the Southwold DMA would experience poor pressure or nil supply.
- ESW's options appraisal has identified Option 6B (Supply from Barsham TWs to Alder Carr tank via Enhanced Treated Water Main) as ESW's preferred option for maintaining levels of service in the Southwold DMA.

Application for an allowance in price limits to cover the implementation of Option 6B has been included in the Company's final Business Pan.

Given the above conclusions ESW has assumed a complete loss of DO from these sources within the Northern/Central zone supply demand balance from 2012. It has then been assumed that the option to secure supply would be available from 2014.

3.3. Outage

Outage is defined as "a temporary loss of deployable output" (UKWIR, 1995b). Outage events can be divided into planned and unplanned outage; which are defined as follows:

- Planned outage is defined as "A foreseen and pre-planned outage resulting from a requirement to maintain sourceworks asset serviceability".

- Unplanned outage is defined as "An outage caused by an unforeseen or unavoidable legitimate outage event affecting any part of the sourceworks and which occurs with sufficient regularity that the probability of occurrence and severity of effect may be predicted from previous events or perceived risk".

Both planned and unplanned outages were considered in the outage assessments for the Essex and Suffolk resource zones.

Outage has been evaluated for all the Company resource zones using the UKWIR methodology, "Outage Allowances for Water Resources Planning" (UKWIR, 1995b). The methodology includes both planned and unplanned outage events, and defines legitimate unplanned outage types as pollution of source, turbidity, nitrate, algae, power failure, and system failure.

The overall approach is a frequency based one, utilising probability distributions to define magnitude and duration of outage events based on historical information and limited by the definition of planned and unplanned outage contained in the methodology. The defined probability distributions are then used in a Monte Carlo simulation to determine overall percentiles of probability of a defined average daily outage volume being equal to or below a defined value. A final outage allowance figure for each resource zone was then determined by consideration of the required return period, which equates to a particular percentile selected from the Monte Carlo analysis output.

Outage was determined separately for the Essex and Suffolk areas and has been detailed in two separate reports as supporting documents (ESW, 2008a & ESW, 2008c). The results of the assessments can be summarised as follows:

3.3.1. Essex Resource Zone

The detailed methodology, assumptions and results for the Essex resource zone are outlined in a separate supporting report (ESW, 2008a).

The basis of the assessment was focussed around the four major treatment works that supply the Essex resource zone at Layer, Langham, Langford and Chigwell. The key stages to the assessment were as follows:

(1) Data Gathering & Interpretation

The Essex resource zone is an integrated network; therefore any resource shortfall effectively becomes a shared problem throughout the supply system. All works except Hanningfield are normally kept at or above a minimum threshold production rate, unless a reduction in output has been planned to occur or if production is constrained. Hanningfield then normally makes up the remaining difference between production and demand. Given this operational policy, if the works output dropped below the minimum threshold production rate at anytime during the year then a potential outage event had occurred and investigations were conducted to confirm the validity of the event. Part of these investigations included comparing the works output with the planned output as set by the ESW Networks and Production Departments 4 to 6 weeks in advance. Occasionally, the works output may be planned to be lower than the minimum threshold production rate due to low demand or cost of treatment for example. In these cases a legitimate outage event had not occurred and so this information prevented an overestimation of outage.

(2) Development of Triangular Distributions for Outage Magnitude and Duration

Using the data available for the Essex resource zone the outage identified at each treatment works was categorised as planned or unplanned outage and the type of unplanned outage event identified. The total duration and daily magnitude of each outage event was also calculated from the data. The data on the outage events occurring at each treatment works over the seven-year data set from 2000 to 2006 (inclusive) was collated into months. The minimum, most frequent and maximum outage duration and daily magnitude at each treatment works was then calculated for each month.

(3) Monte Carlo Analysis

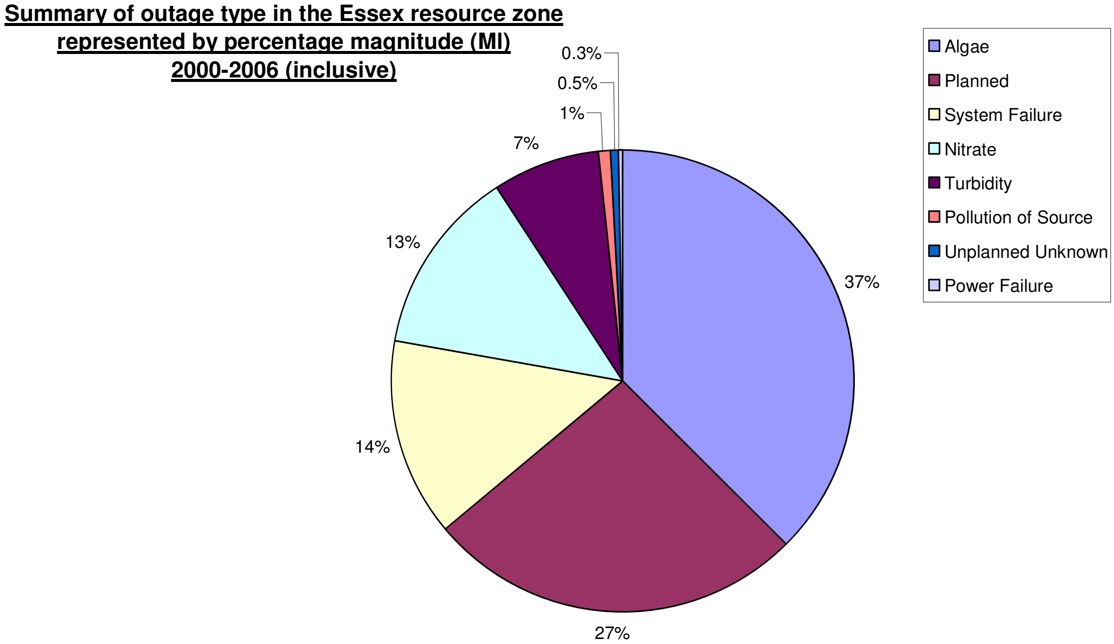
The minimum, most frequent and maximum figures were inserted into a spreadsheet and used to define triangular distributions to represent the range of both the magnitude and duration of outage. This was undertaken for each water treatment works and for each month of the year. The triangular distributions formed the basis of a Monte Carlo analysis using the risk analysis software package Crystal Ball®7.3.1. The software was used to conduct 5000 iterations combining magnitude and duration of outage, for each month, at each works, based on random sampling across each triangular distribution. The results from each WTW were combined to give a zonal outage figure for each month. A final figure was then obtained by summation of the total monthly outage volumes for the resource zone to produce an average daily outage for the Essex resource zone in Ml/d.

The output from Crystal Ball consists of a forecast report for the Essex resource zone summarising the statistics of the results from the 5000 iterations conducted by the Monte Carlo analysis. The results are displayed in a frequency chart and as a list of percentiles indicating the percent of the distribution that is equal to or below a stated value. These percentiles relate to pre-defined return periods as required under the Agency's Water Resource Planning Guideline (Environment Agency, 2007a). For example the 90 percentile relates to a 1 in 10 return period and the 98 percentile relates to a 1 in 50 return period. These results were used to define the outage figure for the Essex resource zone.

(4) Interpretation of Results

A summary of the data analysis illustrating the types of outage that occurred at the Essex treatment works during the period 2000 to 2006 inclusive is provided by the pie chart below. This indicates that for Essex as a whole the majority of outage is unplanned and the largest cause of unplanned outage was algae.

The results of the Monte Carlo simulation are contained in the full forecast report, which along with the figures relating to each return period are included in the Essex outage report (ESW, 2008a). A decision was taken to use the result corresponding to the 90 percentile (one in ten year equivalent) to represent the outage allowance in the Essex resource zone for an average demand scenario. This return period corresponds to the Company's specified level of service for frequency of an 'appeal for restraint' on water use. The 90 percentile for outage allowance in the Essex resource zone was calculated from the Monte Carlo simulation to be **14.79 Ml/d**. Due to flexibility within the Essex supply zone it was determined that the outage allowance for critical periods and peak demands should remain the same as that calculated for the average demand scenario.



3.3.2. Suffolk Resource Zone

The detailed outage assessment methodology, assumptions and results for the three Suffolk resource zones, Northern/Central, Hartismere and Blyth, are outlined in a separate supporting report (ESW, 2008c).

The outage assessment was undertaken on a water treatment works basis for each resource zone. The key stages to the assessment were as follows:

(1) Data Gathering & Interpretation

Data were collated for the five year period 2002 to 2006 inclusive. Quantitative daily sourceworks output data was analysed to identify sudden troughs in works output or longer periods of unusually low output. Qualitative information in the form of Treatment Works Managers Monthly Reports, Production Works Status Reports, Maintenance and Planning Department records and Water Quality Department Weekly Reports were reviewed to collect information on recorded outage events. The quantitative and qualitative data was then cross-referenced to confirm the occurrence of legitimate outage events and to determine duration and daily magnitude.

Where the start and finish dates of an outage event had been qualitatively recorded it was found that generally these were accurately reflected in the works output data and so calculating the duration of the events was largely unproblematic.

The larger surface-water works at Lound, Barsham and Ormesby are operated to a target output simply based on a historical average, so these targets are not comparable to the minimum production threshold rates used in the operation of the Essex resource zone treatment works. The Suffolk borehole works have no target production rates due to their demand-reactive nature and because of the interconnectedness of the resource zones, where more than one works directly supplies the same district storage tank or supply area. Ensuring consistency in calculating outage magnitude therefore required developing a set of mathematical procedures, the use of which depended upon the sourceworks and suitability of data set for a particular procedure. Where output was consistent, the average output from the 7 days previous to an event provided a baseline figure which was then used to calculate the deficit in output during the event. Where works output was highly variable or uncharacteristic just previous to an event, the baseline figure was found by taking yearly average minus 10% of that average.

Where the sourceworks output data indicated a potential outage event but confirmation could not be found in the qualitative information sources, the dates were cross-referenced against works site diaries by Suffolk Production Managers. If no information was recorded to confirm the occurrence and legitimacy of a potential outage event then it was excluded from the assessment.

(2) Development of Triangular Distributions for Outage Magnitude and Duration

The outage identified at each treatment works was categorised as planned or unplanned and the type of unplanned outage identified. The total duration and daily magnitude of each outage event was calculated from the works output data. The data on the outage events occurring at each treatment works over the five-year data set was collated into months. It was not possible at this stage to calculate the minimum, most frequent and maximum outage duration and daily magnitude due to insufficient data. Therefore, outage from all works in each resource zone was collated into months in order to develop the triangular distributions required to perform the Monte Carlo analysis.

(3) Monte Carlo Analysis

The minimum, most frequent and maximum figures were inserted into three spreadsheets, one for each Suffolk resource zone, and used to define triangular distributions to represent the range of magnitude and duration of outage that occurred over the five-year data set, for each month of the year. The triangular distributions were then used to perform Monte Carlo simulations using the risk analysis software package Crystal Ball®7.3.1. The software was used to conduct 5000 iterations combining magnitude and duration of outage, for each month, for each resource zone, based on random sampling across each triangular distribution. The Monte Carlo analysis combined duration and magnitude to give a figure for each month of the year representing the total outage by month. These figures were divided by the total number of days in each month over the five year data set to give the average daily outage figure. The summation of these figures gave the outage allowance for each of the Suffolk resource zones in Ml/d.

The output from Crystal Ball consists of a forecast report for each Suffolk resource zone summarizing the statistics of the results from the 5000 iterations conducted by the Monte Carlo analysis. The results are displayed in a frequency chart and as a list of percentiles indicating the percent of the distribution that is equal to or below a stated value. These percentiles relate to pre-defined return periods as required under the Agency's Water Resource Planning Guideline (Environment Agency, 2007a). For example the 90 percentile relates to a 1 in 10 return period and the 98 percentile relates to a 1 in 50 return period. These results were used to define the outage figures for the Suffolk resource zones.

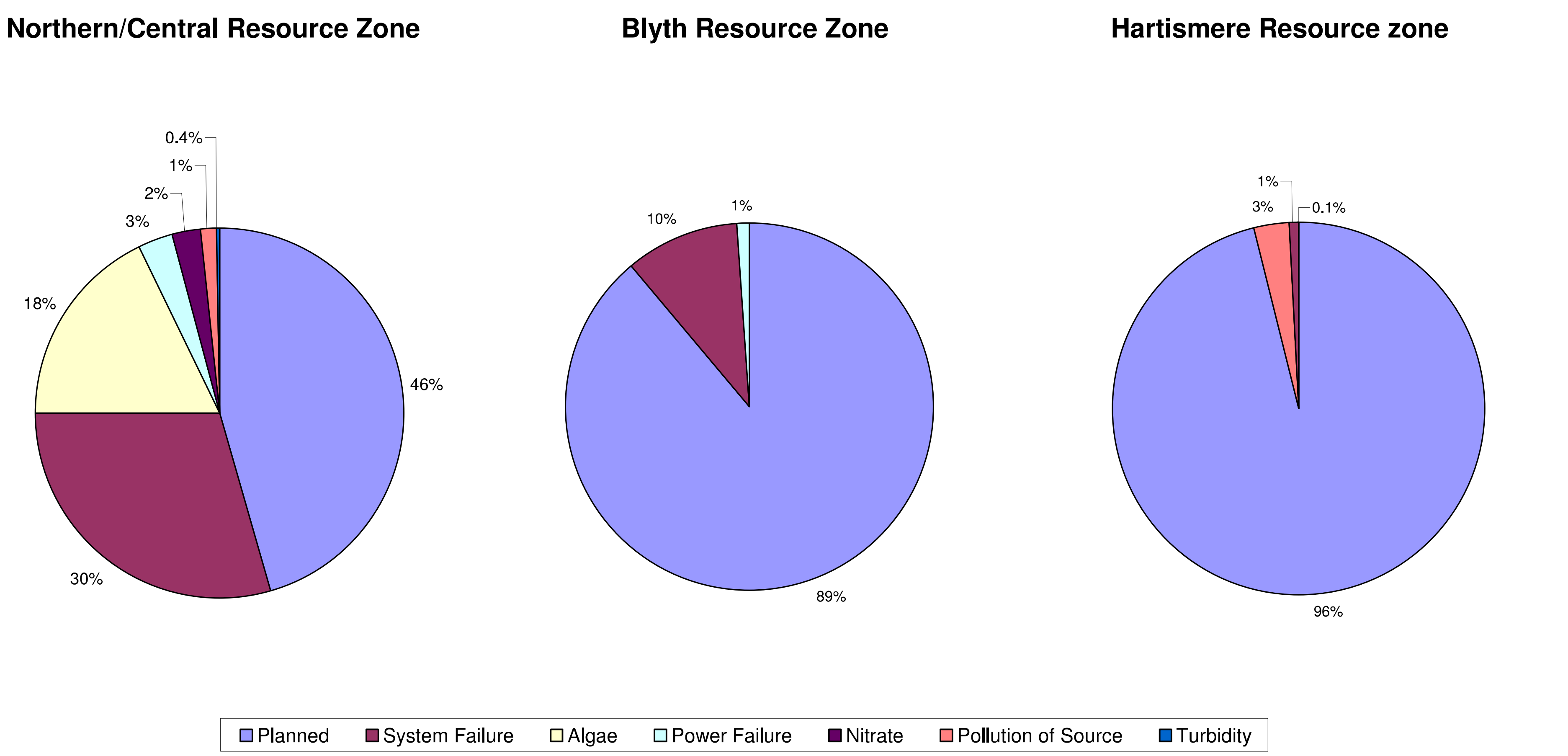
(4) Interpretation of Results

A summary of the data analysis illustrating the types of outage that occurred in each Suffolk resource zone during the period 2002 to 2006 inclusive is provided by the pie charts below.

The outage events affecting the Blyth and Hartismere resource zones were almost all planned, with minor contributions from outage due to system failure, power failure and pollution of source. The treatment works supplying these two resource zones are all groundwater fed and so are not subject to outages caused by surface-water quality issues such as algae, turbidity and nitrate.

Almost half of the outage affecting the Northern/Central zone was planned but outage due to system failure and algae were also significant. This largely reflects the high algal load in the surface-water lakes and ponds that feed Lound treatment works and the resulting problems caused to secondary sand filters. Minor contributions were made by outage due to nitrate, turbidity and pollution of source all experienced at Barsham treatment works, reflecting its river raw-water source.

Summary of outage types in the Suffolk resource zones represented by percentage magnitude (Ml) 2002-2006 (inclusive)



The results of the Monte Carlo simulation are contained in the full forecast reports, which along with figures relating to each return period are included in the Suffolk outage report (ESW, 2008c).

A decision was taken to use the results corresponding to the 90 percentile (one in ten year equivalent) to represent the outage in each resource zone for an average demand scenario. This corresponds to the Company's specified level of service for frequency of an 'appeal for restraint' on water use. The 90 percentile for outage allowance in the Northern/Central zone was calculated from the Monte Carlo simulation to be **2.28 Ml/d**, in the Blyth zone to be **1.09 Ml/d**, and in the Hartismere zone to be **0.64 Ml/d**. The Suffolk resource zones contain a degree of headroom and flexibility in supply and so it was decided that the outage allowance for critical periods and peak demands should remain the same as that calculated for the average demand scenario.

3.3.3. Outage Reduction Strategy

The Water Resource Planning Guidelines (November 2008) requires Companies to "outline a strategy to reduce outage as part of the overall supply/demand options appraisal". ESW are not considering an outage reduction strategy, as our level of outage is already low compared to the rest of the water industry and we believe it already represents a minimum realistic level of outage to plan against.
The remaining significant elements contributing to the outage figure are maintenance of our treatment processes and algal events in the raw waters.
Maintenance is essential to ensure that the water produced complies with the stringent drinking water quality regulations. This has lead to significant amounts of quality driven investment in treatment works, which in turn increases the level of maintenance required to be carried out, and hence the increase in this contribution to outage.
In Essex we treat lowland eutrophic surface waters which are prone to significant algal growth which can impair water treatment. However algal blooms tend to be random and unpredictable in the sources in which they occur, the timing of the blooms and the type and duration of the blooms. As such it is not cost beneficial to build very expensive capital schemes at each treatment works to remove algae when they would only be sporadically used. This is demonstrated in section 9, where an algae outage reduction scheme has been assessed alongside the full options list but has failed to be selected in the final planning solution.

Water Resource Zone	Outage allowance Ml/d	Distribution input (DI) Ml/d*	Outage allowance as a percentage of DI %
Essex	14.79	391	3.8
Northern Central	2.28	49.5	4.6
Hartismere	0.64	7.2	8.9
Blyth	1.09	9.5	11.5

*Final planning, dry year scenario figures averaged over the planning horizon.

In the Hartismere and Blyth zones outage allowance forms a higher percentage of DI than in the Essex and Northern/Central zones. This reflects the rural nature of these zones and the fact they are fed entirely from small localised groundwater sources.

Catchment Management

On catchment management, ESW is leading with initiatives such as the Trinity Broads Partnership and the Lound and Fritton Lake Water Quality Partnership. Although in its infancy, ESW is developing its Branch Out initiative which aims to deliver biodiversity and water quality benefits through new and existing partnerships with other utility companies, conservation organisations, farmers, landowners, local authorities and the general public. We will also be working closely with farmers, the Agency and Natural England to investigate the source of pesticides in main river systems and to identify and agree with farmers ways of reducing them to acceptable concentrations.

3.4. Raw and Potable Water Transfers and Bulk Supplies

Raw and potable water imports and exports are most relevant to the Essex resource zone. No such transfers occur in the Suffolk resource zones, with the only exception being the internal transfer of raw water from the Bleach Green groundwater sourceworks (located in the Suffolk Northern/Central resource zone) to Syleham WTW (located in the Suffolk Hartismere resource zone).

3.4.1. Essex Raw Water Imports - Chigwell Bulk Supply

The Chigwell bulk supply arrangement is captured in an agreement between the Metropolitan Water Board (now Thames Water Utilities) and South Essex Waterworks Company (now Essex & Suffolk Water) dated 30 May 1963.

In summary the agreement allows, under normal operating conditions, for a bulk water supply of 91 Ml/d on average not exceeding 118 Ml/d on any one day from Thames Water to ESW. The bulk supply is provided from the King George and William Girling Reservoirs in the Lea Valley, potentially supported by abstraction directly from the River Lea at defined intakes, if required.

Thames Water and ESW met in September 2007 to jointly reconfirm interpretation of the agreement with respect to how the bulk supply is operated in the event of a drought affecting either party. The results of this meeting can be summarised as follows:

- Clause 2b of the bulk supply agreement refers to what will happen in the event of Thames Water imposing a hosepipe ban on its domestic customers. If ESW also applies a hosepipe ban on its customers then the full average quantity of 91Ml/d remains available to ESW. The last occasion this occurred was in 1976. If ESW do not impose a hosepipe ban on its domestic customers, then the supply from Thames Water Utilities is reduced by 25%. This was the situation in 2006.

- Within the agreement is also a statement that during an "unusual drought" Thames Water shall supply to ESW such quantities as shall represent “fair apportionment” of the water available. We have agreed with Thames Water that "unusual drought" will in future be defined as when Thames Water have entered their stage 3 drought restrictions (implemented powers for a non-essential use ban). Fair apportionment will not be pre-emptively defined as the circumstances of each particular drought differ spatially and temporally (evidenced by 1995/97 and 2005/06). This will be considered however at the time that stage 3 restrictions are put in place. The apportionment will be derived from the relative shortfall in deployable output that each company is experiencing.

Therefore in future droughts affecting ESW the potential for temporarily increasing the bulk supply will be dependent on Thames Water Utilities own resource situation, the nature and spatial distribution of the drought, and demand in the Chigwell area.

On the basis that historically there has not yet been an 'unusual drought' within the Thames Water area that has affected the transfer of water to Essex, then the average demand deployable output of the transfer has been assumed to be 91 Ml/d. Although currently viewed as unlikely, there must be some uncertainty as to whether the 91 Ml/d could be continued to be supplied in the future, particularly in the event of an unusual drought affecting the Thames Water area. The uncertainty associated with the bulk supply has therefore been included with headroom uncertainty and is outlined in Chapter 5 of this document.

3.4.2. Essex Raw Water Exports

There are no raw water exports from the Essex resource zone.

3.4.3. Essex Potable Water Imports

There is only one treated water import into the Essex resource zone at Cressing (near Silver End) from Anglian Water Services (AWS), which has previously averaged 1.174 Ml/d. Accordingly this is the figure that has been adopted for planning purposes. ESW has tried to ascertain how AWS account for this export within their WRMP, but without success. ESW has assumed that as this volume of water is not contracted between the two companies, then AWS treat thesupply as a non-household large user, which is how the supply is billed.

3.4.4. Essex Potable Water Exports

There are small potable water exports from the Essex resource zone to Three Valleys Water and Anglian Water Services.

Anglian Water Services has determined that ESW's export (principally via Tiptree) has an effective maximum average transfer of 3.05 Ml/d, although the actual transfer has historically been much less than this. For reasons of consistency ESW has adopted the same figure for planning purposes.

Over the last few years the average quantity exported to Three Valleys Water has been 0.024 Ml/d, and accordingly this is the figure that has been adopted for planning purposes.

3.5. Zonal Summary of Deployable Output and WAFU

The following table summarises the results of the supply calculations for each of the Essex and Suffolk resource zones for the 2006/07 base year and assuming the mid climate change scenario. The sensitivity to supply around climate change is discussed in Chapter 6.

Zonal Summary of Supply Parameters for 2006/07 Base Year

Resource Zone	Total DO of own sources 2006/07 Mid Climate Change	Reductions in DO in 2006/07 (see text)	Outage	WAFU Own Sources 2006/07	Balance of Raw and Treated Water imports/exports	Total WAFU 2006/07
Essex	316.88	0.17	14.79	301.92	+89.10	391.02
Suffolk Blyth	14.69	0.39	1.09	13.21	0	13.21
Suffolk Hartismere	8.50	0.34	0.64	7.52	+1.5	9.02
Suffolk Northern/Central	71.20	1.90	2.28	67.02	-1.5	65.52

All values in Ml/d

4. WATER DEMAND FORECASTS

4.1. Introduction

The methodologies used to prepare the demand forecasts have followed published best practice as defined in UKWIR (1995c) and UKWIR/Environment Agency (1997).

Forecasts have been prepared for the Essex and Suffolk areas separately. The Suffolk forecast has then been apportioned into the Suffolk resource zones. Normal year forecasts have been made against a 2007/8 base year which has been amended from the published June Return figures to take account of the latest population and occupancy forecasts. This ensures a smooth projection from the base year into the forecast.

The normal year forecasts have been used as the basis for dry year and wet year forecasts, and adjusted to provide figures for three climate change scenarios.

4.2. Base Year

For the June Return 2008, a water balance was prepared applying the Maximum Likelihood Estimation technique at the Essex and Suffolk area level. In both the Essex and Suffolk areas demand in that year was deemed to be within the range classified as normal and therefore no weather-related adjustments have been necessary to create suitable base year demands for the forecasts. However it has been necessary to re-base the water balance to take account of the revised population and occupancy forecasts, as these show a discontinuity against the previous forecasts.

In addition, at the end of each AMP period ESW believe the best approach is to group all the metered households, metered by the base year, into a single group, which we call “Existing Metered”, for forecasting forward. This is because households which became metered through customers opting for a meter, will in time have new occupiers and no longer exhibit characteristics of a new optant household. Also from AMP to AMP ESW’s metering policy changes, which impacts upon the type of households metered, and over time the balance of low occupier/low consumption and high occupier/high consumption households varies between the unmeasured and metered categories.

In the sections below, the derivation of the June Return water balance base year figures is described followed by the re-basing processes.

4.2.1. Per Capita Consumption

The per capita consumption estimate has been determined from ESW's unmeasured household monitor, the Study of Water Use (SWU). Once all data had been validated and leaks had been checked and removed, daily and monthly summary flows were calculated. The summary flows include minimum, maximum and average flows, either on a daily or monthly basis.

The daily summary flows and validated manual meter readings were used in the PCC calculation. The logged data were given the greater priority in the calculation but where no logger information was available, the manual readings were used.

The total monitor sample contains 1,060 properties after any meter optant households, empty properties, leaks and outlying data have been removed.

The best estimate of supply pipe leakage (see section 4.2.5) is added to the calculated household consumption figures to provide the water delivered to unmeasured households.

The Study of Water Use (SWU) is an individual unmeasured household consumption monitor, established in 1993/94. Over the last 15 years the sample has been enlarged and maintained with the data becoming much more robust in the move from taking quarterly manual meter readings to the use of data loggers along with the manual meter readings.

The UKWIR Best Practice for Unmeasured Per Capita Consumption Monitors report was published in 1998 (UKWIR, 1998b). At that time a thorough review of the findings of the report was carried out and continues to be monitored annually. ESW is operating to this best practice and it is the Company's policy to continually review sample size with a view to continued enlargement of the sample in order to improve confidence banding.

In 1999 a purpose-designed database was developed for the company by Tynemarch Systems Engineering Ltd to ensure that the complexities resulting from changes in occupier, validation, meter exchanges etc are adequately incorporated into the analysis. This database is continually monitored and updated to provide greater functionality.

The total number of properties in the Study of Water Use up to 2007 was 1,060, which is slightly less than last year. The majority of these properties are, as would be expected, located in the higher population supply area of Essex (799 properties) whilst the remaining 261 properties are in Suffolk

To calculate the annual Per Capita Consumption (PCC), the daily consumption for each property is determined. This means that the number of properties used in the PCC calculation is determined on a daily basis. As a result where loggers are faulty, data for that period can be ignored, allowing the PCC calculation to use as many properties as it can over the whole 12 months. Over the last year, the minimum and maximum numbers of properties used each month are found in the second table below. It should be noted that PCC is calculated on a calendar year basis, this is because the data is downloaded every three months and the data is needed in the Annual Return.

The table below shows the number of properties throughout the year contributing reliable data and the monthly variability in the results.

Month 2007	Min. No.	Max. No.
Jan	877	900
Feb	893	930
Mar	916	947
Apr	935	945
May	926	937
Jun	931	936
Jul	931	941
Aug	940	960
Sep	950	984
Oct	971	981
Nov	954	973
Dec	947	1245

Monthly variation in properties included in PCC calculations

The consumption of water by each property is stored as flow data every 15 minutes on loggers, which are downloaded every three months on a rolling basis. At the time of download, manual meter readings are taken from externally installed meters. The manual meter readings are validated and a consistency check (within 5%) is carried out comparing logger data with consumption between meter readings. If this shows inconsistency then it is addressed and the correct flow data used where appropriate.

The 15-minute data is passed through a validation procedure to identify leaks and remove spurious data from further analysis. The following table shows the parameters, which are used in validation.

ID	**DESCRIPTION**	VALUE	**UNITS**
1	Highest value above which no flow would normally occur.	1	l/s
2	Lowest value below which no flow would normally occur.	0	l/s
3	Period for which constant non-zero flows would not normally persist.	1	Whole Days
4	Period for which continuous near-zero flows would not normally persist (used in same test as parameter 5).	28	Whole Days
5	Definition of near-zero flow (less than value, used in same test as parameter 4).	.003	l/s
6	Minimum normal period between zero flows (i.e. greater than this would indicate a possible leak).	3	Whole Days

Logged flows validation parameters

Properties with possible leaks are flagged, these are investigated firstly as a desk study and then potentially by a visual inspection of the property by the Distribution team in order for them to identify which are supply pipe leaks so that they can be mended. If no leak can be found it is presumed that any unusual flow is a result of internal plumbing leaks (e.g. dripping taps). Flow data on days with confirmed Supply Pipe Leaks are excluded from PCC calculations.

Once all data has been validated and leaks checked and removed, a summary of daily and monthly flows is calculated. The daily summary flows and validated manual meter readings are used in the PCC calculation. For calculation of daily flows logged data is given priority but if logger information is not available for a particular property, manual readings are used. If this is the case an average consumption between quarterly meter readings is assumed

As recommended in the UKWIR report (UKWIR, 1998b) gaps in the data, occurring when there is no logger data and no meter readings, are not filled as this could introduce error due to the sample size.

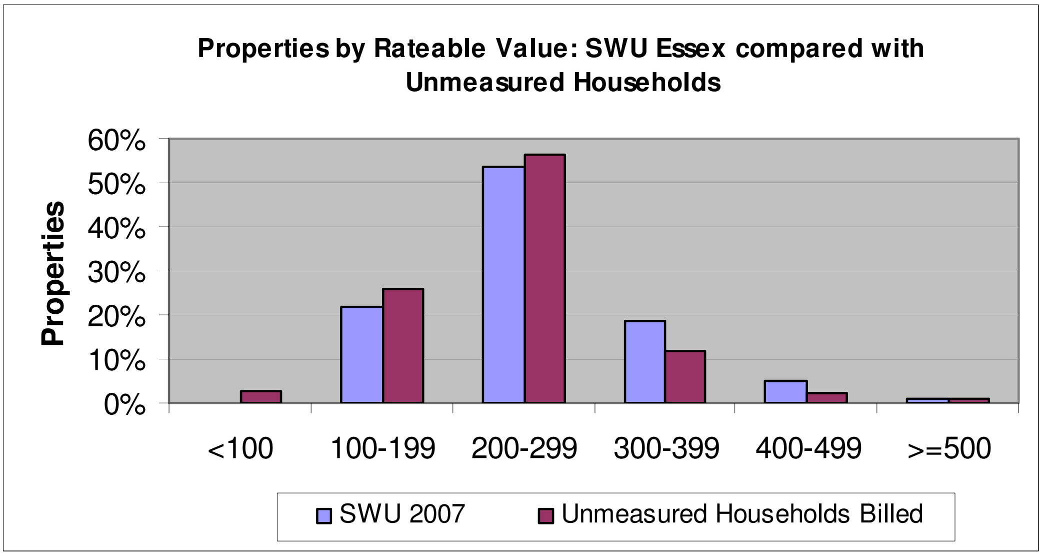
Minimising the potential misrepresentation from a monitor is clearly a difficult issue. Potentially error in the PCC calculation is introduced by over- or under-representation of particular consumption groups, but equally, the choice of scaling method can replace this error with a different error – that from an imperfect scaling methodology. To assist us with this issue, we employed Professor McDonald from the University of Leeds to review our monitor in 1997-98 to provide us with an independent assessment of the sample size and structure of the SWU. Prof. McDonald found the sample to be reasonably representative of the Essex and Suffolk areas. He further concluded that the difference in PCC between the Essex and Suffolk areas was relatively large and therefore these areas should be studied separately.

ESW considers the sample is sufficiently representative, and hence no scaling method is used (method A in the UKWIR report). Since Prof. McDonald's review the Company continued to review the make-up of the sample to ensure that all property and customer types remain well represented. The relationship between PCC and various explanatory factors (such as occupancy and property type) has continued to be assessed. ESW has therefore focussed on ensuring that the sample size is increased such that the representative nature is maintained and improved where possible.

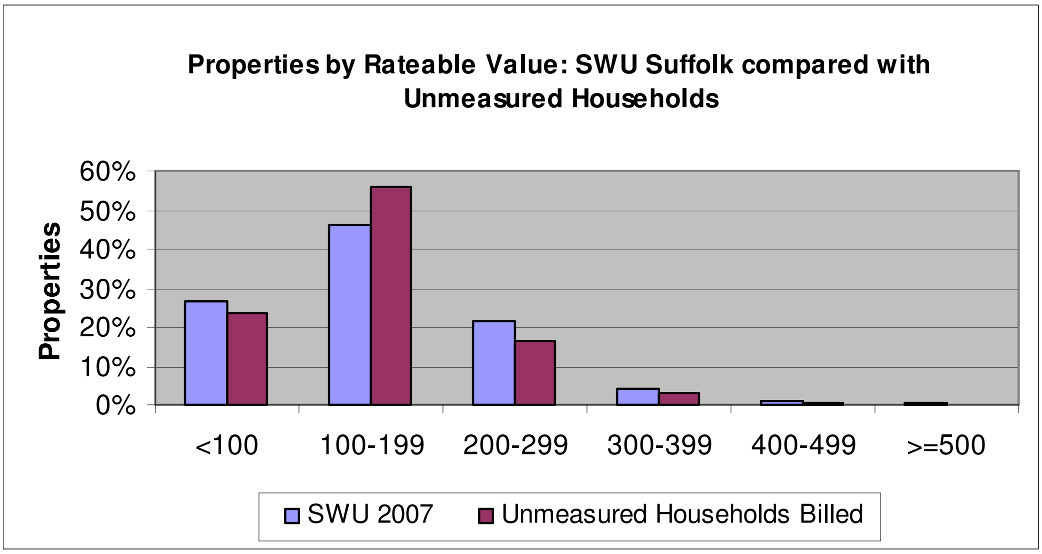
In order to demonstrate how well the SWU matches with available population data for the Essex and Suffolk areas graphs 1 – 8 have been produced. Rateable value (RV), property type, occupancy and the social demographic indictor 'Acorn' have been used to compare the sample to the population. In the case of RV and Acorn the data for our supply area has been taken from our customer billing database 'ICIS'. The data for the property type is taken from the 2001 census, which is divided by areas e.g. Southend on Sea, Great Yarmouth and Suffolk Coastal. The data for the occupancy comparison comes from two recent customer surveys. A survey of 2067 unmeasured customers in Essex was carried out in 2005 and 949 customers in Suffolk were surveyed in 2006. The data for the SWU is taken from the annual questionnaires sent to customers on the study. As this data changes year on year it is necessary to annually update this information.

In each case the match between the SWU and all billed households is very good. Obviously it is nearly impossible to manage the SWU such that an absolutely perfect match was continuously achieved, but it is very encouraging that a good match is obtained for such a variety of factors. Despite this, it is recognised that some property/customer groups are less well represented than others, such as lower income groups, flats and detached houses in the Essex area. This is not surprising as few flats have separate supplies allowing external metering and logging, to allow data collection on a routine basis. Also the lower socio-economic groups are difficult to recruit onto studies such as this. To improve the representative nature of the SWU, ESW tries to target these groups when recruiting additional properties/customers to the sample.

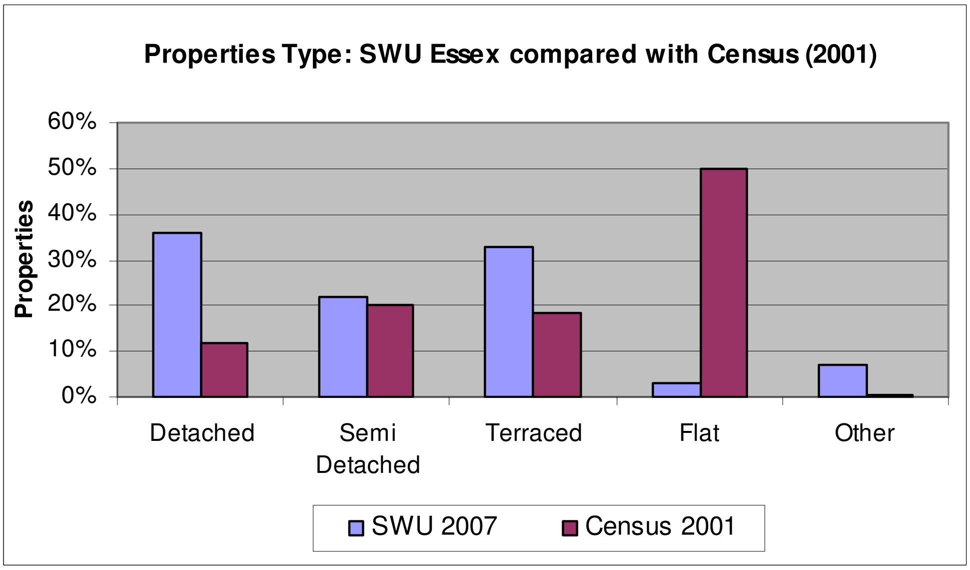
The graphs below compare the rateable values for Essex and Suffolk. For both areas there is a relatively good representation of the total population of our supply area.



Rateable Value: SWU Essex compared with Essex unmeasured households.



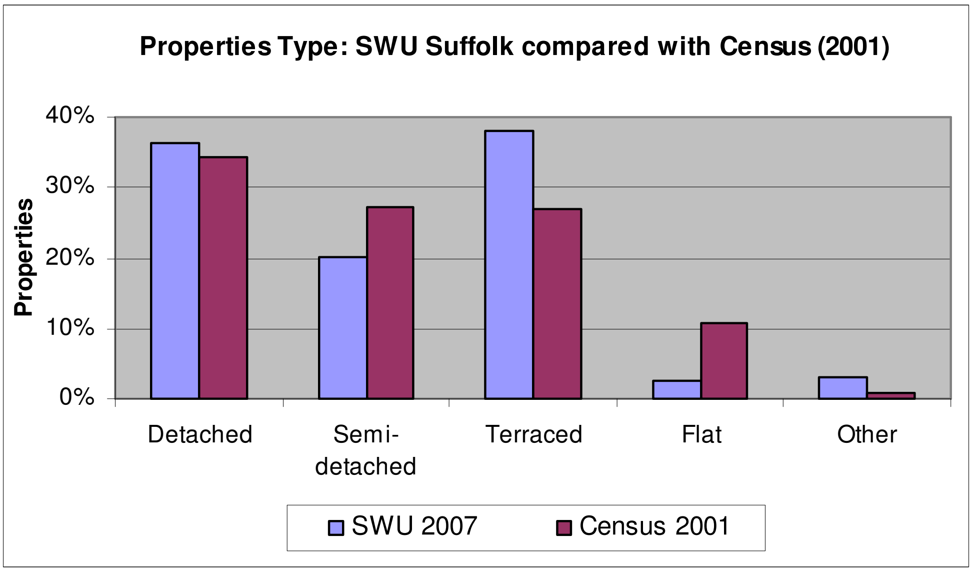
Rateable Value: SWU Suffolk compared with Suffolk unmeasured households.



Property Type: SWU Essex compared with 2001 Census

For property type the SWU Essex matches well to the Census data in particular for terraced houses (see above). There is an underestimation of semi detached houses and flats and an over estimation of detached.

The match between SWU properties in Suffolk and the census data is good for detached houses (see below) but slightly underestimates semi detached houses and flats. The proportion of terraced houses is slightly too high in the SWU sample.



Property Type: SWU Suffolk compared with 2001 Census

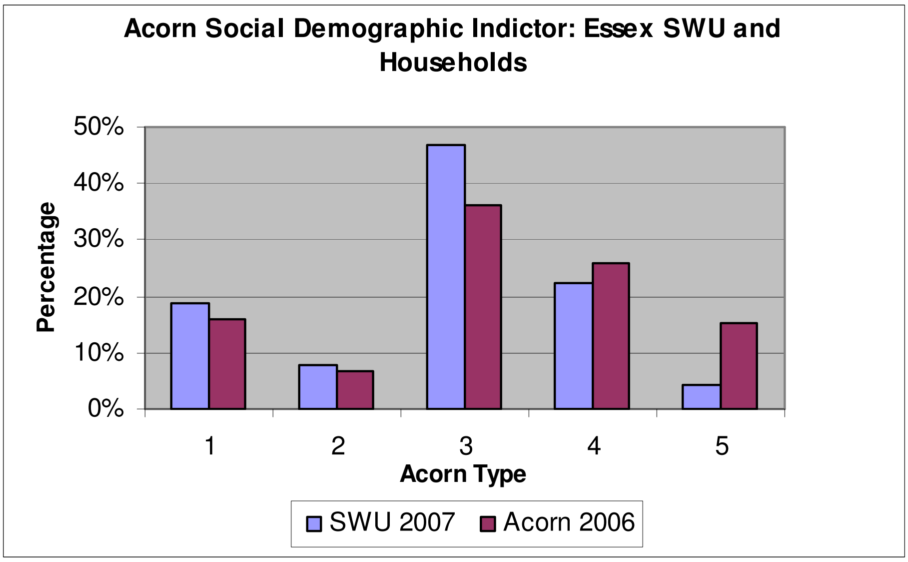
As the Company does not have a full dataset for property types in our supply area, the census data from 2001 has been used. The areas covered by the census data do not match exactly with our supply area; this could explain the slight difference between the SWU and census data. The census data does not split between measured and unmeasured properties; this may also explain some of the discrepancies.

Acorn is a postcode based lifestyle segmentation system using household lifestyle characteristics and demographics. It is based upon lifestyle and demographic information and therefore includes both property and customer based information. Acorn groups populations into five categories, 17 groups and 56 types. For this study the categories give enough detail for analysis.

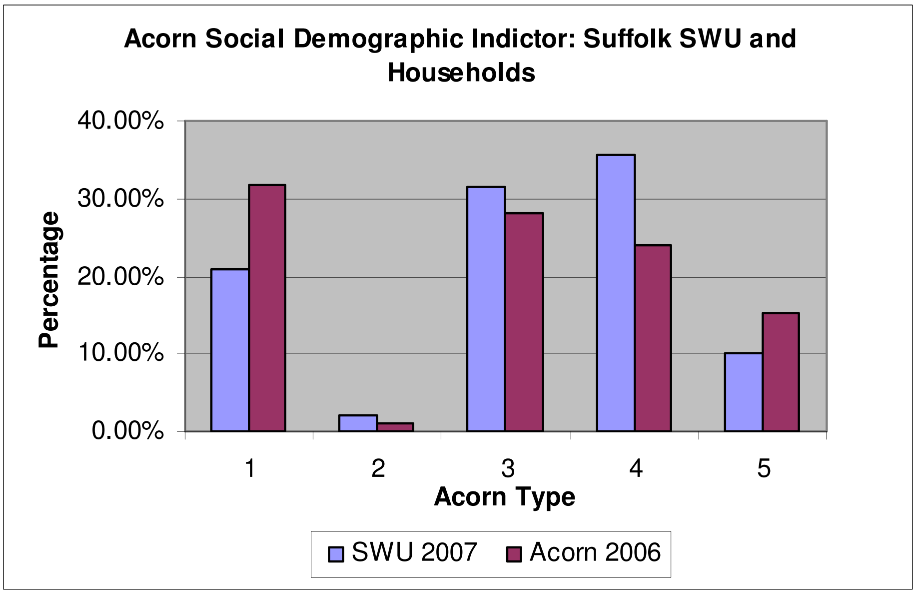
The five categories are:

1. Wealthy Achievers
2. Urban Property
3. Comfortably Off
4. Moderate Means
5. Hard Pressed

See graphs below, shows the comparison between properties in the study and the Essex base. There is a slight over representative for type 3 (comfortably off households) and an underestimate on type 5 (hard pressed households).



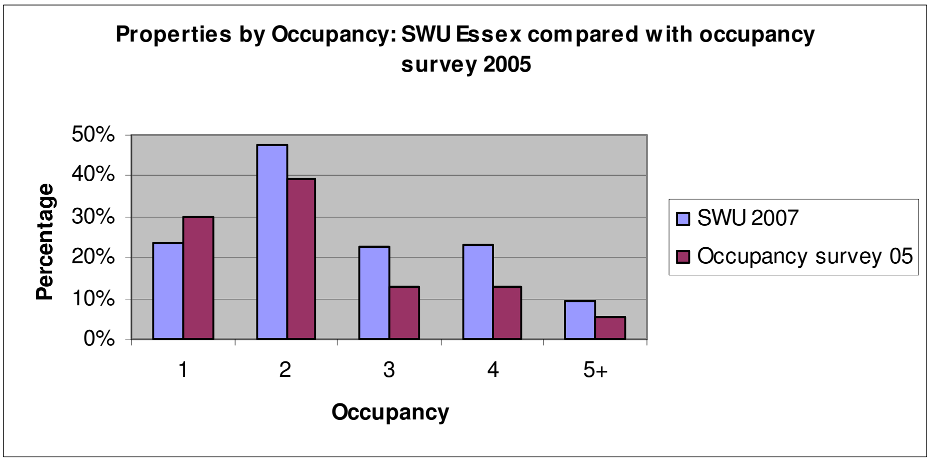
Acorn Type: SWU Essex compared with Essex households



Acorn Type: SWU Suffolk compared with Suffolk households

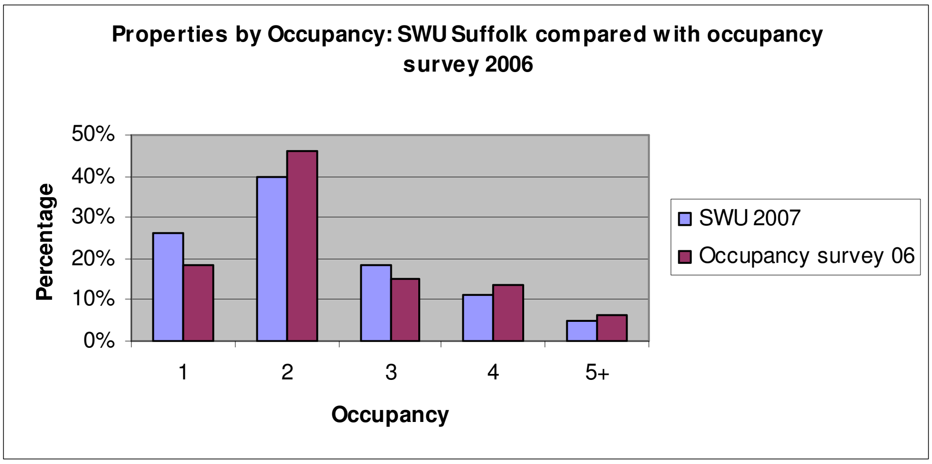
The Suffolk SWU sample does not match as closely to the customer base as Essex does with over representing type 4 (Moderate Means) and under represention of types 1 (Wealthy Achievers) and 5.

Graphs below compare the study customers with two occupancy surveys completed in the last two years. For Essex there is a relatively good match between the survey and the study members. There is a slight underestimate of properties with only 1 occupier, this links with an underestimate of flats.



Occupancy: SWU Essex compared with occupancy survey completed in 2005

The graph below shows a very good match between the study members in Suffolk and the occupancy survey completed in 2006.



Occupancy: SWU Suffolk compared with occupancy survey completed in 2006

Occupancy information and the categorisation of people in a property are derived from an annual questionnaire sent to every customer at the end of the calendar year. Exact knowledge of the occupancy is seen as vital data and consequently any non-responding customers are re-contacted to ensure this data is regularly updated.

In the database, an occupancy figure is assigned to each property for each day, to allow for changes of occupier to be taken into account from the correct day. Change of occupancy is checked on a regular basis and new occupants are invited to join the Study and issued with a questionnaire.

The questionnaire data is applied forward in time in the case of an existing SWU customer, or from the date of moving in, forward, in the case of a new occupier joining the SWU.

On an annual basis, customers are lost from the SWU as they switch over to a metered basis and also during house moves. To balance this out new occupants are recruited wherever possible (when the change is within a property already on the Study) and new properties are brought into the sample throughout the year. The number of properties in the sample is therefore varying all the time.

When a customer enquires about paying by meter, ESW offer to provide a measured bill estimate based on their meter readings. In the last year there have been 12 customers choosing to switch over to a meter. If a customer proceeds with switching, the database is amended with the date of change. Daily consumption values up until that day are still included in the PCC calculation. From the date of opting to pay by meter the customer leaves the SWU (the property is no longer included in the property figures) and their consumption data is no longer included in the PCC calculation.

A selective metering programme has taken place in the whole of the Essex area since October 2005. On change of occupancy the Company is able to install a meter on an unmeasured property; the new occupiers must then pay by a metered charge. 31 study members were lost in 2006 to this project. There were 51 properties that became empty during 2006, customer moved into seven of these properties leaving 44 empty properties at the end of 2006. 36 of these were in Essex; these will change to a metered property once the new occupier moves in and so will no longer be part of the study. The remaining eight properties were in Suffolk; once these become occupied the new customer will be contacted in the hope to recruit them to the study.

The table below shows how the numbers of properties on the study has changed throughout 2006. 70 new members have joined the study, these are from existing properties where there has been a change of occupancy and the new occupier has been recruited onto the study and following a project to recruit more properties onto the study that have never been on the study before.

Changes to the number of properties on the study in 2006 *Figures up to 31/12/2007*	**2007**
Study members (year beginning)	849
Meter Optants	18
Selective metering programme	65
Annual questionnaire not returned	9
New Study Members	72
Study Members (year end)	**1060**
Change of owner	122
Properties becoming empty	48

In 1999, an analysis was undertaken of the SWU meter optants, comparing their characteristics with properties remaining on the SWU and with optants outside the SWU, results are summarised in table below.

Summary of meter optant survey	SWU Optants – Essex	SWU Unmeasured - Essex
Average RV	£288	£250
Average Occupancy	1.8	2.6
Consumption 98/99	188 l/p/d	397 l/p/d

The characteristics of these meter optants are comparable with those outside the SWU. There is consequently little concern that they adversely influence the make-up of the sample or the applicability of the calculated PCC. The graphs above show there are still sufficient properties in the various household and customer groupings to imply a representative sample.

In 2006 236 loggers failed and no data was recorded for a short period. By carrying out a rolling replacement scheme this failure rate is expected to decrease. Each Radcom logger has an expected battery life of five years; the aim is to replace loggers before they reach their expiry date. During 2006 only 36 loggers were recorded as being replaced before their life expectancy was reached. It is thought that some of the loggers that were logged as failed were actually replaced due to an expired battery and the data was input incorrectly. During 2007 a review of the paper work will occur to re classify the reason for removal.

Although each logger has been given an expiry date this does not mean that the logger will not provide accurate data after this date. Many loggers have been installed since 1999 and are still working and providing valid data.

As reported in ESW's June Return 1998 (ESW, 1998), at the time when Professor Adrian McDonald reviewed the SWU the following biases were acknowledged:

- The Hawthorn effect – this is reduced because meters are installed externally but customers are reminded each year they are on the Study when asked to complete the questionnaire;
- Selection of households and self selection – tends to be in favour of lower users as customers who use excessive amounts of water (e.g. ignore the requirement to pay by meter if a sprinkler is used, ignore hosepipe bans etc) are unlikely to agree to take part. There is also the likelihood that customers agreeing to participate are from a similar socio-economic grouping, who appreciate the objectives of such studies;
- Financial advantage bias associated with the confirmation of whether benefit would be gained from switching. The level of switching has been reduced and therefore the lower users are still reasonably represented;
- Sample decay and monitor maintenance.

As ESW's methodology with regards to recruitment and sample selection has not changed since 1998, there is no reason why the impact of bias would have changed to any quantifiable level. Professor McDonald (McDonald, 1998) estimated that in combination, the above biases led to the calculated per capita consumption under-estimating the true average by 3%, this comprised:

- Self selection 1-5%
- Financial 1%
- Hawthorn 1%

It was stated that "the evidence for the existence of bias and its direction is stronger than the evidence for numerical values. The range of numerical values can, in most instances, be argued from past studies but must continue to be regarded as best estimates only. To determine the total range the individual maxima and minima were summed". It was concluded that the best figure to apply to the estimated PCC was the lower estimate of 3%.

Under-registration has been assumed to be 2% as the properties are visited at least every three months and any required meter exchanges are affected very quickly. In the light of Professor McDonalds' advice and our modest estimate of meter under-registration we have in the past increase the unmeasured household PCC by 5%.

When recruiting additional properties, suitable properties are identified and the customer is approached with a request for the questionnaire to be completed. A short brochure explains that as part of the study a meter will be fitted solely for monitoring purposes. In the first few years further reassurance had to be provided to a proportion of potential recruits that they would not have to pay a metered charge, but this is no longer an issue.

On-going improvements are made to the SWU but ESW believe it provides a good and representative PCC figure, and as far as possible it complies with the recent best practice recommendations reported in the Ofwat report (Ofwat, 2007a).

4.2.2. Water Delivered Measured Households

The average water consumption for measured households for each area has been determined from our billing database. This is multiplied by the number of billed measured households and then increased by 3% to allow for meter under-registration. An estimate of supply pipe leakage for internally metered households is added to this to provide the water delivered figure.

Over the last year, the consumption of switchers and measured consumers generally has continued to be analysed. The reported figures are the consumption billed within the reporting year plus a calculation of the consumption of those switchers who did not receive their first measured bill within the report year. The latter consumption is not double-counted in the water delivered to unmeasured households, due to the use of monthly property numbers in the calculations.

4.2.3. Water Delivered Measured Non-Households

As for households, the average water delivered to measured non-households for each area has been determined from our billing database. This is multiplied by the number of billed measured non-households and then increased to allow for meter under-registration.

The estimate of meter under-registration has been based on the output from a project carried out in the last year on rightsizing of non-household meters in Essex & Suffolk, which demonstrated that meters of 40mm and over that had been installed prior to 1999 were under-recording consumption by an average 7.94%. An overall non-household meter under-registration figure has been derived from a consumption-weighted average, assuming 8.5 % for the larger meters, 1-3% for newly replaced large meters and 3% for the small meters.

As measured non-households are almost exclusively externally metered, no allowance for supply pipe leakage for internally metered non-households is added.

4.2.4. Water Delivered Unmeasured Non-household

ESW's estimate of consumption for unmeasured non-household consumption has been based on the review reported four years ago, in which unmeasured customers were compared with metered properties of the same type (e.g. shops, warehouses) and also compared the rateable values of metered and unmetered properties. It has been assumed that an unmeasured customer consumes 50% of a similar metered property, based upon the relationship between rateable value and consumption and the average rateable value of unmeasured properties being 50% of that of equivalent measured properties.

It should be noted that because of the very small number of properties involved, this group only accounts for around 2% of total water delivered.

4.2.5. Supply Pipe Leakage

A new methodology for quantifying supply pipe leakage has been used since 2006, when a project was undertaken to improve our estimates. For this project, unmeasured leakage flows were collected from the Study of Water Use (SWU) and measured leaks were gathered from the customer billing database, which stores information collected on leakage allowance forms. Two databases (measured and unmeasured) were compiled, through which the average volume, duration and frequency of leaks could be calculated. It was recognised that the measured database had limitations because generally only larger leaks are recorded because they have been detected through meter readings. Similarly, the SWU leaks have not been left to run as long as undetected leaks on unmeasured households could run for. The leaks mainly referred to properties in the Essex area.

It was established early on that every leak would start with similar characteristics irrelevant of the property meter status. It was also suggested that every leak has a hypothetical flow rate, at which the leaks become ‘noticeable’. The average leakage volume of the ‘noticeable’ stage could be taken from the respective databases. The importance of determining the average duration, frequency and flow rate of leaks before they reach the hypothetical ‘noticeable’ stage was recognised.

The SWU leakage records provided daily flow rates. Analysing these in detail allowed a natural rate of rise in leakage curve specific to the Southern operating area, to be constructed. From this, it was possible to assume that the average leak will run for a period at a flow rate of 0.0057 l/sec (regarded as so small that it cannot be noticed). Once noticeable, the duration, frequency and volume of leaks depend upon the meter status of the property. The frequency of occurrence of leaks was 0.0188 for unmeasured properties and 0.0047 for measured properties. The frequencies were calculated using population and leakage figures specific to each year.

Simple calculations revealed average daily leakage volumes of 39.77 litres per property for unmeasured properties in Essex and 17.74 litres per property for measured properties in Essex. For Suffolk it was necessary to calculate equivalent values due to the very small size of the database. This gave figures 20.61 litres per property for unmeasured properties and 9.19 litres per property for measured properties.

4.2.6. Operational Use and Water Taken Unbilled

As a result of the work carried out for the Annual Return by Ewan Associates, operational use continues to be assessed using similar methods to those applied in the Northern Operating Area. This review looked at developing methodologies for determining all aspects of operational use and water taken unbilled and included site measurements for certain parameters. Since the review, wherever possible, the methodologies supported by Ewan's report (Ewan Associates, 2002) have been used and new data input where it has become available. Some improvements have been made since last year generally in data reporting systems and also the standpipes we hire are now metered.

The reported figure for Operational Use covers volumes used for treatment works' use, service reservoir and tower cleaning, third party bursts, flushing, new mains and rehabilitation.

Water taken legally unbilled includes the following components:

- Supply pipe leakage on voids
- Sewer jetting
- Unbilled supplies to customers
- Staff accounts
- Company offices
- Standpipe use
- Roving licences
- Bowser hire
- Water donations
- Council usage
- Metered allowances for the Protect tariff and discolouration
- Chronic illness allowance
- Unbilled consumption from new occupiers before meter fitted under selective metering programme
- Waste notices
- Fire fighting
- Water for building supplies

The reported allowances for metered volumes have been determined from individual accounts and meter readings.

Water taken illegally unbilled includes an estimate of consumption of occupied void properties, based on our recent void inspections, and an assessment of illegal hydrant use, based on methods from the Ewan's report (Ewan Associates, 2002).

4.2.7. Total Leakage

Our strategy for leakage control in the Southern Operating Area is based on a system of district metering, which covers the great majority of the networks in this area. The system comprises 314 district meter areas (DMAs) in Essex and 75 in Suffolk. Total leakage is determined from continual night flow measurements, analysed separately for the Essex and Suffolk areas. Continual night flow monitoring is carried out, covering 90.4% of customers in the Southern Operating Area, which is unchanged from the previous year. All of the district meters are connected to telemetry loggers that collect data on both pressure and flow at 15-minute intervals. This data is transmitted to central computers in our Southern Operating Area offices every night by means of telephone lines, cable TV lines, or cellular telephone links.

Netbase Software Package

The Netbase software package has been used routinely across the Southern Operating Area for automated management and analysis of leakage data since 2000. This extremely powerful package carries out the following tasks:

- Analysis of flow data from district meters to calculate net zonal demands at 15-minute intervals for each DMA;

- Calculation of the minimum rolling one-hour average flow for each DMA nightly and the weekly median of these daily values;

- Application of allowances for household and non-household night use in each DMA to calculate leakage for each week. These analyses follow the recommended methodologies from the two recent UKWIR studies on night use allowances.

- Calculation of the hour-day factors from pressure data transmitted from each district meter location and application of these factors to convert night leakage into daily average leakage.

- Validation of all flow data records for each day, using a hierarchy of data validity tests. The most important of these is carried out by dividing the total daily flow for each DMA into its main components of household demand, non-household demand and leakage. The second and third of these are derived from billing records and night flow analysis, respectively, and the first is then calculated as the residual component of the total net demand. This is then expressed as an implied per capita household consumption and checks are applied to ensure that this is within reasonable limits.

- If the data for a given DMA fails this PCC test on any particular day, then the measured value of leakage is replaced with an estimated value for that day. This process is carried out automatically as follows:

- If valid data exists for that DMA within the previous three months, then the most recent valid data is used.
- If no recent valid data exists, then leakage is estimated from the average of the leakage rates (in l/prop/hour) in the adjacent DMAs within the same zone.

Household Customer Night Use

The household customer night use has been determined from the data-loggers used for the Study of Water Use (SWU). Flows from the 1,000 properties have been analysed for a full year, by time of day, to give the one hour averages over the year for each rolling 15-minute period in the early hours of the morning. The district net night flow data for every DMA have been analysed to determine the hour when the minimum nightflow most commonly occurs (3.15 am to 4.15 am) and the customer night use for this same hour has been selected. In 2006/07, the measured average household night use rate for Essex was 3.21 l/prop/hour. As this is within 9% of the previous value used in Netbase (2.95 l/prop/hr), no change has been made to this parameter in Netbase. Values of this parameter as calculated from the SWU data since 1999 have been remarkably consistent.

For Suffolk, the average value from the SWU loggers this year was 3.11 l/prop/hour. This value is also very close to the 8-year average and therefore the value of 2.95 l/prop/hr has also been used for Suffolk.

Non-household Customer Night Use

Non-household customer night use is based on a major sampling study carried out across the Southern Operating Area. The entire database of non-household customers was divided into 20 categories of property type. Each of these groups was then further subdivided into five subgroups by size, based on total annual measured demand, making a total of 100 subgroups. A sample of each subgroup was then logged for several days, and from this data the following were derived for each subgroup:

- The average percentage of customers that are "active", i.e. using water at night.
- A log-log relationship between night use and average daily use, for the "active" customers.

All non-household customers are allocated to DMAs by geographic processes within Netbase and the above relationships are then used to calculate night use allowances for each customer individually.

An entirely new survey of non-household night use is currently under way, and the results should be available by the end of 2007/08.

A major review of hour-day factors was carried out in 2001/02. Hour-day factors were calculated separately for each DMA, using DMA-specific pressure data. The analysis was compiled for weekdays and weekends, in both summer and winter conditions, and a weighted average value calculated for each DMA. The overall average across the Southern Operating Area was 22.18 hours. It is not expected that hour-day factors will have changed significantly since 2001/02, since there has not been a significant increase in the coverage of pressure management since that date.

Areas Outside DMAs

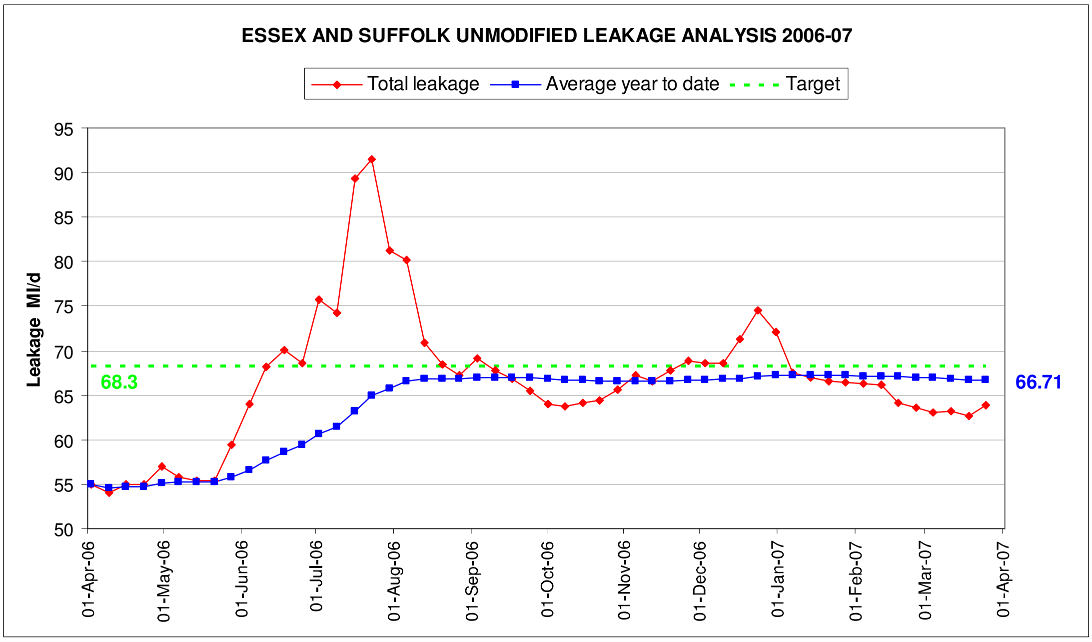
In recent years, increased attention has been paid to those areas, covering 9.6% of customers within the Southern Operating Area that are not contained within DMAs. These areas fall into the following categories:

- Isolated areas, often rural, that do not fit conveniently into the district metering system;
- Industrial areas, where minimum night flow is not a valid indicator of leakage levels;
- Urban areas where district metering zones cannot be formed without causing unacceptable reductions in pressure.

In these areas, known as “dummy DMAs”, our policy is to survey by sounding at regular intervals. There are 88 dummy DMAs in the Southern Operating Area, containing a total of 70,580 properties. Of these, 25 dummies were rejected for survey because they are very small and contain fewer than five fittings available for sounding. The remainder are surveyed at intervals of approximately 12 months. 80% of all properties in dummy DMAs were surveyed at least once in 2006/07.

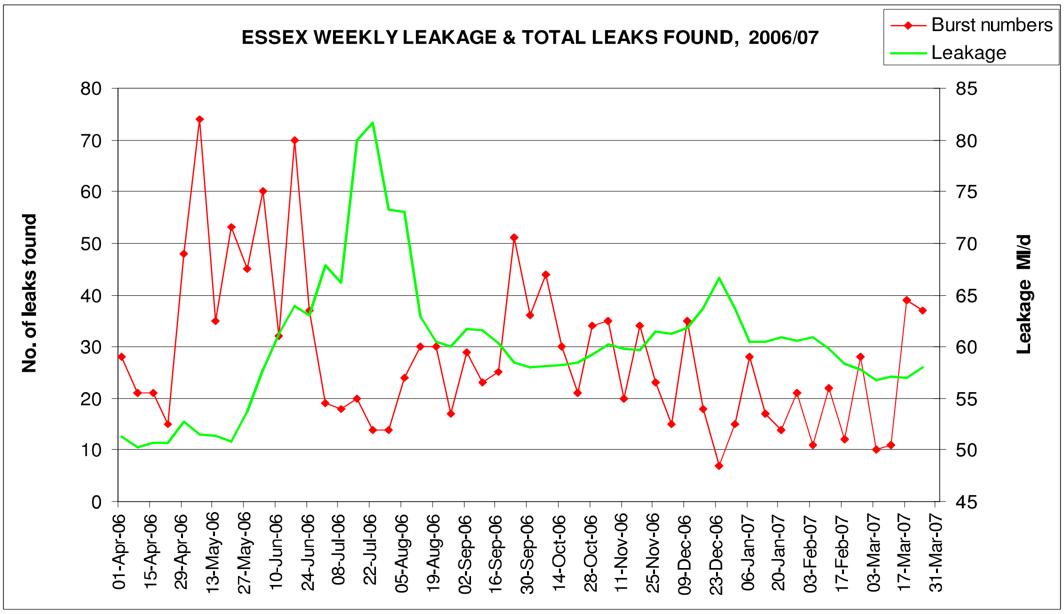
Seasonal Variations

Although Netbase is able to provide daily leakage values for each DMA, in practice leakage reporting is based on weekly median values for each DMA and dummy DMA. Each week, these values are summed to provide the total leakage level for the Southern Operating Area. The unadjusted weekly values are shown in the following graph, together with the rolling year-to-date average figure, which reaches 66.71 Ml/d at the end of March 2007. The Ofwat target of 68.3 Ml/d for 2006/07 is also shown.



The notable features of this graph are the steep rise in the spring, the sharp peak in the summer and the much smaller peak in the early winter. Leakage in Essex rises in the winter every year, although this year's peak was the smallest ever recorded. This was a small but genuine peak in leakage, which was brought under control by timely response from leakage technicians and repair crews.

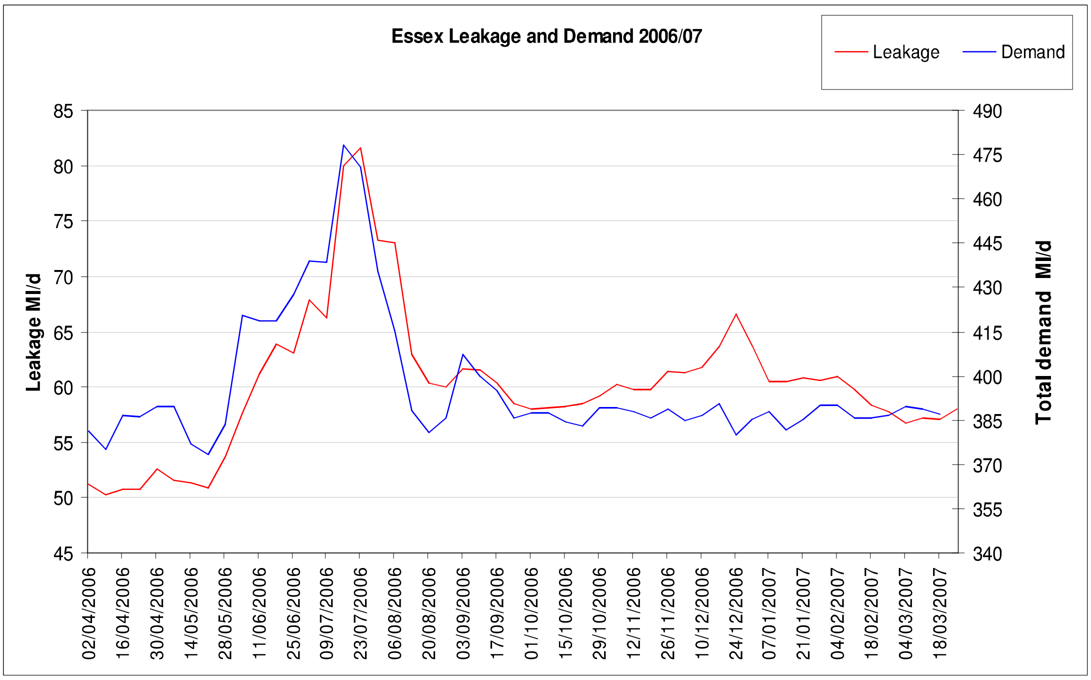
The following graph shows weekly leakage values in Essex, and the weekly numbers of leaks found. The steep rise in leakage from late May to the end of June was accompanied by an increase in the number of leaks found and was a genuine rise in leakage. However the peak through July and early August did not correspond to a period of high burst activity.



Leak location effort continued at a steady rate during both the apparent rise and the apparent fall in leakage.

Such sharp summer peaks in the leakage graph are a regular feature of the annual leakage analyses for Essex and Suffolk. In most years, they are seen as a series of three or four very short peaks, each of one or two weeks' duration. In previous June Returns, a large amount of detailed analysis has been presented to demonstrate that these apparent short-duration summer peaks in leakage, which occur every year, are in fact due to short term increases in household night use, probably related to night sprinkler use, and do not relate to leakage at all.

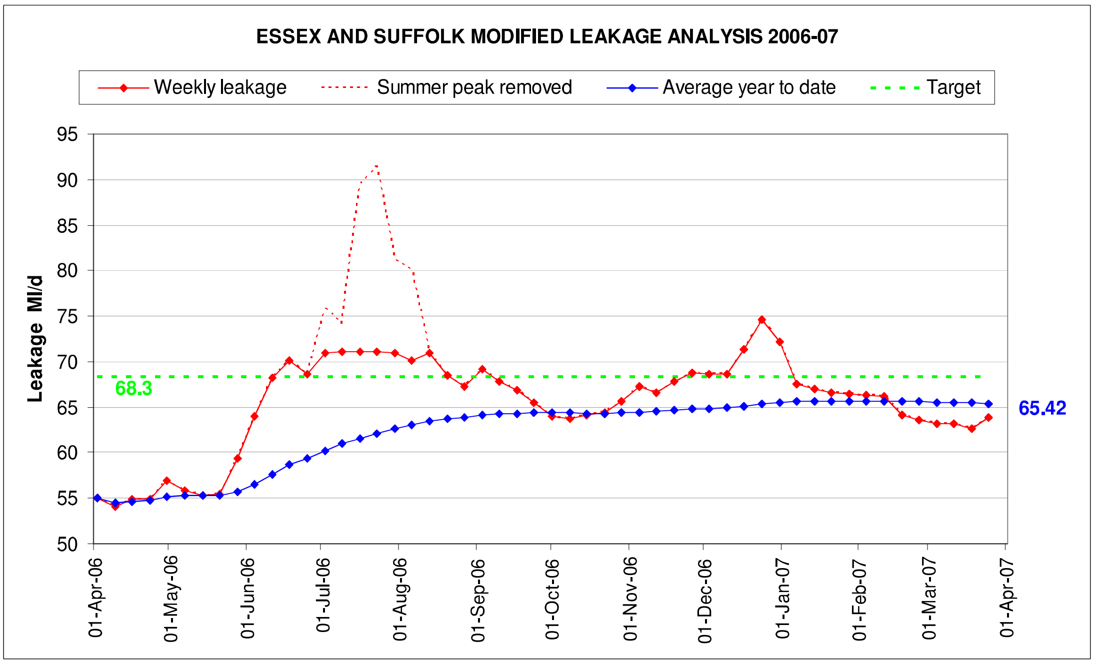
The following graph shows weekly leakage and total weekly demand for Essex through the summer period. These two parameters are clearly in step in the summer but not in the winter, which reinforces the theory that the apparent summer peak in leakage is, in fact, demand-related.



Real Leakage Profile

In view of the above analysis, we have concluded that the profile of real leakage is as shown in the graph below. The summer peak has been replaced by an interpolation of the values before and after the peak. This analysis was carried out for Essex and Suffolk separately. Data were adjusted for six weeks in Essex but for only two weeks in Suffolk. The plot of weekly total leakage below is the sum of the resulting values for Essex and Suffolk respectively.

The underlying trend shows a sharp increase through late May and June, followed by a gradual fall until mid October, then a second rise in November/December, falling again to a minimum in March/April. This trend is typical for the company and is repeated in most years.



The average of these adjusted values over the full reporting year is 65.42 Ml/d. This is the figure that has been taken forward to the water balance MLE analysis for total leakage. However, the MLE analysis has resulted in this figure being adjusted upwards to 67.99 Ml/d. This final value is 0.3 Ml/d (or 0.5%) below the target for 2006/07 (68.3 Ml/d).

The table below compares the three-year rolling average of post-MLE leakage with the three-year rolling average of the targets.

Year	Actual Leakage (Ml/d)	Leakage Target (Ml/d)
2004/05	66.8	69.8
2005/06	66.7	69.0
2006/07	67.99	68.3
3-year average	**67.16**	**69.0**

Therefore, on a three-year rolling average basis, the actual leakage level is 1.8 Ml/d (or 2.7%) below the target.

4.2.8. Bulk Supplies

The bulk supplies are as follows (2007/8):

Import – raw water	TWUL	87.32 Ml/d
Import – treated water	AW	0.96 Ml/d
Export – treated water	AW	2.92 Ml/d
Export – treated water	Three Valleys	0.01 Ml/d

4.2.9. Re-basing the 2007/8 Figures

For both the Essex and Suffolk areas the June Return volumes have been used. PCCs have been calculated from the revised population and occupancy figures from the new forecast described below.

The company's work planning database has been analysed to provide improved figures for the number of households internally and externally metered and for the sub-division into AMP4 optants, selectives and new, and pre-AMP4 Existing metered group. Previous estimates (as used in JR08 (NWL, 2008)) were based on annual change.

For the final submission of the NWL Business Plan in 2004 it was decided that the best way to forecast metered household consumption, was to create a category of customers we call "existing metered". To forecast metered consumption, base year consumptions had been derived from the billing database (ICIS) for recent new houses and for recent optants. In theory, the base year customer base could be divided into these broad categories, abut past metering policy had not been this simplistic – eg prior to free meters for all optants, ESW had a policy of metering sprinkler users – strictly an optant process in that the customer could chose whether to be metered or to discontinue using a sprinkler, but customers metered through this process would be expected to have different occupancy and consumption characteristics from other (financially driven) optants. Also ESW had compulsorily metered the Galleywood zone in 1993/4 and later introduced free meter optants for single occupant OAPs.

For these reasons, the base year consumptions for recently metered new and optant customers, if applied to the whole metered household base in 2002/3 did not give a total metered consumption matching that of the June Return reported total household metered consumption. It was therefore decided that all metered household metered up until the base year would be placed into a single category of known consumption – the existing metered, with the total base year metered household consumption. For these customers their consumption is known with confidence and so it makes sense to use this certainty in the forecast. The consumptions from recently metered new homes were used as the basis for the microcomponent-driven forecast of new homes.

The existing metered customer base will not increase over time within the forecast, in that new customers will not be added until a new forecast is created every 5 years, but the number of households may be expected to change/decrease slightly due to voids and disconnections.

Now, the same process has been applied. The customers metered by the 2007/8 base year have been moved into the existing metered base – added to those from 2002/3. Customers metered from 2008/9 onwards will join one of the following categories: new, options, selective, compulsory.

We believe it is reasonable to regroup the customers every 5 years because changes in occupiers mean that a household metered through one particular metering process cannot be expected to keep those characteristics for all time – low occupier optants will be replaced by "average" occupiers, those whose behaviour may have changed through publicity surrounding a compulsory metering process may be replaced by occupiers who are ambivalent to the property being metered etc. Any attempt to forecast these uncertain changes could not be completed with reasonable accuracy and therefore such a process would not improve the accuracy of the demand forecast. A compromise position is therefore to re-base every 5 years.

To create the base year figures for the WRMP the following processes took place.

1. The June Return 2008(JR08) figures were re-worked following a review of the numbers of properties in the new, existing, optant, internally metered and externally metered categories. This reworking was because a small imbalance had occurred over the 5 years due to assumptions about the internal/external split rather than exact numbers. The delays between our work planning database (Engarde) data and the billing database (ICIS) data and the complications from metering which are not mirrored in the forecasts eg dual supplies to homes, changes in meter location etc, though insignificant in overall numbers can make it hard to track numbers exactly. The new split of the JR08 metered household billed property count (the total remained unchanged) impacted on the demand figures largely through supply pipe leakage.

2. The households in the reworked JR08 new, optant and selective groups were added to the existing metered group. This means for the WRMP, figures for 2007/8 have zero households in the new, optant and selective categories, but from 2008/9 households are added to these groups in line with the metering forecast. The existing group have the base year consumption for metered households from the reworked JR08 figures and take on the revised occupancy figure for the existing household group.

3. From 2007/8 onwards the revised population forecast was applied. This is the Experian 2008 forecast with the Demographic Decisions' figure for illegal and short-term migrants added. The overall occupancy forecast from 2008/9 onwards is derived from this population forecast and household forecast.

The re-basing process is shown diagrammatically below:

	2002/3	2002/3	2003/4	2004/5	2005/6	2006/7	2006/7	2007/8
New	X	0	X1	X2	X3	X4	0	X5
Optant	Y	0	Y1	Y2	Y3	Y4	0	Y5
Selective	Z	0	Z1	Z2	Z3	Z4	0	Z5
Existing metered		D=X+Y+Z	D1	D2	D3	D4	D4+X4+Y4+Z4 = E	E1
JR total	D	∑above	∑above	∑above	∑above	∑above = E		

4.2.10. Maximum Likelihood Estimation

The reported figures have been adjusted using the MLE technique as follows:

Component	JR08 Reported Figures Ml/d	Re-based Initial Estimate Ml/d	Re-based post MLE Final Estimate Ml/d
Water delivered unmeasured household	212.10	201.77	207.99
Water delivered measured household	90.97	86.10	89.92
Water delivered unmeasured non-household	1.75	1.69	1.79
Water delivered measured non-household	99.08	96.78	100.76
Operational Use	1.13	1.07	1.17
Water taken legally unbilled	3.32	3.16	3.43
Water taken illegally unbilled	4.38	4.20	4.50
Distribution Losses	44.83	44.27	45.22
Total Leakage	68.25	67.12	69.04
Distribution Input	457.55	461.57	454.78

4.3. Populations

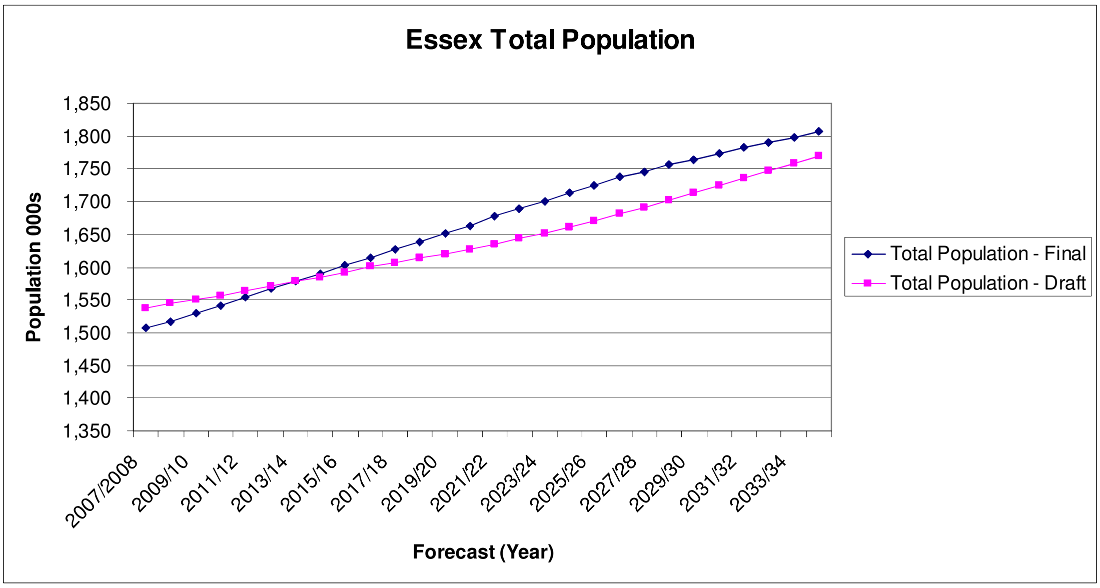
Overview

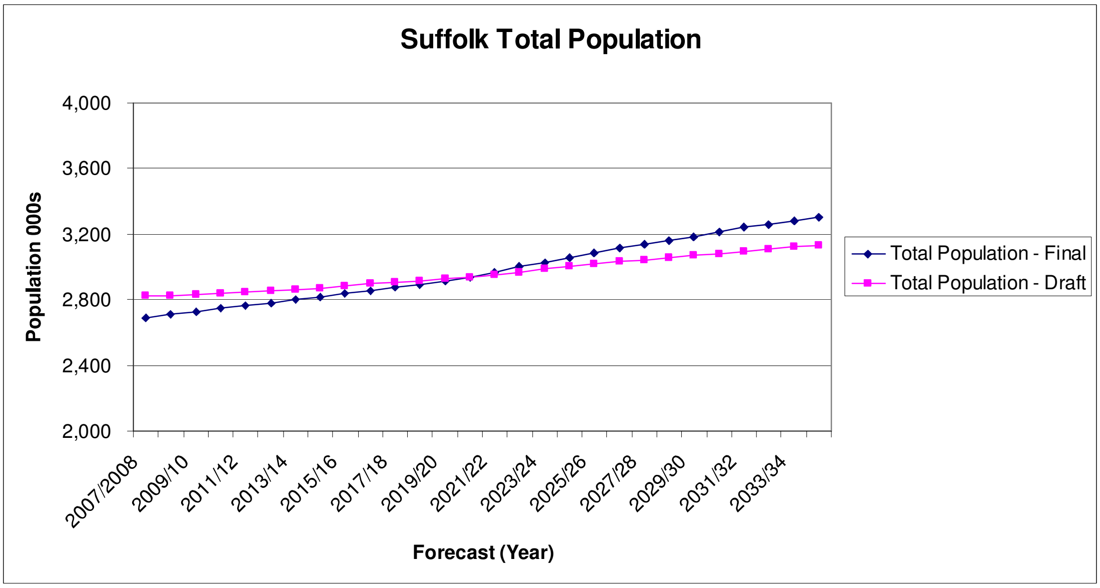
The work on population for the base year and population forecasts for future years has been commissioned from Experian. This work is an update on the population figures used in the draft Water Resource Management Plan. The original draft plan used the population forecasts based on the Office for National Statistics (ONS) 2003 mid year update prepared by Experian for the company in 2004. We had received new population data based on the ONS 2007 mid year update but they were so different from the 2004 figures, and doubt on the validity of population forecasts was being expressed by a significant number of organisations, that we decided to keep with the WRP04 numbers. The ONS had stated that they were to fully revise the population figures and release the revision in June 2008. Experian were contracted to reproduce the population and property forecasts using the latest RSS figures for property and the ONS 2008 revision for population. We have maintained the short term migrant and illegal immigrant populations, likely to be residing in our supply area, that was commissioned from Demographic Decisions Ltd for the draft WRMP. Although anecdotally it is thought that some Polish migrant workers have returned home, it is also thought that they have been replaced by workers from the recent accession countries.

Experian used best practice methodology which follows the requirements of the Water Resource Management Plan Guidelines and the Ofwat population guidance, requiring that figures should be based on the Office of National Statistics (ONS) population statistics. For the base year (2007/08) populations, Experian used ONS statistics based on the 2001 National Census and the annual updates and revisions including the 2008 revision. This report is produced as Appendix A at the back of the plan.

Essex

The figures for Essex show a slight decline in the base year, eroding to zero by 2013/14 then a continuous increase, above the previously used 2004 numbers, through to the end of the planning horizon. The maximum increase in population occurs in 2026 when it is 56,000 above the draft plan, and still shows an increase of 36,000 in 3035.





4.4. Occupancy

Essex

The overall occupancy comes from the Experian domestic population figure plus the short term migrant/illegal immigrant population from Demographic Decisions. This total population is divided by the total number of billed household for the year to give an overall occupancy rate. However, whilst a total population figure is essential in our demand forecasts, an overall occupancy figure is a too higher level number to be useful in the demand forecast directly. This is because the different housing categories of our customers have different average occupancies. For example unmeasured customers have a higher occupancy than that of the optant meter customers.

This is because it tends to be low occupied properties where the customer gains financially by paying a measured charge whereas a high occupied property, if electing for a meter, would pay more for their water and sewage than if they remained unmeasured. It is therefore necessary to have a specific occupancy for different classes of customer.

The occupancies are set by various sources of information available to the Company, ranging from specific occupancy surveys sent to a random selection of customers, occupancy taken from meter optant applications, occupancy of customers on unmeasured consumption monitor, The Study of Water Use, and professional judgement based on past occupancy and future forecasts of changes in the customer base.

Sources of Information

Customer Type	New pop. 2007/08	Survey 2005	Survey Sel. 2005	Optants 04/05	Optants 05/06
Overall	2.54				
Unmeasured	2.91	2.47			
Existing	2.00	2.24			
New	2.35	2.55			
Optant	1.60	1.90		1.54	1.62
Selective	2.66	2.64	2.68		
Measured	2.00	2.24			

The most recent survey data has come from the Microcomponent Survey used to determine the ownership and frequency of use of water using appliances in the home. This was carried out in 2007 to populate the model for looking at future changes in per capita consumption. For Essex & Suffolk Water 2,500 survey forms were returned, about 2,000 for the Essex water resource zone (WRZ). The results are indicated below:

Customer Type	Occupancy
Unmeasured	2.34
Existing measured	1.96
New homes	2.34
Optants	1.63
Selective	2.59

From all of the above data the following base year occupancy and future forecast occupancies were derived and used in the WRMP.

New homes

The occupancy for new homes has been lowered to 2.35 from the previously used 2006/07 forecast occupancy to reflect the overall lower occupancy, the results from the microcomponent survey and the fact that in the recent few years there has been a significant increase in the number of single bedroom apartments being built. This area of the housing market has seen a much stronger growth than the family housing end as property prices have risen so steeply. The occupancy is forecast to remain stable through to 2025 after which it will decline gradually through to the end of the planning horizon in line with the decline in overall occupancy.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	2.35	2.35	2.35	2.35	2.32	2.30

New Optants

The optant occupancy has been lowered to 1.60 from the previously forecast 1.86. The microcomponent survey (1.63) and the 2004/05 meter optants (1.54) and 2005/06 meter optants (1.62) demonstrate a fairly consistent level of occupancy that encourages customers to opt for a meter. The Company forecast a modest increase in optant occupancy through to 2034/35 (1.71) as there will always be changes to families occupancy, such as divorce, loss of a spouse or children leaving home, that will result in the remaining occupier opting for a meter. While the occupancy rate of optants remains relatively steady over the 25 years, the actual number of properties opting for a meter decline rapidly as compulsory metering removes eligible properties.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	1.60	1.63	1.65	1.67	1.69	1.71

Selective/compulsory

The occupancy of the selectives, up to 2014/15, is above that of new homes as the change of occupier that triggers selective metering is into pre-1989 properties which have a lower proportion of single apartments than the current new homes. Beyond 2014/15 the compulsory metering programme begins to meter the larger families that have not moved property and the occupancy moves closer to the unmeasured property occupancy. The occupancy does remain below that of the unmeasured as the social housing is not metered and there is a tendency for larger families in social housing. This is a consequence of the points system of allocating social housing which favours priority of being given a house to larger families.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	2.66	2.73	2.78	2.76	2.71	2.65

Existing metered

The base year for what becomes the existing measured is the measured occupancy used in the June Return 2008, rebased to take account of changes in overall population and information from occupancy surveys. The figure of

2.00 has been used in the rebased numbers to account for the overall drop in total population and to update the measured PCC within 2006/7. This figure then increase steadily over the whole of the planning horizon to 2.10 in 34/35. In reality this occupancy is reset every five years when the new Water Resource Management Plan is produced.

Measured properties

The occupancy of the overall measured is calculated from all of the differently metered components using their assigned occupancy and weighted by their forecast property numbers. Changes in this occupancy in the forecasts are influenced by the occupancy of the groups that dominate in future years e.g. new homes, optants or compulsory.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	2.00	2.15	2.30	2.34	2.34	2.32

Unmeasured properties

The unmeasured occupancy is calculated by subtracting the population assigned to all of the measured groups from the total household population and dividing this by the remaining number of billed unmeasured properties. This would always be expected to be the highest occupancy class but over time the overall measured occupancy and unmeasured occupancy converge towards each other. However because of the compulsory metering programme not reaching some of the social housing, and this being the bulk of the remaining unmeasured, a high unmeasured occupancy towards the end of the planning horizon can be predicted.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	2.91	3.03	3.00	2.83	2.67	2.69

Suffolk

A number of sources of data on the occupancy of different property groups in Suffolk were used to inform the occupancy in the base year and future years occupancy for the Suffolk demand forecasts. The occupancy of the groups is set for Suffolk as a whole and then the same occupancy used for each of the three Suffolk Water Resource Zones (WRZ). It is not considered that any of the three WRZs have different occupancy characteristics nor is it considered viable to determine the three WRZ occupancies separately. Suffolk is likely to have different occupancies to Essex due to the high level of meter penetration (54% in 2007/08) that has been predominantly achieved by customers opting for a free meter. This suggests that Suffolk has a very high proportion of low occupancy housing compared to Essex. However, with an identical overall occupancy to Essex, this does mean that the unmeasured households in Suffolk will have a significantly higher occupancy. The higher number of low occupancy households in Suffolk is thought to be partially due to the touristic nature of the area, attracting a large number of second home owners than Essex. If a property is a second, or weekend only, home then it is usually more financially beneficial to have a measured, rather than an unmeasured, supply.

In December 2005, ESW undertook an occupancy survey of domestic properties in the Suffolk region of the ESW supply area.

6,000 simple anonymous questionnaires were sent to a random sample of customers in Suffolk. 3,340 questionnaires were completed and returned to ESW representing a return rate of 55.7%.

The average occupancy was 2.09. However, the survey was split into four meter groups; unmeasured, metered (pre 2003), new properties (metered post 2003) and meter optants (post 2003). The table below shows the return rate and average occupancy associated with each meter group.

Meter group	Return rate	Av. occupancy
Unmeasured	47.5%	2.463
Metered (pre-2003)	62.2%	1.865
New properties (metered post-2003)	51.8%	2.417
Meter optants (metered post-2003)	61.7%	1.696

The 2007 microcomponent survey also produced occupancy data from over 500 returns per property type.

Property Type	Occupancy
Unmeasured	2.34
Existing Measured	1.83
New homes	2.33
Optants	1.75

Overall occupancy

The overall occupancy for all households steadily declines from 2.53 in 2007/08 down to 2.15 in 2034/35.

New homes

The occupancy of new homes has been increased to 2.45 in 2007/08 from the previously assumed 2.36 in 2006/07 to more reflect the survey information and the greater tendency for family homes, rather than single apartments to be built in Suffolk. Single apartments are being built more in towns on the edge of large cities e.g. London, to house the younger commuters in affordable housing. The Suffolk demographics are different because of location and relatively cheaper property prices. Future new home occupancy is forecast to follow the overall occupancy figures.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	2.45	2.42	2.42	2.40	2.38	2.35

New Optants

The optant occupancy from 2007/08 to the end of the planning horizon has been set at a constant 1.68. This figure is close to the recent survey results and is unlikely to increase much further as the higher occupancy properties are unlikely to see an obvious financial benefit from opting for a meter

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	1.68	1.68	1.68	1.68	1.68	1.68

Selectively metered

Selective metering will not now be introduced until April 2015. As Suffolk does not currently have any selectively metered properties, and the existing measured cannot be used as a surrogate because of the high proportion of optants customer within it, experience from Essex has been used. Like Essex, the occupancy is forecast to be between that of new homes and the unmeasured homes and decline steadily over time as the overall occupancy declines.

Year	2010/11	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	n/a	n/a	2.86	2.78	2.64	2.50

Existing Metered

The base year for what becomes the existing measured is the measured occupancy used in the June Return 2008 (NWL, 2008), rebased to take account of changes in overall population and information from occupancy surveys. The figure of 1.83 increasing to 1.86 by 2034/35 has been used in the rebased numbers. This occupancy is reset every five years when the new Water Resource Management Plan is produced.

Measured properties

The occupancy of the overall measured is calculated from all of the differently metered components using their assigned occupancy and weighted by their forecast property numbers. Changes in this occupancy in the forecasts are influenced by the occupancy of the groups that dominate in future years e.g. new homes, optants or compulsory.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	1.83	1.89	2.00	2.06	2.08	2.08

Unmeasured properties

The unmeasured occupancy is calculated by subtracting the population assigned to all of the measured groups from the total household population and dividing this by the remaining number of billed unmeasured properties. This would always be expected to be the highest occupancy class but over time the overall measured occupancy and unmeasured occupancy converge towards each other.

Year	2007/08	2014/15	2019/20	2024/25	2029/30	2034/35
Occupancy	3.25	3.11	2.98	2.84	2.69	2.57

4.5. Properties

The property figures for each of the years are provided by Experian and the sources of information they use to determine the numbers is provided in their report that is reproduced in Appendix A of this plan. Due to the slight difference in the description of a domestic property and a non-domestic property between Experian and the requirements of Ofwat, the base year Experian property number is reconciled to the Total Domestic Premises numbers on our customer billing database. All future year property numbers are then adjusted by this reconciliation factor.

All property changes from new homes and the metering programme are converted to “mid-year” changes for the purpose of demand forecasting.

Since the draft WRMP was constructed the economic downturn has increased significantly and the likely reduction in new homes actually being built cannot be ignored. We have therefore made an allowance in new property numbers to take account of the downturn and the likely increase above projections when the recession ends. This accords with the current Government statements coming from CLG.

Experian have provided new housing growth numbers, along with new population figures, based on the latest available growth numbers in the various regional spatial strategies. They are generally higher over the 25 year planning horizon than the numbers used in the draft plan but no account is taken of the current economic climate, especially the lower availability of mortgages and the subsequent slow down in house building.

For the remainder of this AMP, and the FBP, the numbers have been altered, as detailed below, to try and account for, and predict the effects of, the prevailing economic conditions.

2008/09

Up until August 08 the actual number of properties connected is about 66% of the previous year's number. The Experian number has been reduced to 70%.

2009/10

We are assuming there was some carry over of new builds in 08/09 but for 09/10 this will not have occurred. 60% of the Experian number has been taken.

2010/11

As 2009/10 i.e. 60% of Experian numbers.

2011/12

The recovery begins but does not go straight back to full production. 80% of Experian numbers assumed.

2012/13

Experian forecast numbers achieved.

2013/14 – 2020/21

The number of properties "lost" since 2008/09 are divided by 8 and added equally on to the existing Experian forecasts for these years.

The result is that by 2020/21, the end date of many RSS plans, the Government's overall total of new homes is reached. For 2021 onwards we revert exactly to Experian's forecasts.

All new properties, whether household or non-household have measured supplies.

4.6. Baseline Household Demand Forecasts

The household demand forecast has been developed by considering the population in six groups as follows:

- Unmeasured customers
- Meter Optants (from 2008/9)
- New Homes (from 2008/9)
- Selectively metered (from 2008/9)
- Compulsorily metered (from 2008/9)
- Existing Metered (metered up until 2007/8)

These groups have been chosen because we believe their consumption characteristics are noticeably different. However, households already metered cannot sensibly be maintained assigned to the separate metered groups, as the consumption of this group is known, so it makes sense to regroup the metered customer base into a single category, which ESW define as “Existing Metered”, every five years.

For the meter optant and selectives groups ESW has determined their future PCCs as a percentage reduction relative to the unmeasured PCC, maintaining our previously accepted and agreed assumptions. For the unmeasured, new homes and existing metered groups PCCs have been forecast using a new improved microcomponent model, which has been populated for the base year using data collected from an appliance survey.

Savings from the water efficiency target have been included in the baseline PCC forecasts. It has been assumed that the savings will be met equally by measured and unmeasured customers and by Essex and Suffolk area customers. Further details of these savings are provided in section 5.1.16.

4.6.1. Meter Optants, Selectives and Compulsory PCC

Recent work by NERA, on behalf of UKWIR (UKWIR, 2001) suggests that 5% is still a reasonable assumption of the savings attributable to optional metering. This saving has been applied to a pre-switching consumption of 80% of average unmeasured PCC in Essex and 88% in Suffolk, to take account of the effect of lower occupancy on household PCC.

Similarly in this UKWIR project, a figure of 8% saving on unmeasured PCC is quoted for those customers selectively metered. The same assumption has been applied to those metered though a compulsory programme.

4.6.2. New Homes PCC

It has been assumed that all new homes are built to the proposed Water Efficiency in New Homes target of 125 l/hd/d from 2009/10. Before then we have assumed that one-third of new homes comply with the Code for Sustainable Homes level 3, of 120 l/hd/d plus 7 l/hd/d for external use.

4.6.3. Thames Gateway

It has been assumed that new homes within the Thames Gateway will be built to meet the 125 l/hd/d target as above. ESW was interested in the research into the feasibility of water neutrality (Environment Agency, 2007b) but does not consider the proposals to be sufficiently well developed to allow the Company to assume that water neutrality is achievable. In the peer review (Environment Agency, 2007c) it has been concluded that the “suggestions above may help *both* to complete and ‘round out’ the story *and* pursue the economic narrative further, even if they are (or rather were) clearly incapable of practical implementation in the time period available." Further work is required to confirm the assumptions and also to develop proposals and mechanisms for the implementation.

ESW has however, made an assumption that the new homes target is met and maintained.

4.6.4. Appliance Survey 2007

Background

ESW require detailed ownership, frequency of use and volume data to form the basis of the microcomponent aspect of the demand forecasting. In order to attain this data, an appliance survey was carried out in 2007 to update the data previously used for this purpose.

Sample size and selection

A standard questionnaire (see below) and letter was sent to 7,200 customers in October 2007. 5,029 customers in the Essex supply area were invited to take part, whilst the remaining 2,171 customers lived in the Suffolk supply area.
The questionnaires, although anonymous in terms of customer name and address, were printed with a property number and a meter status code. This allowed the results to be analysed by meter status. Descriptions of the meter categories are given in the table below:

Meter category	Description
Unmeasured	Refers to customers paying for their water by the rateable value of the property.
Existing (metered)	Refers to all households that were metered before 2003.
Optant (metered)	Refers to households whose occupier opted to have a meter fitted after 2003.
Selective (metered)	Refers to households that had meters installed upon change of ownership (after 2003).
New (metered)	Refers to new houses built after 2003 that had a meter fitted when they were built.

Customer details were obtained from the customer billing system. The aim was to send questionnaires to 1,000 customers in each meter category in the Essex supply area and to 500 customers in the each category in the Suffolk supply area. A random sample was selected from the customer billing system. 1,100 and 550 records were purposefully selected to allow for a reduction in the sample size through the data cleaning process.

Results summary

The following table shows a summary of the number of customers contacted, the return rate and the average occupancy by meter status. The reference code was printed on the questionnaire, along with the property reference number, to ensure that the results could be analysed by meter category.

Meter status	Code	No. sent	No. returned (and %)		Av. occupancy
Essex Unmeasured	EU	1071	271	25.3%	2.34
Essex Existing	EE	993	419	42.2%	1.96
Essex Optants	EO	998	463	46.4%	1.63
Essex Selectives	ES	996	227	22.8%	2.59
Essex New	EN	971	218	22.5%	2.34
Suffolk Unmeasured	SU	540	153	28.3%	2.34
Suffolk Existing	SE	544	271	49.8%	1.83
Suffolk New	SN	541	204	37.7%	2.33
Suffolk Optants	SO	546	274	50.2%	1.75
Total		**7,200**	**2,500**	**34.7%**	**2.04**

2,500 customers completed and returned their questionnaires, giving and overall return rate of 34.7%.

Survey processing

The answers provided on the returned questionnaires were input into an Access 2007 database. A form was designed so that the property reference number on each questionnaire could be input, which would then bring forward the details of that specific property.

The input date of each questionnaire was also detailed in the access database.

It was inevitable that a small number of customers might misunderstand some of the questions asked. Where it was obvious that this was the case, the following actions were taken to correct mistakes.

- **Occupancy** – customers were asked to state the total number of occupants, and then the number of occupants within three different age groups. Several customers left the ‘total’ box blank and entered the number of occupants within each age group. Where this was the case, the numbers were totalled to give an overall occupancy. On the contrary, several customers did the opposite, stating the total number of occupants but not stating the breakdown. In these cases, the breakdown could not be established and were therefore left blank.

- Several questions required the customer to answer the number of years or the number of uses per year. The Access input form required 'whole' years. Where customers were specific to months, these were rounded to the nearest whole year.

- **Question 13** – this question asked customers to state the number of each water using appliance within their home. In a few cases, customers simply ticked boxes. In the majority of these cases, customers started off answering correctly. However, when they got to the washing machine and dishwasher section of the question, some customer ticked rather than stated the number. Where this happened, it was assumed that there was 1 appliance.

- **Question 13** – the question showed another problem similar to that described under the heading 'occupancy'. Customers were asked to state the total number of toilets and also the number of each type.

Water use questionnaire

ESSEX & SUFFOLK WATER

To help Essex & Suffolk Water understand water use in homes, please answer the questions below by ticking the relevant boxes. The confidentiality of this information is guaranteed through the Data Protection Act.

Property Number: 888926

Please tick where appropriate

Q1. In your household, how many people are there in the following age groups? (include only those resident for more than 6 months of the year)

- Total number of people ☐
- Over 16 years old ☐
- 5-16 years old ☐
- Under 5 years old ☐

Q2. How many adults are normally at home during the day from Monday to Friday? ☐

Q3. When was your property built?

- Pre 1900 ☐
- 1900-1950 ☐
- 1951-1988 ☐
- 1989 onwards ☐

Q4. Is the property your:

- Main residence ☐
- Second home ☐

Q5. How long have you lived at the property? ☐ years

Q6. Do you have a water softener (plumbed in)? Yes ☐ No ☐

Q7. Do you have a waste disposal unit? Yes ☐ No ☐

Q8. If yes, how often is it used in a typical WEEK? ☐

Q9. Do you have a pressure washer (patio/drive cleaner)? Yes ☐ No ☐

Q10. If yes, how often is it used in a typical YEAR? ☐

Q11. Do you have a Jacuzzi or hot tub? Yes ☐ No ☐

Q12. If yes, how many times is it drained and re-filled each YEAR? ☐

Q13. Please state the number of each of the following you have in your household?

- Sink ☐
- Wash basin ☐
- Bath ☐

Toilets

- **Total number of toilets** ☐
- WC (single flush installed before 1993) ☐
- WC (single flush installed between 1993 and 2000) ☐
- WC (single flush installed after 2000) ☐
- WC (dual flush installed before 1993) ☐
- WC (dual flush installed after 2000) ☐

Shower

- Mixer / hand-held low pressure shower ☐
- Mixer / high pressure shower ☐
- Electric shower ☐
- Power or pumped shower ☐

Washing machine

- Washing machine (pre 2000) ☐
- Washing machine (post 2000) ☐
- Combined washer-drier (pre 2000) ☐
- Combined washer-drier (post 2000) ☐

Dishwasher

- Dishwasher (pre 2000) ☐
- Dishwasher (post 2000) ☐

Cold water tank (in roof supplying cold water) ☐

Other ☐ ________

Please turn over...

Q14. Have you replaced any of the water using appliances listed in question 13 over the last 10 years?

Yes ☐ No ☐

Q15. If you answered yes to question 14, please specify which water using appliances you have replaced:

☐

Q16. In a typical WEEK, how many loads do you wash?

Washing machine ☐ Dishwasher ☐

Q17. Do you run your washing machine at night? Yes ☐ No ☐

Q18. What is the total number of baths run (by all persons) each WEEK? ☐

Q19. How many of these are re-used (e.g. children sharing the bath)? ☐

Q20. What is the total number of showers taken (by all persons) each WEEK? ☐

Q21. Do you leave the tap running when cleaning your teeth? Yes ☐ No ☐

Q22. What are your main methods for watering the garden in the summer (April-Sept)?

Hose ☐
Sprinkler ☐
Watering can ☐
Mains-fed irrigation system ☐
Irrigation system (rain collected) ☐
Do not water during the summer ☐

Other, please state ☐ ☐

No garden ☐ If no garden, please go straight to question 27.

Q23. Do you own a water butt? Yes ☐ No ☐

Q24. If yes, how many? ☐

Q25. Are they connected to your guttering? Yes ☐ No ☐

Q26. For how many hours during the hot weather do you water your garden in the week?

Less than 1 hour ☐ 2-3 hours ☐ More than 4 hours ☐

1-2 hours ☐ 3-4 hours ☐

Q27. Which do you normally use to wash the car(s)? (tick all that apply)

Hose ☐ Car wash ☐

Bucket ☐ Pressure washer ☐

Q28. TOTAL number of car washes for all cars within the household per MONTH? (EXCLUDE car wash visits)

1 ☐ 2 ☐ 3 ☐ 4 ☐ More than 4 ☐

Q29. Do you rinse your cans/tins/jars under a running tap for recycling? Yes ☐ No ☐

Q30. If yes, how do you do this?

Under a running tap ☐
Fill a bowl especially ☐
Using washing-up water ☐
Other, please state ☐ ☐

Q31. Do you have a swimming pool? Yes ☐ No ☐

Q32. If yes, how often is it filled each year? ☐

Q33. Do you have a pond? Yes ☐ No ☐

Q34. If yes, how often is it filled each year? ☐

Q35. Do you have a large paddling pool (over 8 ft)? Yes ☐ No ☐

Q36. If yes, how often is it filled each year? ☐

Q37. Is there anything else that you can tell us to help us understand your water use?

☐

Thank you for taking the time to complete this questionnaire. Please return the questionnaire to Essex & Suffolk Water using the reply envelope enclosed.

Demand Planning, Essex & Suffolk Water, Hall Street, Chelmsford, Essex, CM2 0HH

4.7. Microcomponent Model

A model has been developed which allows the assumptions to be explicit and enables the impacts of changes in technology, occupancy and trends in usage to be clearly understood. For the WRP 2004, Experian Business Strategies (Experian) developed a microcomponent model for us and a number of other companies. Experian were able to incorporate into the model the results of some of our survey work but not all. This was an unsatisfactory position as we had company specific data we wished to use in preference to national default data. However, the model was very complex with numerous "lookup" tables, functions and extremely long formulas which made it difficult within the time constraints to modify the model with confidence. We therefore had to return to our previous forecasting spreadsheet which presented ownership, frequency of us and volume data for each year, but did not show how these figures were derived, and the report from Experian whilst it listed assumptions did not give us a full understanding of the forecast to allow all questions to be answered fully (Experian, 2003).

The model uses 2007/8 as the base year and projects forward annually to the end of the planning horizon. The microcomponents have been subdivided into the following principal components and sub components:

Personal Washing	**Bath**
	Showers: Mixer/handheld low pressure Mixer high pressure Electric Power
	Handwashing/teeth cleaning etc
	Bidet
WCs	Single flush pre 1993
	Dual flush pre 1993
	Single flush 7.5l
	Single flush post 2001 Regulations
	Dual flush post 2001 Regulations
Clothes Washing	4 machine types based on volume
	Washer-drier drying component
	Washing by hand
Dishwashing	Dishwashers
	Washing up by hand
	Waste disposal
	Recycling
Outdoor	Pressure Washer
	Lawn sprinklers
	Hose for garden watering
	Watering can
	Bucket for car wash and rinse
	Bucket for car wash only

	Hose for car rinse
	Paddling pools
	Large paddling pools/ temporary swimming pools
	Pond filling
	Swimming pools
General Use	Plumbing losses, animals, cleaning, drinking, food preparation and cooking, running taps, hot tubs and softeners and other internal uses

These align well with the Agency's suggested categories.

For all microcomponents, the start position is defined and a rate of change which is then applied for all years. For those components involving white goods, we have defined a range of models with average volumes per use and stated an assumed life for each machine and dates when the new lower volume technologies become available.

Wherever possible company specific data has been utilised. This data has been benchmarked against previous surveys and other available data sources to ensure that spurious results from small samples are identified and treated with caution.

The assumptions for each microcomponent are described below.

4.7.1. Toilet Flushing

Toilet flushing has been split into five separate groups to reflect the varying flush volumes. These include:

Full (single) Flush pre 1993 – 9 litres
Dual Flush pre 1993
Full (single) Flush – 7.5 litres
Full (single) Flush installed after 2001 – 6 litres
Dual Flush installed after 2001

These groups are the same used in the previous model.

For each group the flush volume has been assumed to be slightly higher than the nominal cistern capacity. This is to take account of the fact that water continues to be released for a period whilst the cistern is refilling. The 9 litre flush has been increased by a greater amount than the other flush volumes due to the larger cistern taking longer to re-fill.

Full (single) Flush pre 1993 – 9 Litres

As the customer group new homes only includes properties built since 2001 there are no pre 1993 toilets. The percentage ownership for the unmeasured and existing groups for the base year has been taken from the 2007 appliance survey. The Experian model suggested a replacement rate of 3% per annum. All new toilets purchased will be subject to the water regulations changes in 2001, therefore no new 9 litre toilets will be brought. In order to forecast this into the future the following formula is used.

(No. billed unmeasured households in previous year x Previous years ownership)
+
(Difference between no. of unmeasured household in current year and previous year)
x
replacement rate of 3% / (No. billed unmeasured household in the current year)

A frequency of use of five flushes per person per day was used for 2002/03; this is set to increase at a rate of 0.0504 flushes per week per year based on an extrapolation of Herrington (1996). Therefore by 2007/08 the frequency is 5.043.

The flush volume is assumed to be 9.40 litres. This remains constant over the forecast horizon.

	Ownership		**Frequency (/h/day)**		**Volume (litres)**
	2007/08	**Replacement rate**	**2007/08**	**Growth rate**	
Unmeasured Essex	38.60	3% per annum	5.043	(0.0504/7) per annum	9.40
Existing Essex	42.00				
Unmeasured Suffolk	43.04	3% per annum	5.043	(0.0504/7) per annum	9.40
Existing Suffolk	46.19				

Dual Flush pre 1993

For this category, because the WC type is not easily identified by many customers, we have calculated the ownership as 100% less the percentage ownerships of the other WC types.

The same formula as the 9 litre full flush above has been used to calculate the forecasts.

The assumptions used for a 9 litre full flush frequency, have been used for the frequency in this category.

The flush volume is assumed to be 9.25 litres for unmeasured customers and 7.70 litres for measured, we assume the measured customers will use single flush function more than the unmeasured. Again this remains constant over the forecast horizon.

	Ownership		**Frequency (/h/day)**		**Volume (litres)**
	2007/08	**Replacement rate**	**2007/08**	**Growth rate**	
Unmeasured Essex	1.01	3% per annum	5.543	(0.0504/7) per annum	9.25
Existing Essex	2.88				7.70
Unmeasured Suffolk	4.64	3% per annum	5.043	(0.0504/7) per annum	9.25
Existing Suffolk	4.06				7.70

Full (single) Flush – 7.5 litres

Ownership has been based on the 2007 appliance survey. The same assumption of a replacement rate of 3% per annum has been used for the forecast of ownership.

The assumptions used for a 9 litre full flush frequency, have been used for the frequency in this category.

The flush volume is assumed to be 7.7litres. Again this remains constant over the forecast horizon.

There are no 7.5 litre toilets installed in new homes.

	Ownership		**Frequency (/h/day)**		**Volume (litres)**
	2007/08	**Replacement rate**	**2007/08**	**Growth rate**	
Unmeasured Essex	20.81	3% per annum	5.543	(0.0504/7) per annum	7.70
Existing Essex	18.88				7.70
Unmeasured Suffolk	18.98	3% per annum	5.043	(0.0504/7) per annum	7.70
Existing Suffolk	21.69				7.70

Full (single) Flush and Dual Flush installed after 2001

For both these types of toilet the same assumptions have been made. Ownerships for the base year 2007/08 has been taken from the 2007 appliance survey.

For the unmeasured and existing customer groups, as each of the older three types of toilets decrease the newer two types increase. The forecast of ownership of toilets installed after 2001 feeds off the change in the other three toilet types. For each year the calculation:

[100% - (Full Flush pre 1993 + Dual Flush pre 1993 + Full Flush)]*0.7
It has been assumed that 70% of the new toilets will be dual flush.

[100% - (Full Flush pre 1993 + Dual Flush pre 1993 + Full Flush)]*0.3
It has been assumed that 30% of the new toilets will be full flush.

Again the base year value and change in frequency has the same increase in frequency as assumed above. The frequency for both toilet types also includes an addition for double flushing. It has been assumed that 1 in 10 flushes will be a double flush.

Full Flush installed after 2001 regs

	Ownership		Frequency (/h/day)		Volume (litres)
	2007/08	**Replacement rate**	**2007/08**	**Growth rate**	
Unmeasured Essex	19.79	3% per annum	5.543	(0.0504/7) per annum	6.20
Existing Essex	16.50				6.20
Unmeasured Suffolk	20.57	3% per annum	5.543	(0.0504/7) per annum	6.20
Existing Suffolk	14.60				6.20

Dual flush installed after 2001

	Ownership		Frequency (/h/day)		Volume (litres)
	2007/08	**Replacement rate**	**2007/08**	**Growth rate**	
Unmeasured Essex	19.79	3% per annum	5.543	(0.0504/7) per annum	6.20
Existing Essex	19.75				6.20
Unmeasured Suffolk	14.05	3% per annum	5.543	(0.0504/7) per annum	6.20
Existing Suffolk	14.85				6.20

4.7.2. Personal Washing

Bath

Ownership levels have been taken from the 2007 appliance survey. The change in ownership suggested by Experian was so small it was decided that the ownership would remain constant.

A frequency of 0.3 per person per day for the unmeasured group was assumed for the base year and the forecast for Essex and 0.31 for Suffolk. A frequency of 0.3 per person per day for the unmeasured group was assumed for the base year and the forecst for Essex and 0.32 for Suffolk. This was based on the Study of Water Use questionnaire data. A reduction in use of 0.5% per annum has been assumed until 2010 and then a reduction of 1%

per annum for the remainder of the forecast. This is taken from the MTP work (MTP, 2007).

A volume of 88 litres per bath was used for the Unmeasured Group. This was based on the Experian model using 80 litres for a bath which has been increased slightly to reflect the customer is not so concerned about using less as they are unmeasured. It remains constant over the forecast period.

For the Existing group, as the customers are metered they are expected to be more conscious of how much water they use, so the volume of their baths are lower than the unmeasured at 70 litres per bath.

	Ownership %		**Frequency (/h/day)**		**Volume (litres)**
	2006/07	**Forecast**	**2006/07**	**Growth rate**	
Unmeasured Essex	91	constant	0.30	0.5% per annum until	88
Unmeasured Suffolk	88		0.31		88
Existing Essex	91	constant	0.31	0.5% per annum	70
Existing Suffolk	82		0.32		70

Showers

It is assumed there are four types of showers:

- Mixer/handheld low pressure showers;
- Mixer high pressure showers;
- Electric showers; and
- Power showers.

From assumptions in the Experian model ownership of showers increased by 2.5% per year until 2012 where it goes by 1% per annum (MTP, 2006). This is capped at a maximum of 96% for unmeasured and existing customer groups. This maximum is likely to be reached in 20009/10.

To calculate the percentage ownership for each shower type the number of showers in each group had to be calculated. For the unmeasured group percentages for power showers, electric showers and mixer high pressure showers were taken from a survey carried out by Per Capita Solutions (2006). This survey was used in preference to the Appliance Survey as the nature of this survey means that more robust information is available than from the Appliance Survey. For the existing the ownership of these three types of showers were taken from the Appliance Survey. The mixer low pressure showers were calculated as a residual of all other showers. The following table shows the percentages used for 2007/08.

% Ownership	Unmeasured Essex	Unmeasured Suffolk	Existing Essex	Existing Suffolk
Mixer/handheld low pressure showers	23.70	26.48	25.48	21.42
Mixer high pressure showers	8.22	10.28	12.33	11.30
Electric showers	38.02	29.95	32.88	32.79
Power showers	23.36	12.75	22.61	14.39

For the growth rate of power and high pressure mixer showers, there is expected to be a growth rate of 2.75% per annum. This is taken from the MTP showers report (MTP, 2006). The report stated that the ratio of mixer showers to electric showers is expected to remain constant over the next 25 years; this provides the growth rate for the electric showers. Again the low pressure showers rate is based on the residual of the total.

The frequency of use has been assumed to be the same for all types of showers. An average figure for the total number of showers taken per person was provided rather than splitting this between each shower type. A base year figure of 0.63 showers per person per day was calculated. An increase of 0.5% per annum has been assumed across the planning horizon, again for all shower types.

As part of ESW audit projects customers are asked to measure their showers flow rates and how long they spend in the shower. The average time spent in the shower is 6.6 minutes. The following table shows the flow rates for each shower type used to calculate the volume used. The volumes remain constant into the future.

Shower type	Flow rate (litres/minute)
Mixer/handheld low pressure showers	5
Mixer high pressure showers	10
Electric showers	5
Power showers (>10 l/min)	12

Hand washing/teeth cleaning

The ownership is set at 100% and remains constant throughout the forecast. The volume is based on the Experian model, which reported a frequency of 5 times per person per day and a volume of 3. Both these values remain constant over the forecast horizon.

Bidet

Data for this has been taken from the Study of Water Use questionnaires giving an ownership of 6% for the unmeasured and existing. New homes have a lower ownership of 3%. All ownerships have been assumed to remain constant over the forecast. A usage of 1 time per person per day with a volume of 2 litres has been assumed. Again these figures have remained constant into the future.

4.7.3. Clothes Washing

Washing machines

All washing machines have been split into four models. Each of these models has been assigned an average volume used per load. A group of machines using an average of 70-80 litres per load represent machines older than 2000. Post 2000 machines are assumed to use an average of 55 litres. The other two models are currently not available but will be during the planning horizon. Models averaging 45 litres are expected to be available from 2012 and models averaging 35 litres from 2022. The replacement rate of a model older than 2000 is 6 years, for all other models the replacement rate is 12 years. It is assumed that customers will buy from the most efficient model available on the market.

From the appliance survey the total percentage ownership of all types of washing machines is calculated. This includes washer driers. The growth rate of washing machines is 0.32 per annum (from the Experian model) with the total ownership capped at 99%. This allows the total number of actual machines to be calculated based on the total number of properties in the reporting year.

In 2002/03 90% of the washing machines owned were model 1 using 70-80 litres per load. As the number of washing machines owned increases and old washing machines are replaced with newer more efficient machines, the percentage of model 1 decreases. Model 1 machines are replaced every six years. The number of model 2 machines is calculated from the total number of machines minus the number of model 1s. By 2008/09 all model 1 machines have been replaced by model 2 machines. In 2012 model 3 machines become available; any replacement machines are therefore model 3. The number of model 2 continues to decrease until 2020/21. By 2022 Model 4s are then available.

From this, the percentage of each machine owned can be calculated.

The ownership by customer groups has been determined from the Appliance Survey, except in the case of the unmeasured, for which the Appliance Survey has provided what appears to be a spurious result, so a figure based on the 2002/3 survey has been projected.

	Ownership % 2007/8	**Frequency of Use Hsehlds/week**
Unmeasured Essex	98.60	4.95
Unmeasured Suffolk	98.32	4.29
Existing Essex	98.62	3.54
Existing Suffolk	89.25	3.29

The frequency of use of washing machines for each customer group is taken from the appliance survey. For all groups the frequencies remain constant. The volume for each year is based on the percentage of each model owned multiplied by the total litres used per year. This means in 2007/08 for unmeasured Essex customers where the ownership of model 1 machines is 8% and for model 2 is 92% the volume of water use is

8% x 80 litres + 92% x 55 litres.

Washer-drier – the drying part

The ownerships for each customer group are taken from the appliance survey for the base year and are set to remain constant into the future.

Washer driers are only able to dry half of the load originally washed. Therefore the frequency of use is twice that assumed for the washing machines. This remains constant.

A volume of 32 litres is used for the base year and constant for the forecast.

	Ownership % 2007/8	**Frequency of Use Hsehlds/week**
Unmeasured Essex	9.38	9.9
Unmeasured Suffolk	8.28	8.58
Existing Essex	11.07	7.08
Existing Suffolk	6.64	6.58

Washing clothes by hand

In 2002/03 a starting point of 10% for unmeasured customers and 8% for existing customers washed clothes by hand. Based on assumptions from Herrington (Herrington, 1996) this has decreased by 0.4% per annum until it reaches 0.3% where the ownership remains constant. This is reached in 2026/27 for unmeasured customers and 2021/22 for existing and new home customers.

A frequency of use of 1.8 times per household per week for unmeasured customers and 1.6 for existing has also been taken from Herrington's work and remains constant.
A volume of 40 litres for the unmeasured and 30 litres for the existing homes has been assumed for the base year and the forecast.

4.7.4. Dishwashers

The model for dishwasher is based on the same format as used for the washing machines. All dishwashers have been split into three models. Each of these models has been assigned an average volume used per load. A group of machines using an average of 25 litres per load represent machines older than 2000. Post 2000 machines are assumed to use an average of 17 litres. The final model averaging 10 litres is currently not available but will be by 2012. The replacement rate of a model older than 2000 is 6 years, for all other models the replacement rate is 10 years. It is assumed that customers will buy from the most efficient model available on the market.

From the appliance survey the total percentage ownership of all types of dishwasher is calculated. The growth rate of dishwashers is 1% per annum with the total ownership capped at 99% (although none of the three groups reach 99% by the end of the forecast). This allows the total number of actual machines to be calculated based on the total number of properties in the reporting year.

In 2002/03 80% of the dishwashers owned were model 1 using 22 litres per load. As the number of dishwasher owned increases and old machines are replaced with newer more efficient machines the percentage of model 1 decreases. The number of model 2 machines is calculated from the total number of machines minus the number of model 1s. In 2012 model 3 machines become available; any replacement machines are therefore model 3. The number of model 2 continues to decrease until 2020/21. Following this all models owned are model 3.

From this the percentage of each machine owned can be calculated.

The ownership by customer groups has been determined from the Appliance Survey.

	Ownership % 2007/8			**Frequency of Use Hsehlds/week**
	Overall	**% Model1**	**% Model2**	
Unmeasured Essex	37.00	14	86	4.72
Unmeasured Suffolk	29.76	5	95	4.34
Existing Essex	42.90	6	94	4.10
Existing Suffolk	41	5	95	4.00

The frequency of use of dishwashers for each customer group is taken from the appliance survey. The frequency of use is related to the number of people living in the property, the forecast of use takes this into account. With unmeasured as the occupancy decreases the number of loads per week also decreases.

The volume for each year is based on the percentage of each model owned multiplied by the total litres used per model.

Washing up (by hand)

It is assumed that all homes without a dishwasher will wash up. Also 60% of people who have a dishwasher will also do some washing up by hand as well. The total percentage of customers who wash up is therefore dependent upon the growth rate of dishwashers.

The frequency is a two part calculation. The people without dishwashers wash up more times than those with a dishwasher. For the unmeasured and new homes groups it has been assumed those without a dishwasher wash up 20 times per week and those with a dishwasher wash up 8 times per week, for unmeasured customers will. This is based on one washing up load per day plus two at the weekend. Using the ownership an overall frequency for each year is calculated. For existing it is assumed that those without a dishwasher wash up 16-18 times per week and those with a dishwasher 5 times a week.

A constant volume of 10 litres for unmeasured has been assumed per washing up load. For existing homes this is reduced to 7-8 litres per load.

Waste disposal units

Ownership figures are available from the 2007 appliance survey. These remain constant. Similarly the survey provides frequency of use figures which are set to remain constant.

From the waterwise components of demand figures (see waterwise.org.uk) a volume of 9 litres per use has been assumed. This remains constant for the forecast.

	% Ownership	**Frequency of use Hse/wk**
Unmeasured Essex	1.85	1.10
Unmeasured Suffolk	1.31	0.43
Existing Essex	3.10	0.90
Existing Suffolk	1.85	0.43

Recycling

For each group a constant consumption has been assumed. The 2007 appliance survey shows that 70% of customers recycle at home. The following consumptions have been determined.

	Consumption l/hd/d
Unmeasured Essex	2.8
Unmeasured Suffolk	2.8
Existing Essex	1.5
Existing Suffolk	1.5

4.7.5. Outdoor Use

Pressure Washers

The ownership and frequency of use is taken from the 2007 appliance survey. Since 2002 there has been an increase in the ownership, it is expected this will continue to rise in the future. The growth rate in ownership is based upon the increase from 2002 to the 2007 survey, but then divided by two as it is not expected the rate of purchase will be as high as previously seen. This gives an increase of 0.5% per annum

The frequency of use remains constant from the base year across the planning horizon. The frequency of use for the existing metered homes groups are lower than seen in the unmeasured group, expected to be due to customers paying by metered tariff.

A typical pressure washer uses 400 litres per hour; this was taken from the Argos website based on the current available stock. It is assumed that unmeasured customers use them for around 30 minutes so the total volume for is 200 litres. The forecast for the volume used is set constant into the future. For existing homes a lower figure of 165 litres has been assumed to reflect use for a shorter period.

	% Ownership	Frequency of use per household per day
Unmeasured Essex	18.21	0.20
Unmeasured Suffolk	20.11	0.008
Existing Essex	19.10	0.010
Existing Essex	19.24	0.006

Lawn Sprinkling

As part of the 2007 appliance survey each customer group was asked if they sprinkled their lawn or not. The figure for unmeasured customers was just 2.95%; it is unlikely this is true. Therefore this figure was increased to 15.5%. For existing houses the figures from the survey have been used as a base for unmeasured 3.23% and 1.82 for existing.

The frequency of use for the unmeasured property type is 20 times per household per year, taken from the Experian model. This is set to remain constant into the future. For existing homes the same assumption has been used. A volume of 1200 litres has been used for the base year and future years for unmeasured and 1000 litres for existing homes.

Hose for Watering Garden

The percentage of people who water their garden using a hose is taken from the 2007 Appliance Survey. An increase at a rate of 0.5% per annum has been assumed for unmeasured groups. A decrease of 0.5% per annum is expected due to customers paying by metered tariff.

	% Ownership 2007/8
Unmeasured Essex	55.28
Unmeasured Suffolk	50.25
Existing Essex	37.62
Existing Suffolk	26.96

For unmeasured customers a frequency of use of 18 times per year per household is assumed, this is based on customers using their hose 2 times a week for 9 weeks of the year (during the summer months). For existing customers it is set lower at 7-8 times per year due to customers paying by metered tariff.

A volume of 340 litres has been used for unmeasured groups from the base year of 2006, (assumes half hour per use with 1000l/hr not using a trigger hose (assume 65%) and 600 l/hr with trigger hose). Volume is expected to reduced annually by 1.42 litres per year.

Watering Can

The 2007 Appliance Survey provided the percentage ownership of customers who use a watering can to water their garden. The same figure used for the base year is used for the forecast.

The frequency of use comes for assumptions used in the Experian model of 4.86 times per week. For unmeasured it is assumed this takes place for 12 weeks of the year, for existing for 10 weeks of the year and for New homes 11 weeks of the year. These frequencies of use remain constant across the planning horizon.

The volume used by each group is between 55-60 litres for the base year and forecast.

	% Ownership	Volume litres	Frequency of use per household per year
Unmeasured Essex	75	60	58.32
Unmeasured Suffolk	65	60	58.32
Existing Essex	59.52	55	38.88
Existing Suffolk	60.89	35	38.88

Washing the car

This has been split into three activities:

- Using a bucket for both washing and rinsing
- Using a bucket just for washing
- Using a hose for rinsing only.

The percentage of people who use only a hose is taken from the 2007 appliance survey. A constant figure of 7% Essex (4% in Suffolk) is used for customers who use a bucket only to wash their car. It has been assumed that 58% of unmeasured customers wash their cars at home (from the Study of Water Use), therefore the number who use a bucket for washing and rinsing is 58 minus the percentage who use a hose. A lower number of existing customers are assumed to wash their cars at home, so 50% has been used instead of 58%. From the Study of Water Use 6.2% of unmeasured customers use a buck and hose and 13.2% only use a hose. From the Appliance Survey 8.68% of metered customers only use a hose and this is combined with the 7% above.

For all customer groups and for all methods of car washing a constant figure of 26 times per year has been assumed. This equates to just over twice a month. The volumes in the table overleaf have been used for each group:

The assumption of 56 litres equates to two buckets per week for washing and six for rinsing, with seven litre buckets. Existing customers are assumed to use the same number of buckets but only 6 litre buckets.

	Bucket for both washing and rinsing		**Bucket just for washing litres**		**Hose for rinsing only litres**	
	Vol l	Ownership 2006/7 %	Vol l	Ownership 2006/7 %	Vol l	Ownership 2006/7 %
Unmeasured Essex	56	38.6	14	7	90	19.4
Unmeasured Suffolk	56	48.98	14	4	90	9.02
Existing Essex	55	42.32	12	7	80	15.68
Existing Suffolk	35	42.32	12	3.76	80	15.68

Ownership, frequency of use and volume are assumed to remain constant into the future.

Paddling Pool

Base on occupancy surveys 5% of households have children and of these it is assumed that 80% will use a paddling pool. This equates to an overall percentage ownership of 4%. Unmeasured and new homes are assumed to use their paddling pools 11 times a year or 0.03 times per household per day. This reduced to seven times per year or 0.02 timers per household per day for the Existing group. Metered customers are expected not to fill their pools with as much water as unmeasured, so the volume reflects this. For unmeasured customers the volume used is 400 litres whereas for the existing and new home customers a volume of 350 litres is used. This is based on advertised products using a range from 200-600l litres.

Large paddling pools

Over the last five years there has been a significant growth in the number of larger paddling pools available on the market. These range in size from 8ft to 15ft in diameter. Ownership percentages have been obtained from the 2007 Appliance Survey. The frequency of use of the pools is highest for unmeasured customers with them also using largest amount of water when filling the pools. Metered properties will be more conscious of how much water they use and so not fill the pool as full. The unmeasured volume is the average of a 12 ft and 15 ft pool, and the metered figure is the average of an 8ft and 12 ft pool. All assumptions made in the base year are carried forward at a constant rate across the forecast.

	% Ownership	Frequency of use (per household per day)	Volume (Litres)
Unmeasured Essex	2.21	0.01	7732
Unmeasured Suffolk	0.65	0.01	7732
Existing Essex	1.67	0.01	5838
Existing Suffolk	0.74	0.01	5838

Pond Filling

The percentage of customers who own a pond has been taken for each customer group from the 2007 Appliance Survey, but with the New and Existing averaged to give an overall metered ownership, as the separate responses were very low so less reliable. Again the unmeasured customers will fill their ponds more than measured customers yet they will all use the same amount of water when they do fill the pond.

	% Ownership	Frequency of use (per household per day)	Volume (Litres)
Unmeasured Essex	14.76	0.01	500
Unmeasured Suffolk	13.90	0.01	500
Existing Essex	6.29	0.003	500
Existing Suffolk	8.33	0.005	500

The figures are assumed constant into the future.

Swimming pool filling

From the 2007 appliance survey the ownership of swimming pools for each group has been identified. The ownership, frequency of use and volume remains constant from the base year into the future.

	% Ownership	Frequency of use (per household per day)	Volume (Litres)
Unmeasured Essex	0.37	0.01	5000
Unmeasured Suffolk	1.31	0.01	5000
Existing Essex	2.14	0.004	5000
Existing Suffolk	1.85	0.005	5000

4.7.6. General Use

The general use category takes into account all other areas of water use within the home and garden. For each customer group a constant figure has been used across the planning horizon. This general use has been split into the following areas of water use:

	Description
Plumbing losses	
Other internal use	DIY, children's play, steam irons, house plants, washing paint brushes etc
Animals	Water used for drinking, washing and cleaning cages etc
Cleaning	
Drinking	Including filling kettles
Food preparation and cooking	
Running taps	Running tap till hot/cold
Hot tubs and water softeners	

For each component the assumptions have been built up from ownership, frequency of use and volume assumptions. The resulting figures are given in the table overleaf.

In determining these figures we took account of the normalised base year total PCCs to achieve a balance. No additional allowance has be made for new appliances or for activities not mentioned above. It is assumed that these are accommodated within the uncertainty of the above assumptions.

	Unmeasured Essex l/hd/d	Unmeasured Suffolk l/hd/d	Existing Essex l/hd/d	Existing Suffolk l/hd/d
Plumbing losses	1.8	1.8	0.2	0.3
Other internal use	2.3	1.3	0.6	0.5
Animals	0.5	0.5	0.2	0.3
Cleaning	4.0	4	2	1.9
Drinking	2.8	2.75	2	2.0
Food preparation and cooking	4.1	3.6	2	2.1
Running taps	1.5	1.4	0.3	0.4
Hot tubs and water softeners	0.01	0.01	0.01	0.01
Total	16.8	15.3	7.3	7.4

4.8. Non-Household Baseline Demand Forecasts

Our forecasts of non-household demand are based upon work undertaken for us by NERA Economic Consulting, who have acted as our main economic consultants for many years and are therefore familiar with NWL and its circumstances. NERA's model uses historic consumption data taken from NWL's billing database, ICIS, in combination with regional forecasts of output and employment provided by Experian Business Strategies to predict non-household demand by broad industrial sector.

The consumption data provided to NERA by NWL falls into two categories:

1. Consumption by individual customers above a threshold of about 10 Ml/yr (some customers are included below this level for historic reasons) - around 800 customers. These customers account for over half of all non-household potable water consumption, varying slightly by area as follows:

Percentage of base year (2007/08) non-household potable water delivered accounted for by individually tracked customers

Northumbrian	59.2%
Essex	49.9%
Suffolk	46.3%
Total NWL	55.5%

2. The total consumption of remaining customers, split by industrial sector.

All three areas (Essex, Suffolk and Northumbrian) have seen significant reductions in non-household demand in recent years. NWL's 2008 Annual Return to Ofwat shows that, overall, non-household water delivered fell by 12% between 2002/03 and 2007/08, 10% in the Northumbrian Region and 16% in Essex & Suffolk. Figures from previous Annual Returns show the decline to have been no less than 26% since 1997/98 (24% in Northumbrian and 30% in Essex & Suffolk).

Against this background and taking account of the current depressed economic environment, our forecasts of non-household demand for all three areas show further reductions from their 2007/08 levels, though their duration and severity varies by area. The table below summarises the actual and forecast average annual growth rates by area and period.

Non-household Potable Water Demand
Actual and forecast average annual growth rates by area

	2002/03-2007/08	2008/09-2009/10	2010/11-2014/15	2015/16-2019/20	2020/21-2024/25	2025/26-2029/30	2030/31-2034/35
Essex	-3.8%	-2.1%	-0.6%	-0.8%	-0.1%	0.7%	0.8%
Suffolk	-1.7%	-2.3%	1.4%	-0.4%	0.3%	0.9%	1.1%
Northumbrian	-2.0%	-2.1%	-0.2%	0.3%	0.7%	1.0%	1.0%
Total	-2.5%	-2.1%	-0.4%	-0.1%	0.5%	0.9%	1.0%

NERA's previous forecasts for the Draft Water Resources Management Plan fell short of the requirements in three respects:

- They only forecast demand to 2020/21 (NWL used its own assumptions to forecast the remaining years to 2034/35);
- They did not provide forecasts at a water resource zone level for the unidentified customer groups;
- They did not provide a sectoral analysis of the unidentified customer groups.

We have worked with NERA to address all of these issues for the updated forecasts prepared for the Final WRMP. These also incorporated updated economic forecasts from Experian, which took some account of the worsening economic circumstances at the time (October 2008). However, the situation has deteriorated significantly since then and we have therefore made additional allowances in our forecasts, taking account of the reductions in demand that we have already seen in 2008/09 to date and assuming further losses in 2009/10. After 2009/10, we revert to the growth rates from NERA's

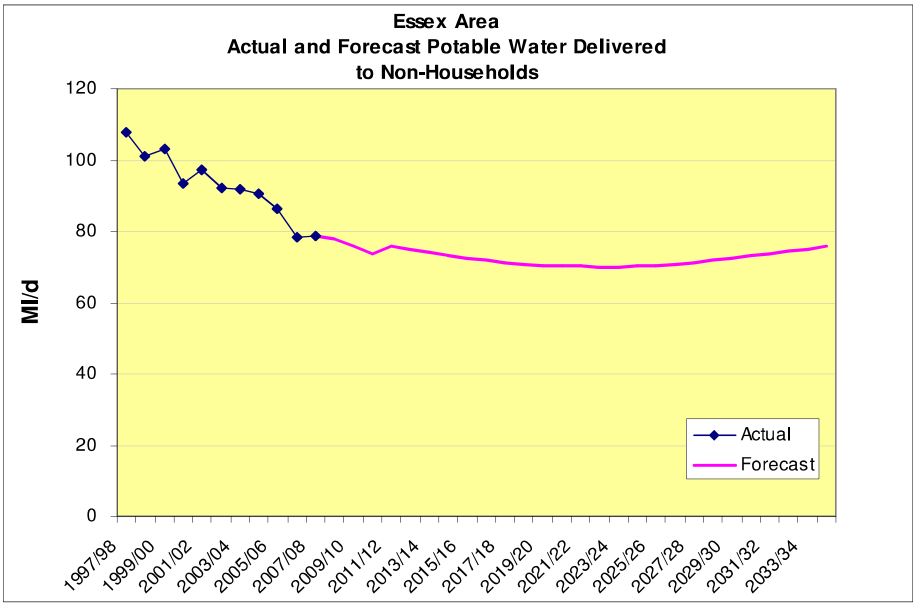
forecasts but from a lower base, as a result of the more pessimistic assumptions made for the intervening period.
Forecasts of non-household demand, particularly those that cover a period of the length required for the Water Resources Management Plan are always likely to be subject to fairly margins of error. However, it must be recognised that the current economic climate, where there is no consensus as to likely length or severity of the downturn, adds a further dimension of uncertainty.

The following paragraphs summarise some of the significant aspects of our forecasts by area.

4.8.1. Essex Area

Non-household water delivered in Essex is forecast to reduce at an average rate of 2.1% p.a. between 2007/08 and 2009/10 and then by 0.6% p.a. until 2014/15. For the following five years, until 2019/20, the rate of decline increases slightly to 0.8% p.a., followed by a period of relative stability until 2024/25. At this point, water delivered will still be about 12% lower than in the base year. In the final ten years of the planning period modest growth of 0.8% p.a. is forecast.

The graph below shows the Essex Area non-household demand forecast in the context of the significant reduction in actual demand experienced since 1997/98. Even by the end of the planning period, demand is forecast to still be nearly 5% below its 2007/08 level and 30% below its level in 1997/98.



The following five sectors accounted for almost two-thirds of non-household water delivered in the Essex area in 2007/08:

Sector	% of total non-household potable water delivered in 2007/08
Other services	23.6%
Education and health	14.9%
Fuel refining	10.3%
Wholesale/retail	8.9%
Transportation and manufacture of transport equipment	8.3%
Sub-total	65.9%
Other sectors	34.1%
Total	100.0%

The following sectors are particularly significant in the reductions in demand seen in the Essex Area over the last 10 years:

- Oil refining
- Car manufacture
- Port activity (closure of facilities)
- Building supplies (transfer of production abroad)

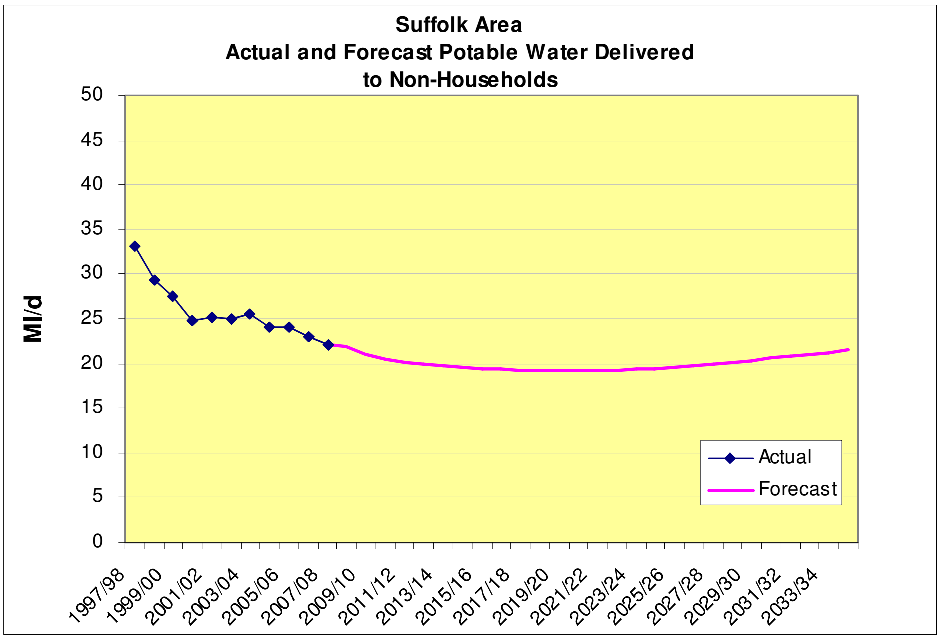
Looking at the period to 2014/15, water demand in three of the sectors noted above as particularly significant to the Essex Area – wholesale and retail, education and health and other services - is forecast to reduce by 9-17%, while oil refining and transportation and manufacture of transport equipment are forecast to increase by 2-6%. However, on balance, the combined demand from these key sectors is forecast to reduce by 7.2% by 2014/15, virtually the same as the reduction in total non-household demand (7.3%).

Over the longer term, forecast demand continues to decline in all key sectors except transportation and manufacture of transport equipment, so that by 2024/25, water delivered to non-household customers in the Essex Area is 12% below its 2007/08 level. In the final 10 years of the planning period, the picture is generally one of some recovery, so that by 2034/35, water delivered is around 5% below its 2007/08 level.

4.8.2. Suffolk Area

Non-household water delivered in the Suffolk Area is expected to decline at an average annual rate of 2.3% between 2007/08 and 2009/10, the rate of decline falling to 1.4% p.a. between 2010/11-2014/15 and 0.4% p.a. between 2015/16 and 2019/20. Thereafter, growth of 0.3% p.a. is anticipated until 2024/25 but by the end of this period, demand will still be about 12% below its 2007/08 level. Growth averaging 1.0% p.a. is forecast for the remainder of the planning period until 2034/35.

The graph below shows the Suffolk Area non-household demand forecast and also the trend of actual demand since 1997/98. By the end of the end of the planning period, demand is expected to still be 2% below its 2007/08 level and 35% below the 2007/08 figure.



The following four sectors accounted for over two-thirds of water delivered in the Suffolk area in 2007/08:

Sector	% of total non-household potable water delivered in 2007/08
Food and drink (manufacture)	19.1%
Other services	18.7%
Hotels, bars and restaurants	16.8%
Agriculture, horticulture, forestry and fishing	14.4%
Sub-total	68.9%
Other sectors	31.1%
Total	100.0%

The following sectors figure heavily in the reduction in demand seen over the last 10 years in the Suffolk Area:

- Food processing and packaging
- Power generation
- Laundry services (site closure)

Looking at the period to 2014/15, water demand in three of the four sectors noted above as particularly significant to the Suffolk Area – food and drink (manufacture), other services and agriculture, horticulture, forestry and fishing - is forecast to reduce by 10-21%. Demand from hotels, bars and restaurants is forecast to increase by a modest 1.3%. On balance, the combined demand from these key sectors is forecast to reduce by 11.0% by 2014/15, as does total non-household demand.

Over the longer term, forecast demand continues to decline by 2.3-2.6% p.a. in the food and drink sectors, while growth in demand of 1.4-2.0% p.a. is forecast from hotels, bars and restaurants, with relative stability in agriculture and other sectors. Overall, the period between 2015/16 and 2024/25 is one of relative stability in total non-household demand, so that by the end of the period demand has fallen by only a further 1% to 12% lower than its 2007/08 level. In the final 10 years of the planning period, the picture is generally one of some recovery, so that by 2034/35, water delivered is about 2% below its 2007/08 level.

In terms of water resource zones, the Northern/Central Zone typically accounts for almost 80% of all non-household demand in the Suffolk Area. Large users are, in the main, concentrated close to the coastline, where the main activities are the leisure industry, power generation and port activity. The Blyth Zone accounts for about 14% (two power stations are located in the zone) and Hartismere for about 9%.

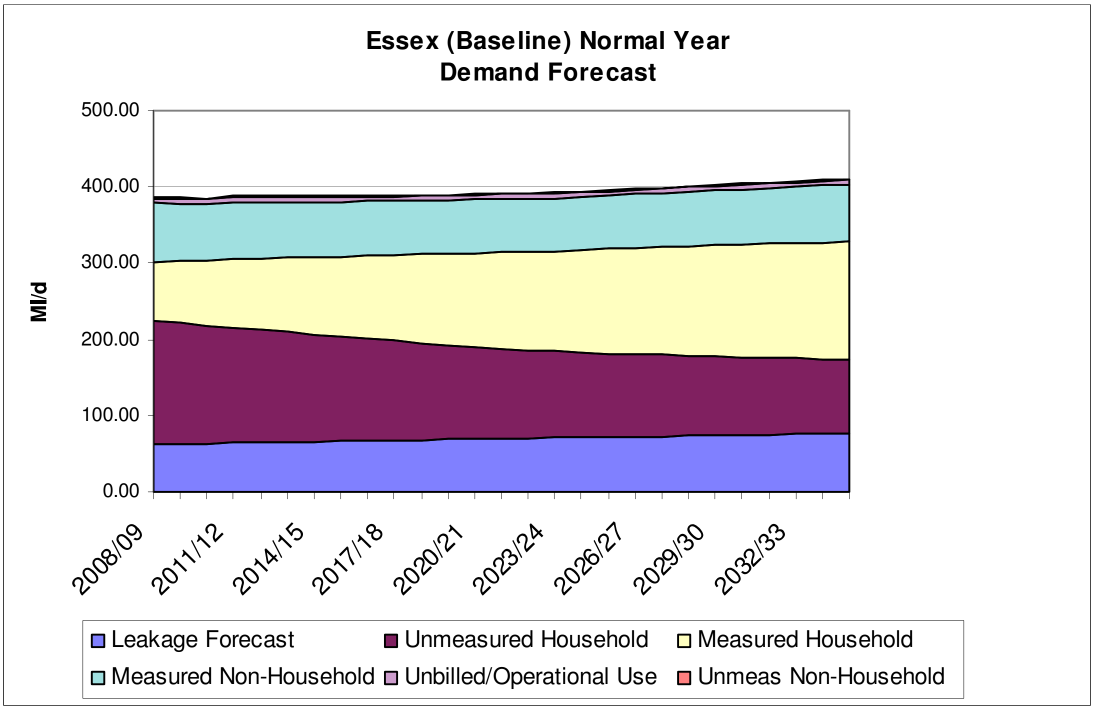
4.8.3. Water efficiency in Non-households

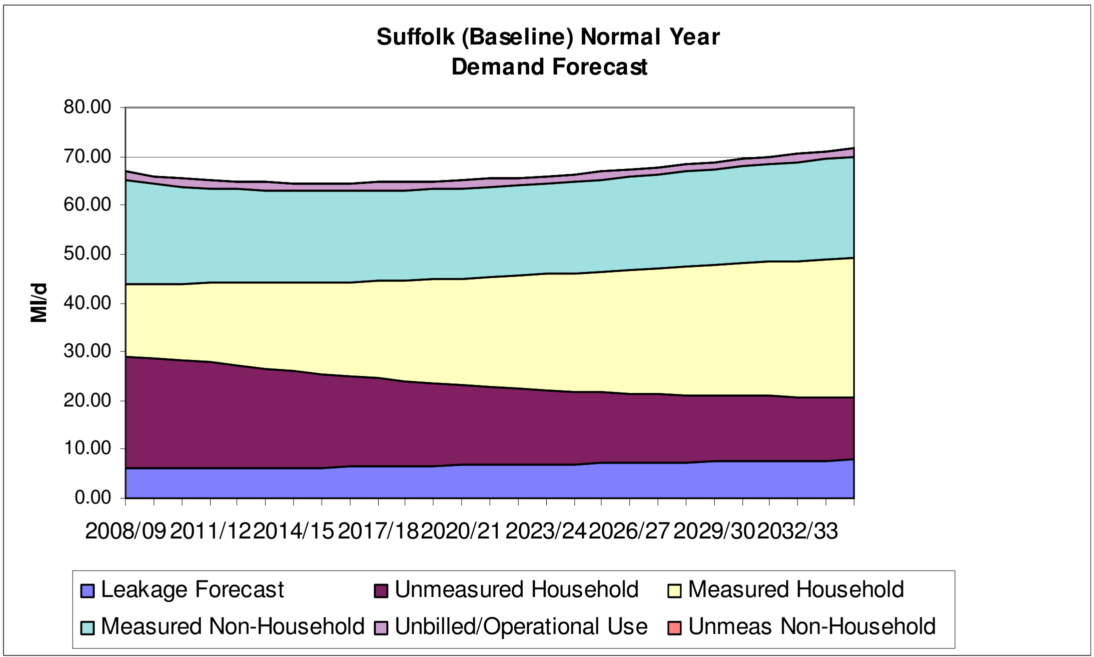
Our non-household forecasts are inclusive of water efficiency measures allowed for in base operating expenditure and of our plans to meet our recently established targets.

4.9. Total Normal Year Baseline Demand Forecasts

The total baseline demand forecast is comprised of the elements described in the preceding sections and the demand management described in section 5 below.

The total demand forecast is very flat across the planning horizon, although the composition of demand varies noticeably as shown below.


Essex (Baseline) Normal Year
Demand Forecast
500.00
400.00
300.00
200.00
100.00
0.00
Ml/d
2008/09
2011/12
2014/15
2017/18
2020/21
2023/24
2026/27
2029/30
2032/33
Leakage Forecast
Unmeasured Household
Measured Household
Measured Non-Household
Unbilled/Operational Use
Unmeas Non-Household


Suffolk (Baseline) Normal Year
Demand Forecast
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Ml/d
2008/09
2011/12
2014/15
2017/18
2020/21
2023/24
2026/27
2029/30
2032/33
Leakage Forecast
Unmeasured Household
Measured Household
Measured Non-Household
Unbilled/Operational Use
Unmeas Non-Household

4.10. Defining Dry Year Factors

4.10.1. Introduction

The historic record of weather versus demand has been examined to identify conditions of a dry year.

4.10.2. Background Information

A dry year definition is required when a company decision is to be made for the June Return submission to OFWAT stating that the weather experienced during the period of the return has been a dry year or not. The dry year criteria will also be useful when forecasting future demand during dry periods. Simple criteria will be selected based on average temperature and rainfall for the return year.

Guidelines from the EA, OFWAT and NERA state that a dry year should be accounted for in the demand planning process, however, there appears to be no distinct, specific definition of the characteristics of a dry year. This definition is problematic to apply as the introduction of demand restrictions is more commonly linked to water resource availability resulting from weather conditions over a prolonged period, usually a previous year.

4.10.3. Objectives

The approach taken will be to examine the relationship between weather and demand and identify years of specific interest due to unusual weather and demand patterns.

Dry Year definitions that are available will be reviewed, analysis of weather conditions and demand for the year's 1994/5-2004/5 carried out. The peak summer period, 1st June – 31st August 1994-2004 will be examined in greater detail.

Rainfall for the period 1994-2004 will be compared with the 10 year long term average, maximum temperatures compared with 10 year and 30 year long-term averages.

The year of 1995 has already been clearly identified as one of hot, dry weather conditions, which may be used as a benchmark for defining a "dry year".

4.10.4. Dry Year Definitions

Environment Agency

The Environment Agency state the definition of a dry year (household) is "A period of low rainfall and unconstrained demand" (EA, 2007a). In the EA report ‘A scenario approach to demand forecasting’ (EA, 2001), 1995 is assumed to represent a dry year.

The ‘Water Resources Planning Guideline’ (Environment Agency, 1998b) defines a dry year as “Below average rainfall and above average temperature without demand restrictions applied.” The report states “A ‘baseline dry year annual average unrestricted demand forecast’ should be produced for conditions that result in a level of demand just equal to the maximum annual average which can be met without the introduction of demand restrictions at any time during the year. The dry year demand should be expressed as the total demand in the year divided by the number of days in the year.”

Implementation of hosepipe ban outside of dry year defining conditions

A hosepipe ban was brought into operation in Essex at midnight on 12th June 1997. This was after a long period of exceptionally dry weather, which started in April 1995. By February 1997 the previous 21 months had been the driest of the twentieth century with combined storage at Hanningfield and Abberton reservoirs only 55% compared to the previous year’s figure of 70.3%.

Many burst pipes were as a result of the ground thawing and freezing at the beginning of the year resulting in a large increase in demand. The freezing weather also caused problems with the transfer of water into the reservoirs so that valuable recharge time was lost.

Ofwat

Ofwat stated in their Business Plan Guidelines (Ofwat, 1998) that “Companies should describe in the commentary of their business plan the relationship between expected demand in a year with normal weather and expected demand in a dry year.

Where a company has provided the Environment Agency with a demand and supply forecast based on its critical period (assumed to be peak week unless otherwise stated), they should focus on key milestone planning years e.g. 2002-2003 and 2007-2008.” (Part D, D8, Business Plan Guidelines)

NERA

NERA (UKWIR/Environment Agency, 2002) state “There is no universally accepted standard specifying the increase and decreases in demand associated with dry and wet conditions. In the absence of a standard, forecasts of weather related variations in demand should have an empirical justification, for example, they might be based on an historical analysis of demand and relevant weather variables, or demand given weather conditions that occur ‘1 in x’ years.”

Guidelines state “The characterisation of supply e.g. during a wet/dry/normal year, is a simplification of reality. The distribution of supply is not necessarily such that a dry year implies the lowest deployable output. Instead, there could be effects that carry over from one year to a next, so that deployable output in a normal year could be low as a result of the preceding year being dry, or it could be reduced in an extremely wet year due to turbidity disabling sources."

NERA (UKWIR/Environment Agency, 2002) also state "Any given year could be categorised as wet, normal or dry, although there is an infinite number of possibilities ranging from the very wettest to the very driest years possible. For any given 'type' of year, say a dry year, there is a distribution of possible yields around the expected value. Thus, it would be possible to say that dry year yield is 120Ml/d with 95% confidence, but only 110Ml/d with 98% confidence, for example. Furthermore, for each 'type' of year, normal, wet or dry, there is a distribution of possible demand outcomes around the expected value, with this distribution driven by stochastic processes. In addition, over a number of years climate change will also influence demand."

Stage 1 of the NERA guidelines suggests that "Planners collect supply and demand detail for a range of weather conditions and for a number of critical periods. Critical periods are when there is the greatest stress on the ability of the water supply system to meet demands. Critical periods may be driven by peaks in demand, by troughs in deployable output, or by a combination of the two."

4.10.5. Methodology and limitations

Weather data obtained from Writtle College weather station, as the single source used this would be the main limitation for this information. It must be assumed that these measurements are representative of the region as a whole although there will be small regional differences. Demand information, in the form of daily distribution input for the Essex area was obtained from Essex MIPS archived data, [Management Information Presentation System] and imported into spreadsheets for analysis.

The period of analysis chosen was 1994/5-2004/5 as it was considered inappropriate to study demand data further back in time. This would be affected by changes in conditions that have occurred over the last 10 years, such as increases in metering and improved leakage controls.

Summaries of weather data were collated and a number of graphs were prepared as a basis for identifying patterns in demand and weather (ESW, 2005).

- Weather summaries for each year 1994-2004.
- Storage levels in Hanningfield and Abberton reservoir during years identified for comparison.
- Average monthly Distribution Input (DI) compared with cumulative monthly rainfall for the period 1994-2005. Appendix I

- Peak period daily demand compared with maximum temperature and daily rainfall. Appendix II
- Average, maximum monthly temperature compared with 10 year and 30 year long term averages. Appendix III
- Cumulative monthly rainfall compared with cumulative 10-year long-term average monthly rainfall. Appendix IV
- Demand as a factor of average Distribution Input for year. Appendix V

Writtle weather classification

Basis for classification of weather records

A classification scheme for seasonal records is presented in London Weather (Brazell, 1968), and is reproduced in the table below. No explanation is given however, as to how the particular values were chosen. This scheme has been used for many years at Writtle for classifying not only seasons but also months and years.

Seasonal classifications (after Brazell (1968))

Temperature		Rainfall	
Difference from mean (°C)	Classification	Difference from mean (%)	Classification
> 1.1	Very warm	> 50	Very wet
< 1.1 > 0.56	Warm	< 50 > 25	Wet
< 0.56 > -0.56	Average	< 25 > -25	Average
< -0.56 > -1.1	Cool	< -25 > -50	Dry
< -1.1	Very cool	< -50	Very dry

The variability of the weather over a time period will depend on the length of time considered: the longer the time, the less a particular period is likely to deviate from the mean. Separate classification schemes for months and seasons are required.

The procedure followed by Writtle weather station has been to scale the seasonal classification values of Brazell (1968) to produce equivalent classification values for months and years using standard deviations of the values of the elements as the vehicle for making the comparisons. This method of classification has been used to produce the following annual weather summaries.

Annual Weather Summaries of Weather Recorded by Writtle Agricultural College

1994: Yearly summary.

- Warmest year since 1990, mild January and March, and a very warm July. November exceptional, temperatures 3.2^{0}C higher than 1958-87 average.
- Rainfall average throughout year. Above average rainfall for April, May and June. July and November exceptionally dry.
- Winter and summer sunnier than average.
- Dull May and November dullest for 26 years.

1995: Yearly summary.

- Classification: Very warm and very sunny.
- Hottest summer since 1976. Coldest December since 1981. One of the warmest years on record. Mean temperature of 10.7^{0}C
- Wettest January and February for 44 years.
- Driest year since 1976, very little rain in August and October.
- Sunniest year since 1909.

1996: Yearly summary.

- Classification: Dry and sunny.
- Exceptional as the driest year on record (records began 1943)
- Rainfall deficit over the year was 31.7% of 1958-87 average.
- Coldest year for 10 years.
- Sunniest June for 20 years.

1997: Yearly summary.

- Classification: Very warm and very sunny.
- Mean air temperature of 10.7^{o}C, 1.1^{o}C above 30-year average for Writtle. January saw a continuation of very cold weather from December 1996, ground frozen to a depth of 10cm for the first 11 days.
- Rainfall was only slightly below average did not compensate for the lack of rainfall experienced during 1995 and 1996.
- Sun hours were more than 20% above average.

1998: Yearly summary.

- Classification: Very warm.
- Globally, warmest year on record. Mean air temperature of 10.7^{o}C, 1.1^{o}C above 30-year average for Writtle.
- Above average rainfall but not exceptionally so, after 3 drier years allowed depleted reservoirs to be refilled.
- Sun hours a little above 30-year average.

1999: Yearly summary.

- Classification: Very warm and very sunny.

- Mean air temperature of 11.0°C, 1.4°C above 30-year average for Writtle.
- Rainfall was only slightly below average.
- Sun hours were 22.3% above 30-year average.

2000: Yearly summary.

- Classification: Very warm and very wet.
- Mean air temperature of 10.8oC, 1.2°C above 30-year average for Writtle.
- Rainfall was 31.9% above 1958-87 average.
- Sun hours were just 3.5% above 1958-87 average.

2001: Yearly summary.

- Classification: A wet year.
- Mean air temperature of 10.3°C, 0.3°C above 30-year average for Writtle. This ends a run of exceptionally warm years since 1997.
- Wettest year since records began in 1941. Rainfall was 39.2% above 1971-2000 average.
- Sun hours were 10.9% above 1971-2000 average.

2002: Yearly summary.

- Classification: Warm and wet.
- Mean air temperature of 10.9°C, 0.9°C above 1971-2000 average for Writtle.
- Rainfall was 23.8% above 1971-2000 average. Well above average for the third year in a row.
- Sun hours were 1.6% below 1971-2000 average.

2003: Yearly summary.

- Classification: Dry, very sunny and very warm.
- Mean air temperature of 10.7°C, 0.7°C above 1971-2000 average for Writtle. It is the 10th year since records began in 1943 that the mean has equalled or exceeded 10.7°C. All such years have occurred in the last 15 years and so 2003 reinforces the current warming trend. 10th August saw the highest temperature of 35.7°C locally with the national record of 38.5oC on the same day.
- Rainfall was 19.6% below 1971-2000 average.
- Sun hours were 24.6% above 1971-2000 average.

2004: Yearly summary.

- Classification: Very warm.
- Mean air temperature of 10.9°C, 0.9°C above 1971-2000 average for Writtle.
- Rainfall was 8.4% above 1971-2000 average.
- Sun hours were 1.5% above 1971-2000 average.

Based solely on the weather and taking into consideration the combination of below average rainfall and above average temperature the years 1995, 1997 and 2003 have potential for being classified as “dry”.

Below the relationships between weather and demand for these years is considered

Years Identified for Comparison.

The weather and demand data for the period 1994/95 - 2004/05 was carefully studied and three years highlighted for comparison.

1995 was chosen for the record-breaking temperatures that were experienced during the summer. It was the driest and hottest year since 1976, these factors heavily influenced demand where a period of prolonged high temperatures with very little rainfall pushed demand repeatedly over 510 Ml/day.

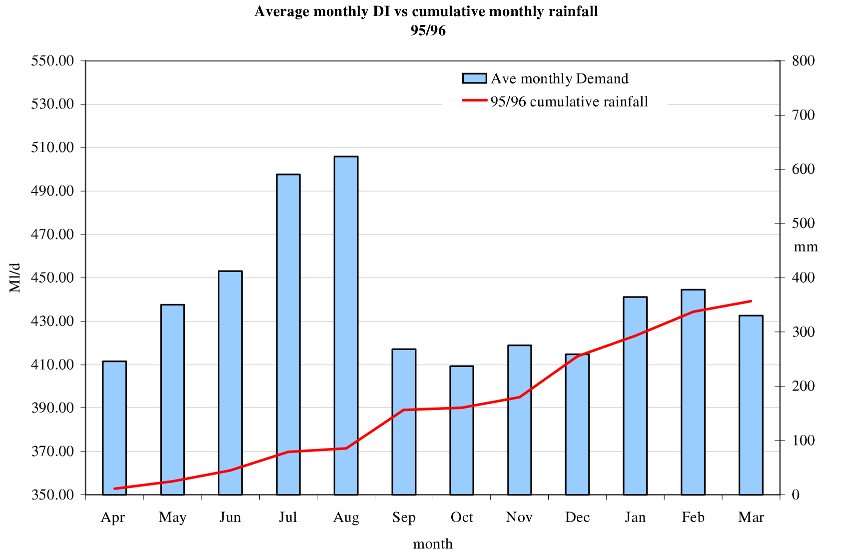
1997 requires further investigation due to the implementation of a hosepipe ban when summer weather conditions were not as extreme as those were in 1995. The hosepipe ban was more a result of the low storage levels experienced in Hanningfield and Abberton reservoirs as a result of the previous two-year’s low rainfall. If average reservoir levels had been experienced at the beginning of 1997, the weather in 1997 itself would not have led to a hosepipe ban.

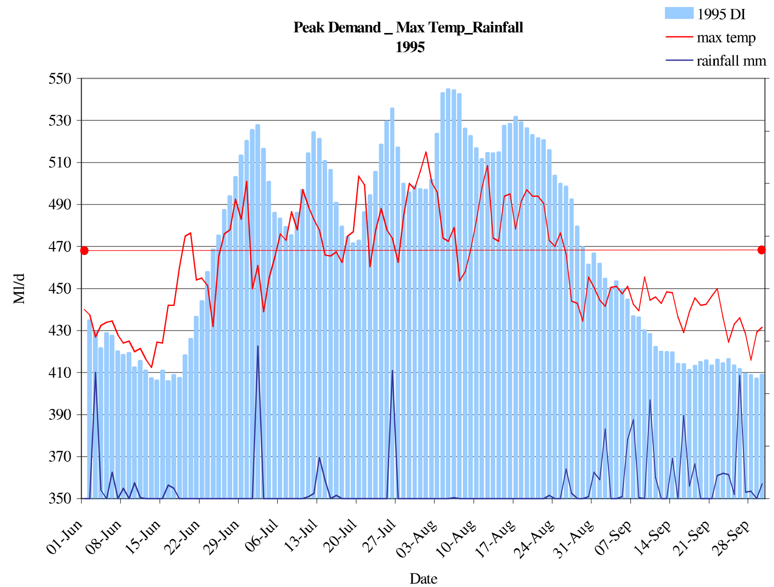
2003 was identified as unusual due to the high temperatures experienced during the summer together with sun hours significantly above average and rainfall below typical levels.

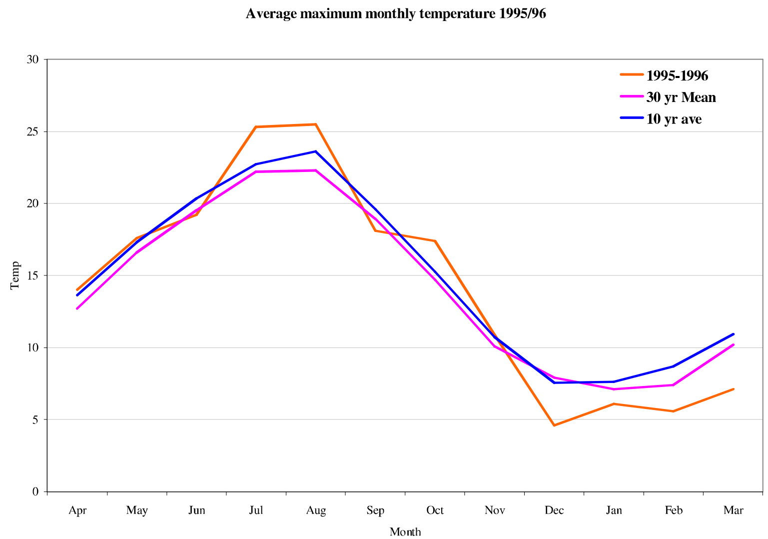
The following graphs summarise the relationships between demand and weather for each of these years and also the reservoir storage levels. Further graphs are provided in the Appendices of the report (ESW, 2005).

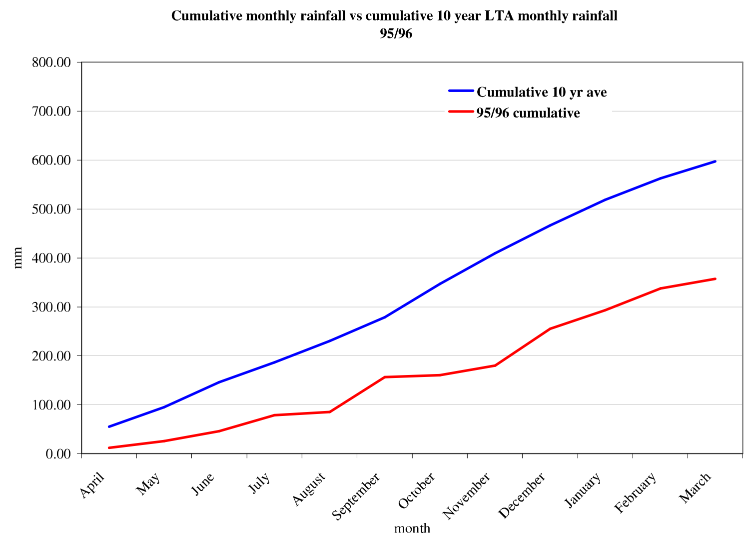
The relationships are discussed below.

1995
Comparison of weather demand data



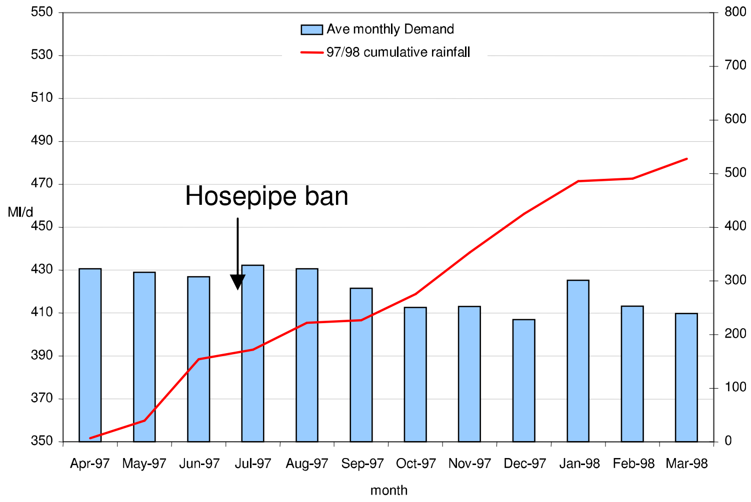




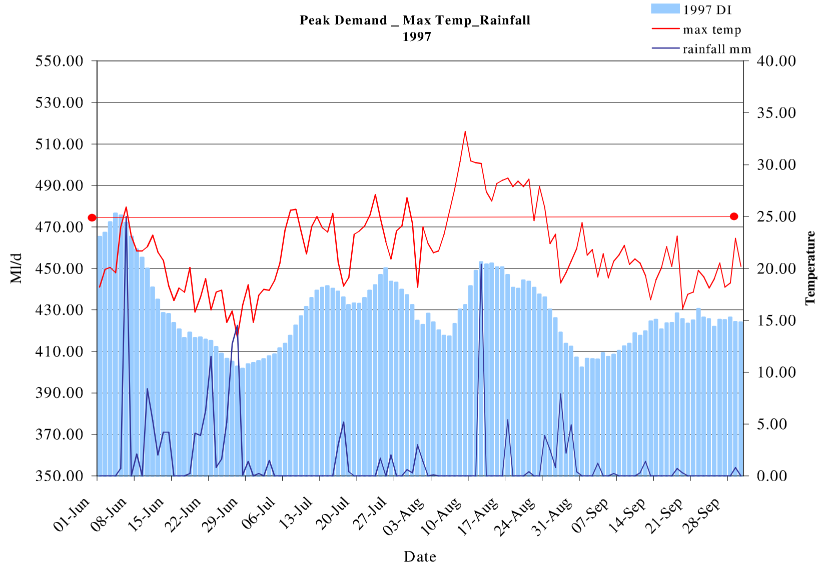


1997
Comparison of weather and demand data

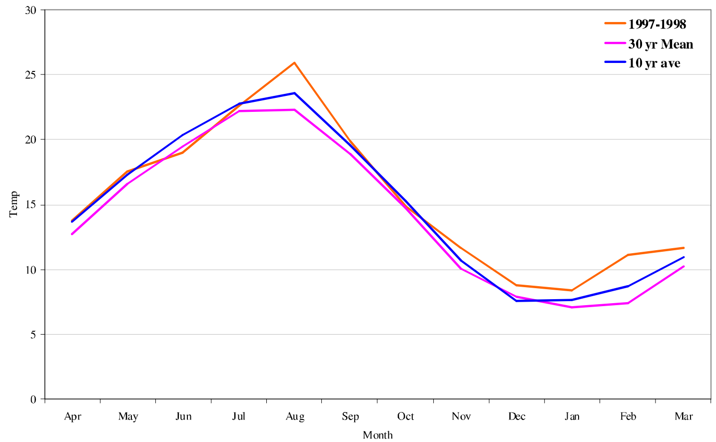
Average monthly DI vs cumulative monthly rainfall
97/98



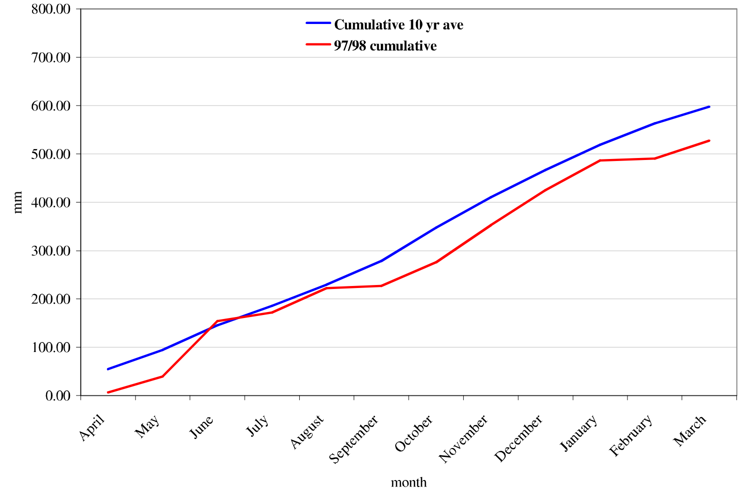
Peak Demand _ Max Temp_Rainfall
1997



Average maximum monthly temperature 1997/98



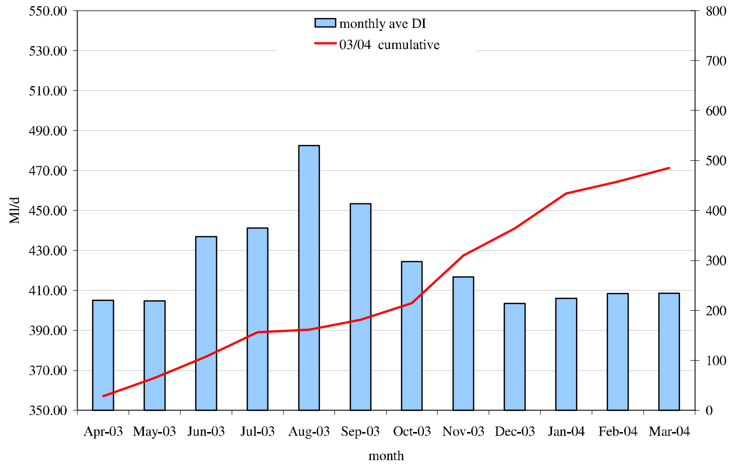
Cumulative monthly rainfall vs cumulative 10 year LTA monthly rainfall
97/98



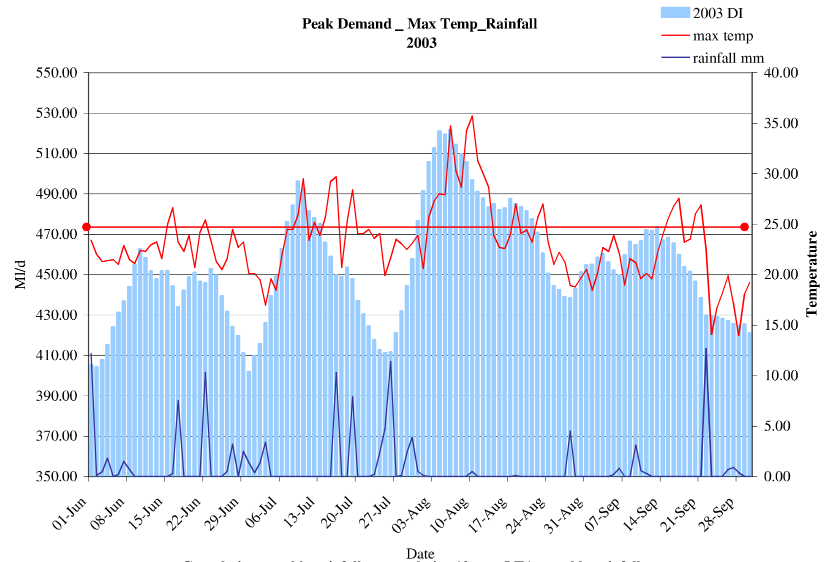
2003

Comparison of weather and demand data

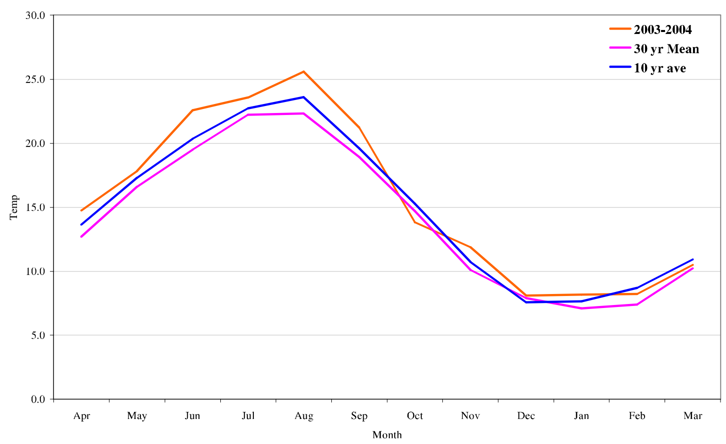
Average monthly DI vs cumulative monthly rainfall 03/04



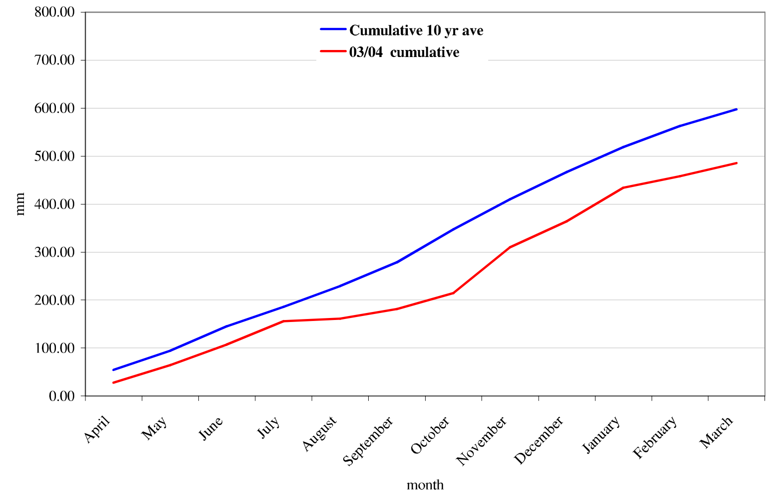
Peak Demand _ Max Temp_Rainfall 2003



Average maximum monthly temperature 2003/04



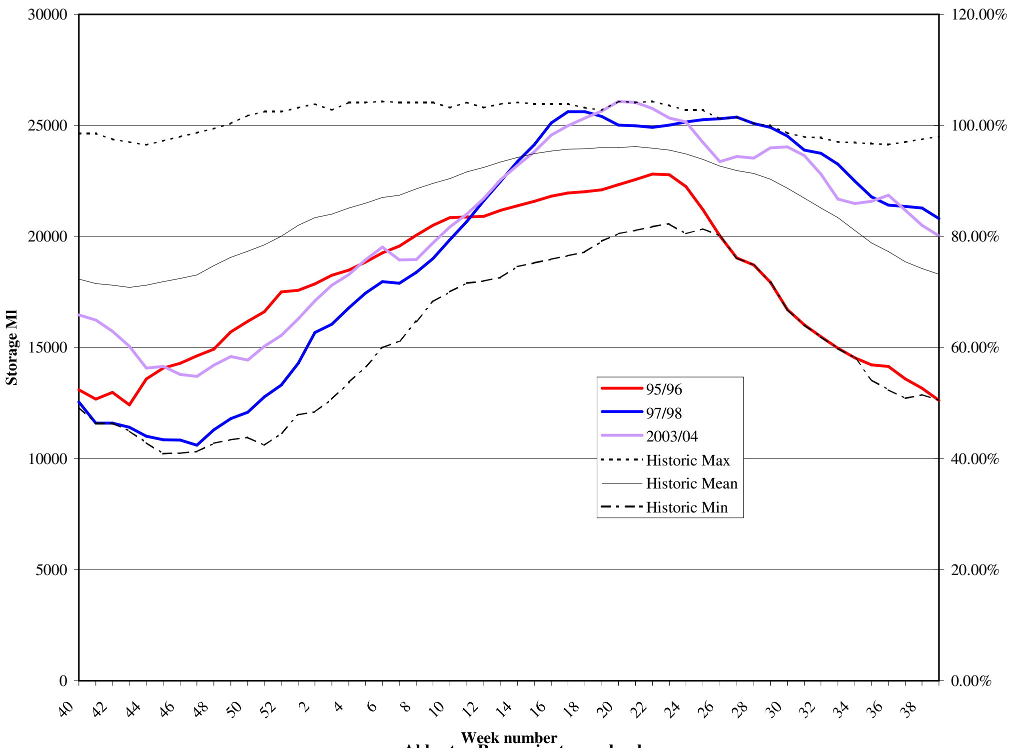
Cumulative monthly rainfall vs cumulative 10 year LTA monthly rainfall 03/04



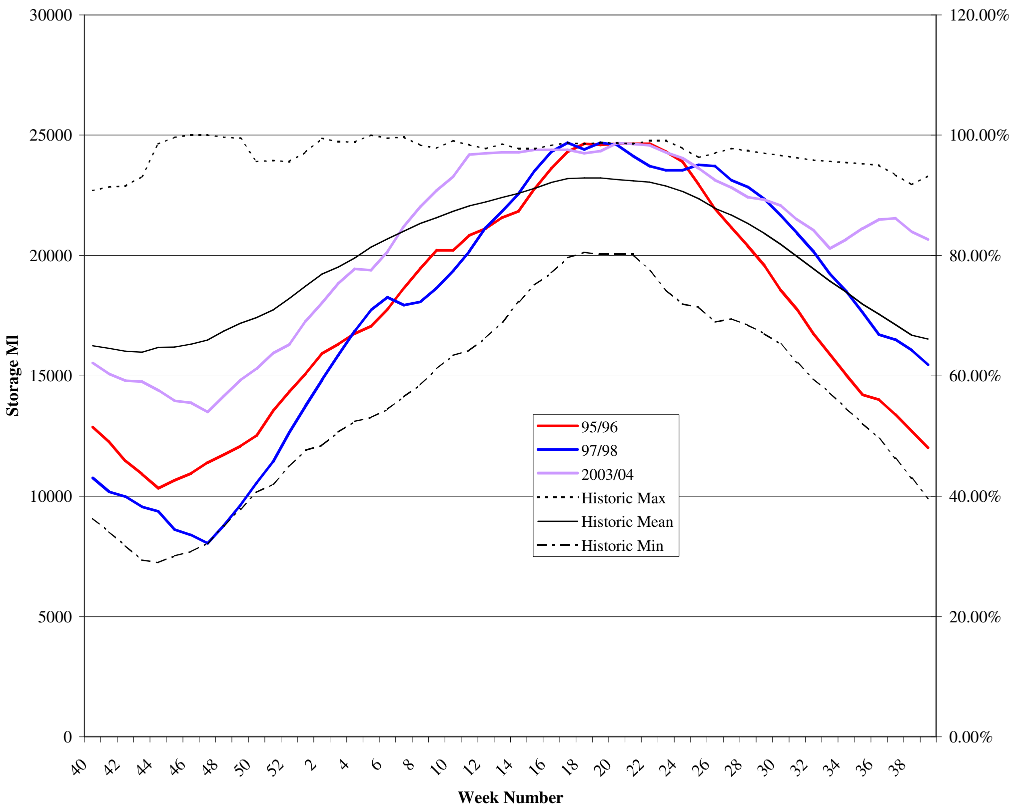
Storage levels for 1995, 1997 and 2003

Hanningfield and Abberton Reservoir historic storage levels

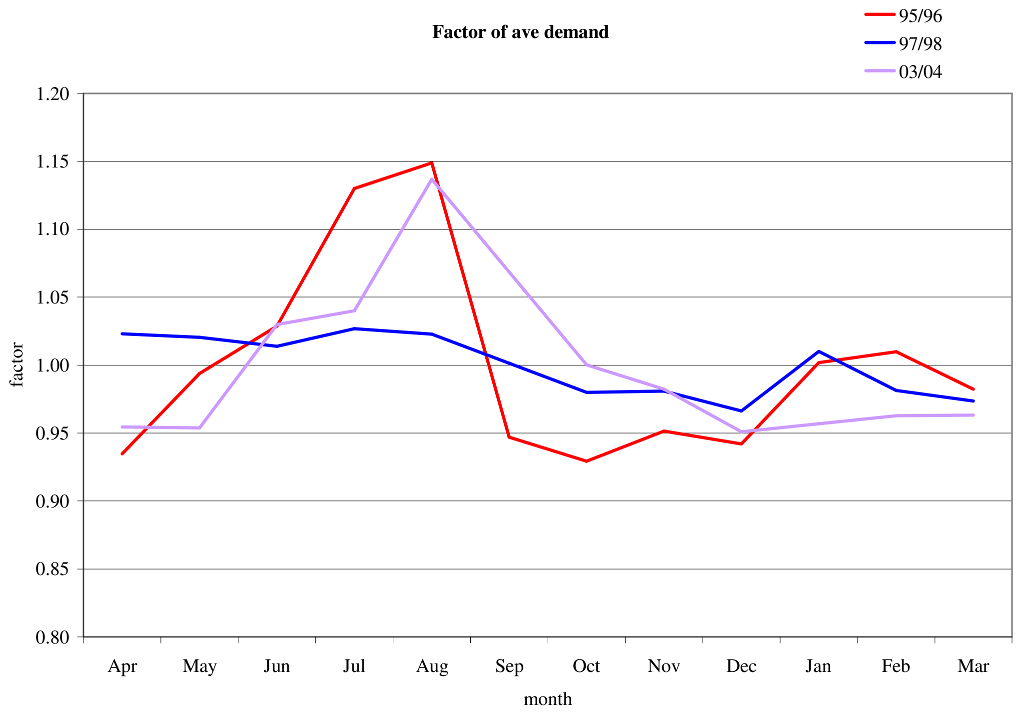
Hanningfield Reservoir storage levels



Abberton Reservoir storage levels



Demand as factor of average demand for year 1995, 1997, 2003
For the same years the variation of demand through the year has been examined using monthly totals as a factor of the annual average.



4.10.6. Data Analysis

1995

1995 clearly stands out as an exceptional year in both weather conditions and Distribution Input. Rainfall was significantly below the 10-year average and together with an extended period of high temperature greatly influenced demand. The number of days during the summer period where the maximum daily temperature exceeded 25°C was 41 with cumulative rainfall for the year measured at 484 mm between January-December.

In 1995, a sustained high demand was experienced for the period 20th July through to 30th September. Demand did not fall below 470Ml/d and weekend peaks rose to an average 530 Ml/d. The demand in the non-summer period was not abnormal.

1997

During 1997, storage levels in both Hanningfield and Abberton reached the historic minimum after two consecutive dry years. This led to a hosepipe ban being imposed during the summer months when the highest demand was expected. Demand was lower this summer as is shown by the much-reduced monthly demands and daily demands during the peak period were also significantly lower.

However there was only a short period of high temperature and rainfall events were frequent. This weather would have led to reduced peak demands.
The number of days during the summer period where the maximum daily temperature exceeded 25°C was 26 with cumulative rainfall for the year measured at 488 mm between January-December.

<u>2003</u>

The rainfall for the period April to July closely followed the long-term average. High summer temperatures were only experienced for a short period of time. The high demand of 1995 was not experienced to the same extent in 2003. The number of days during the summer period where the maximum daily temperature exceeded 25 °C was 26 with cumulative rainfall for the year measured at 465 mm between January-December

Demand as a factor of average demand for year. 1995, 1997, 2003
For 1997, the demand as a factor of the average for the year clearly shows the impact of the weather and the hosepipe ban in reducing demand, the factor remains close to 1.0. Factors for 1995 and 2003 reach the same level but 1995 demand is increased for a longer period of time.

<u>Return periods</u>

Data has also been obtained from the Met Office with regards to likely return periods of temperatures experienced in 1995. The Met Office suggests the return period of the mean daily maximum temperature experienced in August 1995 was 1 in 35 years. For the 1995 summer as whole, such temperatures are experienced once every 18 years, whereas for the summer of 1976 summer as whole, such temperatures are experienced on average once every 63 years. The statistics for 1976 are far more extreme and less likely than the return period for conditions experienced in 1995.

<u>Results</u>

In developing a dry year definition it is important that the approach should combine the summer demands with the all year round weather conditions, as a year definition is being examined, not a summer peak definition.

A simple approach was decided upon, one where the number of days in the year where the temperature rose above 25 degrees centigrade was compared to the cumulative rainfall for that year. Graphic representation of this data produced a graph where the position of the year in a specific quadrant defined whether the year would be called dry, normal or wet.

The quadrants for the graph were drawn where the number of days greater than 25 °C exceeded 30 and cumulative rainfall of less than 635 mm would define a “dry year”.

30 days was chosen, as this would loosely represent one month of very warm conditions.

Rainfall of more than 635 mm for the year would be classified according to Writtle weather station as on the dry side of average for the year.

The dry year definition provided by the Environment Agency contains the key statements, which may be used to apply to a dry year (household):

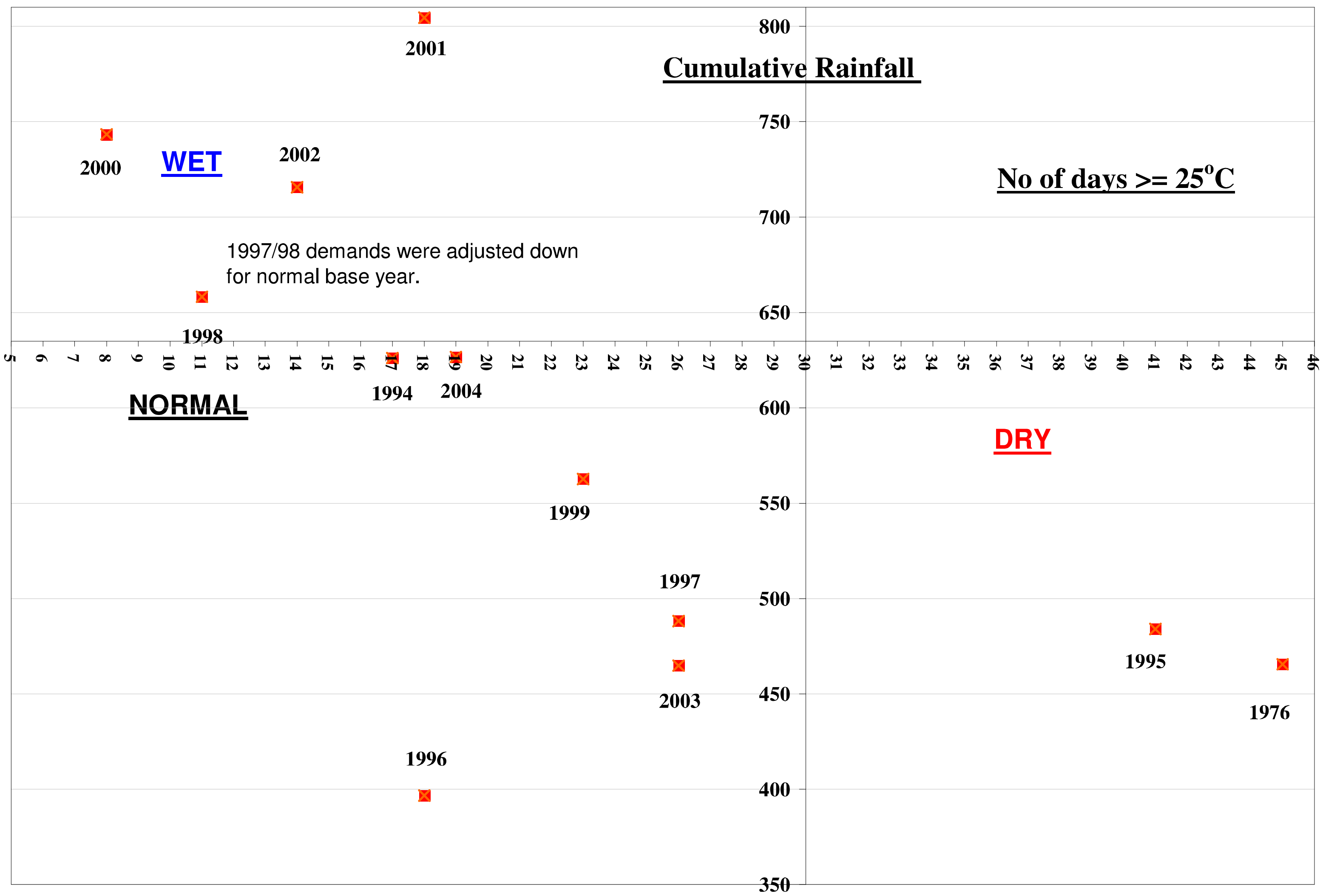
- a period of low rainfall; and
- unconstrained demand.

The following table indicates the number of days where the maximum daily temperature exceeds 25 °C.

Count of days greater than 25, cumulative rainfall 1994-2004

Year	No.of days >25 degrees C	Cumulative rainfall Jan-Dec [mm]
1994	17	626.13
1995	41	484
1996	18	396.6
1997	26	488.25
1998	11	658.16
1999	23	562.7
2000	8	743.4
2001	18	804.6
2002	14	715.6
2003	26	464.8
2004	19	626.6

Graph of Count of days greater than 25 °C against cumulative rainfall



4.10.7. Summary

Various statistical analyses are available to apply to weather data to clearly define the weather conditions for a particular year or seasons of that year but there seems to be no universally accepted method to utilise.

The decision to take into account the two variables of cumulative rainfall and number of days where the maximum temperature was greater than 25 °C offers a very simplistic approach for the definition of a dry year.

Weather and demand data will continue to be gathered and may be included in further work. This will build up a record of historic data that will either reinforce the application of this methodology or influence changes that may be necessary to produce a more robust definition.

4.11. Dry Year Baseline Forecasts

The previous increases (from Normal Year to Dry Year) assumed for a Dry Year were applied to unmeasured and measured per capita consumptions, plus an increase for non-household consumption and leakage. These increases were reviewed in 2008 and it is now considered that only household demand is likely to increase in a Dry Year,

The household increases were based on analysis of the demands in 1995/96 and have been modified to take account of the changes to the base demands arising from metering.

The previous additional PCC has been applied to the 2006/7 populations to provide an estimate of the 1995/96 based Dry Year forecast for 2006/7. It is expected that as metering has increased, the current and future Dry Year impact on unmeasured households will have increased and the impact on measured households will have decreased. This is because the measured households are increasingly composed on meter optants, who are low users of water and selectively metered customers who will be seeking to restrain their bills. The remaining unmeasured households will have a strong element of customers who have deliberately chosen not to opt for a meter, and are high users.

The increases have been calculated as follows:

Previous increase in meas PCC x 2006/7 meas population = 95/96 based additional Dry Year Meas Consumption for 2006/7

Previous increase in unmeas PCC x 2006/7 unmeas population = 95/96 based additional Dry Year Unmeas Consumption for 2006/7

Sum the above to give Total 95/96 based additional Dry Year Consumption for 2006/7.

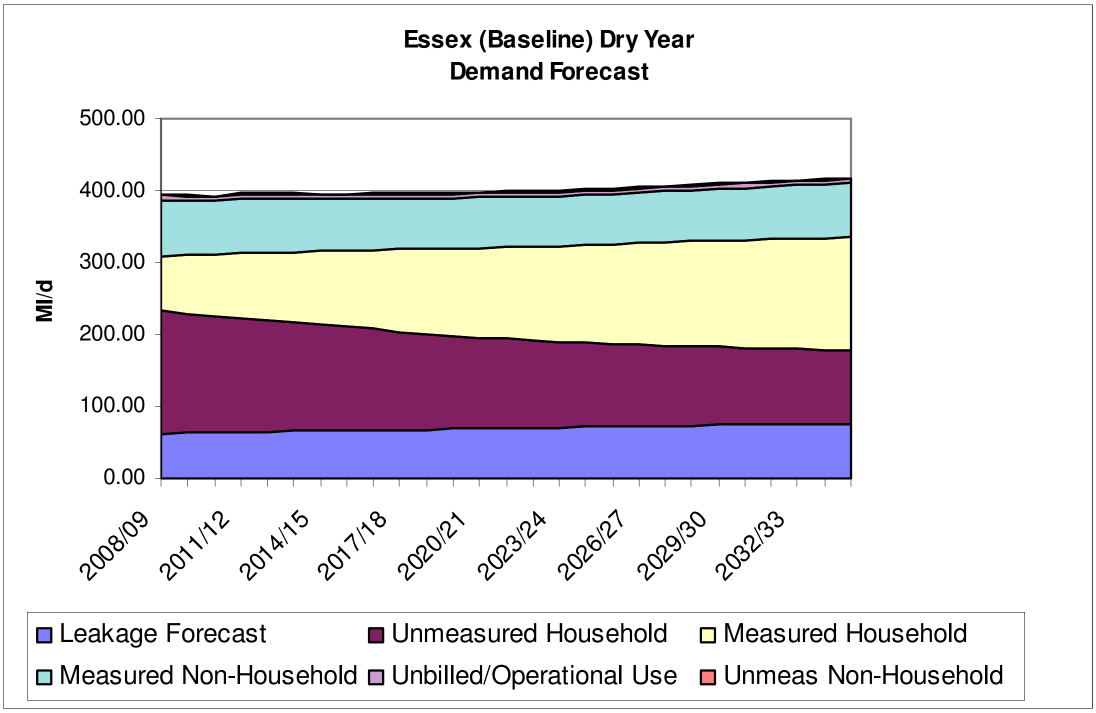
Unmeas. Population x Revised PCC increase = 2006/7 rebased Dry Year Unmeas Consumption

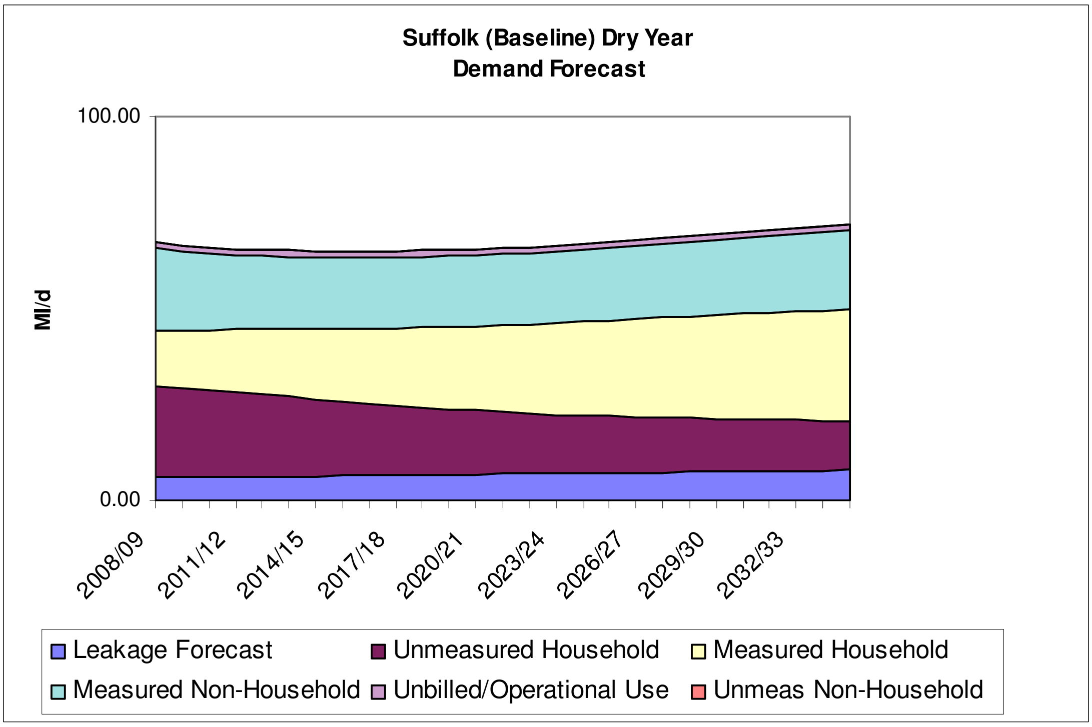
2006/7 rebased Dry Year Unmeas Consumption - Total 95/96 based additional Dry Year Consumption for 2006/7, divided by Meas population gives 2006/7 rebased Dry Year Meas Consumption

The previous and revised increases are as follows:

	WRP2004 Unmeas PCC l/hd/d	WRP2004 Meas PCC l/hd/d	Revised Unmeas PCC l/hd/d	Revised Meas PCC l/hd/d
Essex	7	2	7.3	1.26
Suffolk	2	1	2.1	0.84

The resulting forecasts are as follows:





4.12 Wet Year Forecasts

Wet year demand forecasts have been developed through consideration of the likely impacts of wet weather and the components of demand likely to be affected. In recent years there has been no particular year which can be defined as a "wet year" in the same manner as "1995/96" could be defined as a "dry year".

To determine a forecast of demand in wet years it is assumed that the component of demand which would be reduced from a normal years' demand is garden watering and outdoor leisure and therefore that this is limited to the summer months. During the remainder of the year, it is unlikely that noticeable reductions in demand would occur as a result of wet weather. Thus, the demand profile for the year would be fairly flat, without the normal summer peak and summer demands are likely to be around the rest of the year "average" demand.

Two approaches have been used to estimate the magnitude of the effect. Firstly the microcomponent demands for the unmeasured and "existing metered" groups have been examined. In the normalised previous base year 06/07 the components most likely to be relevant are:

Component	Essex area		Suffolk area	
l/hd/d	Unmeasured	Metered	Unmeasured	Metered
Lawn sprinkling	3.71	3.22	3.74	0.65
Garden watering by hose	6.51	1.79	5.97	0.85
Paddling pools	0.17	0.21	0.17	0.23
Large pools	0.3	0.25	0.09	0.12
Pond filling	0.13	0.05	0.12	0.11
Swimming pools	0.03	0.22	0.12	0.20
Total	10.85	5.74	10.21	2.16

Garden watering and other outdoor use is normally expected to occur in the five months May-September. If a wet year is defined as one is which there is a significant wet period during three of these summer months, demands in a wet year could therefore be assumed to reduce by three fifths of the totals above i.e.

Essex unmeasured	-6.51 l/hd/d
Essex metered	-3.44 l/hd/d
Suffolk unmeasured	-6.13 l/hd/d
Suffolk metered	-1.30 l/hd/d

These figures can be verified by consideration of historical monthly patterns of demand.

In Essex a record from 1992/93 has been considered but excluding the years 1995/96, 2002/3 and 2003/4 as these all had abnormal weather which may distort averages.

	1992 /93	1993 /94	1994 /95	1996 /97	1997 /98	1998 /99	1999 /00	2000 /01	2001 /2002	2004 /05	2005 /06	2006 /07
June	1.04	1.08	1.06	1.11	1.04	1.08	1.06	1.05	1.05	1.10	1.08	1.05
July	1.01	1.08	1.15	1.07	1.01	1.08	1.15	1.15	1.08	1.07	1.08	1.15
August	0.99	1.05	1.06	1.02	0.99	1.05	1.06	1.16	1.03	1.05	1.04	1.01
Ann. Av. Ml/d	400.2	396.8	405.7	419.5	400.2	396.8	405.7	426.3	482.7	401.4	405.5	394.5

If the monthly peaking factors in June, July and August were assumed to be one i.e. at the annual average, this can indicate the likely demand in a wet year. It is also assumed that the wet weather only influences domestic demand.

A check was made that the increase in metering penetration over the period had not influenced the monthly peaking factors. No trend at all was discernible.

For the above years, the average factors for June, July and August were respectively 1.07, 1.08 and 1.05. This quantity is equivalent to 106 Ml in 2006/7, or an average increase of 6.6% over 91 days, equating to 6.37 Ml/d averaged over the year.

A further assumption is made that the summer peaking is derived from an effect which is twice as much for unmeasured PCC as for metered PCC, based on the microcomponent data above:

Let X be the summer peaking on metered PCC
Let Y be the summer peaking on unmeasured PCC
Y=2X as stated above

The metering penetration in Essex in 2006/7 was 37% and the total household population is 1481.1 thousand.

Then

37% X + 63% Y = 6.37 / 1481.13 x 1000 l/hd/d

Giving unmeasured peaking of 5.3 l/hd/d and a metered peaking of 2.6 l/hd/d

This calculation has therefore returned very similar results to the microcomponent analysis above, so factors averaged from the two methods as follows are used to adjust the normal year PCC forecast down to a wet year forecast:

Essex unmeasured -5.5 l/hd/d
Essex metered -3 l/hd/d

In Suffolk a similar approach has been followed.

	1992 /93	1993 /94	1994 /95	1996 /97	1998 /99	1999 /00	2000 /01	2001 /2002	2004 /05	200 5/06	2006 /07
June	1.03	1.11	1.10	1.17	1.17	1.06	1.02	1.06	1.11	1.11	1.07
July	1.05	1.19	1.28	1.20	1.20	1.18	1.05	1.12	0.99	1.00	1.13
August	1.05	1.11	1.13	1.18	1.79	1.10	1.12	1.11	1.07	1.08	1.10

For the above years, the average factors for June, July and August were equivalent to an average increase of 13% over 91 days, equating to 2.33 Ml/d averaged over the year.

Similarly to Essex above the assumption is made that the summer peaking is derived from an effect which is five times as much for unmeasured PCC as for metered PCC, based on the microcomponent data above:

Let X be the summer peaking on metered PCC
Let Y be the summer peaking on unmeasured PCC
Y=5X as stated above

The metering penetration in Suffolk in 2006/7 was 52% and the total household population is 276.6 thousand.

Then

52% X + 48% Y = 2.33 / 276.56 x 1000 l/hd/d

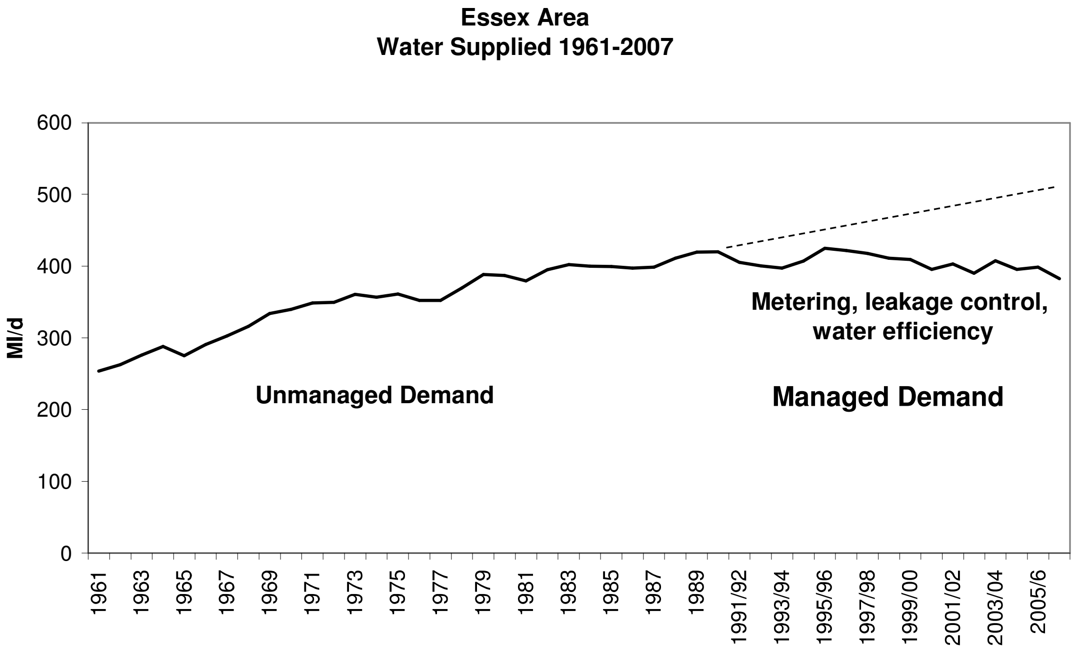
Giving unmeasured peaking of 14.4 l/hd/d and a metered peaking of 2.9 l/hd/d

This calculation has therefore returned very similar results to the microcomponent analysis above, so factors averaged from the two methods as follows are used to adjust the normal year PCC forecast down to a wet year forecast:

Suffolk unmeasured -10.3 l/hd/d
Suffolk metered -2.1 l/hd/d

5. BASELINE WATER EFFICIENCY, METERING & LEAKAGE CONTROL

Demand management has already resulted in significant savings in demand as shown in the graph below. The sections below demonstrate our ongoing commitment to demand management.



5.1. Water Efficiency – Progress in AMP4 and Current Strategy

5.1.1. Overview

Throughout AMP4 water efficiency has remained a key strand of our demand management undertakings in the Southern Operating Area. A continuation of this approach has been assumed for the baseline demand forecast and is incorporated within the microcomponent forecast. The Company has continued to strive to be pro-active and innovative. This has involved researching the most cost effective methods of reducing water consumption, developing new analysis techniques and trying to improve our understanding of people's behaviour and motivations to evaluate the most beneficial approaches to promoting water efficiency as well as providing practical advice and help to customers.

Particular achievements have been the increase in effectiveness of our audit projects, our strong emphasis on the measurement of water savings (at more detailed levels than household meter readings which can easily mislead), our interest in the sustainability of savings and our proactive attempts to share and disseminate our results, experience and learning. Also of key importance has been the influence we have achieved on customers behaviour. For many of our projects we have surveyed customers to understand their motivations for taking part. Predominately they have stated environmental reasons rather than financial. For this reason it has been possible to reach our unmeasured customers in almost the same proportions as our metered customers. Metering has *not* been found to be the driver behind water efficiency in our area.

The strategy is designed to create water efficiency programmes that make genuine savings in water as cost effectively as possible. A critical part of the programme is the monitoring of results to find out what the actual savings in water are and how sustainable they are, and customer surveys to gauge the effectiveness of the approach.

5.1.2. Cistern Displacement Devices

Save-a-flush (saf) devices have been distributed free through a variety of mechanisms. There are adverts in all the Company's leaflets and brochures including newsletters sent out to customers encourage customers to request a save-a-flush. They are provided in audit projects and they can also be requested by writing, phoning or through the Company's website. Information is also available in bills.

The table below shows the number given away each year.

	2004/5	20005/6	2006/7	2007/8 to date
SAF distributed	27020	19413	11297	6178 excluding H2eco

The number is declining over time reflecting the increase in the number of low flush and dual flush WCs, our emphasis in audit project of retrofit to dual flush where possible, and water efficiency minded customers already having safs.

5.1.3. Other Devices

A range of other devices have been distributed free on request and through projects as follows:

Item	Number Sent Out 2004/5		2005/6		2006/7		2007/8	
	Mailing	Through Audits	Mailing	Audit Projects	Mailing	Audit Projects	Mailing	Audit Projects
Trigger hose guns	186	23786	32	11623	33	547	5528	124
Tap magic	37	0						
Tap Insert						225		1222
Tap flow gauge	21	23786				13		
Shower flow bag	0	23786				11		7524

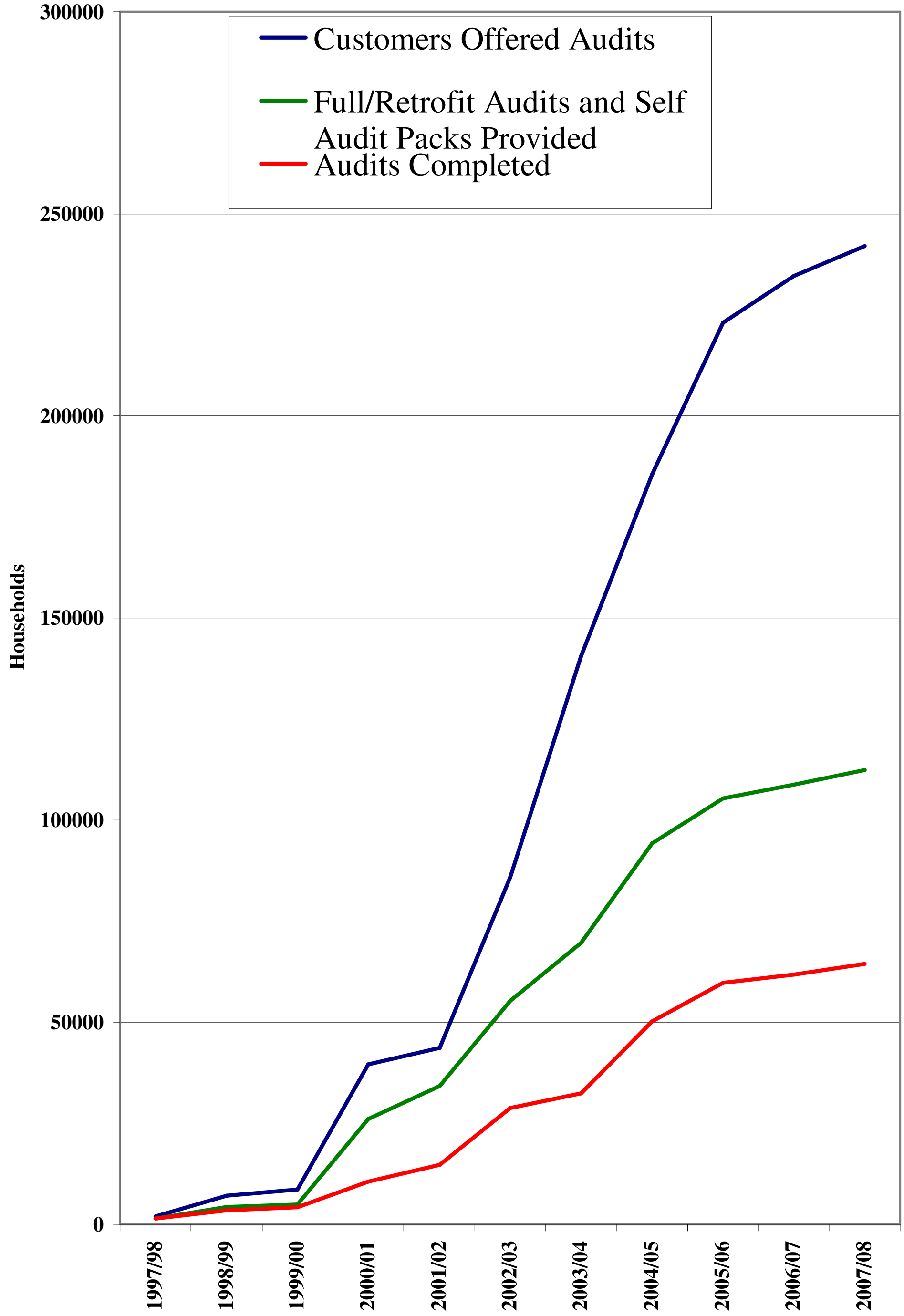
Shower timer	28	23786			494	277	8734	7524
Water storage crystals	0	23786	8	11611	116		7331	151
Plant Gel mats								7331
Shower hat	220	23786						
Tea towels	79	19684						
Beakers	1949	16294			35	58		
Waterbutts	1871	964	1409	907		579	553	981
Magnets	60	45087						
Variflush Toilet device				5		112		
Ecoflush Toilet device				2				
Dudley Turbo 88 Device				10		151		
EcoBETA dual flush device					37	1010		898
Showerheads				1		223		302
Bath Volume Indicator								39
Childrens Detective Pack						54		59
Ecosave						39		
Leak Survey						39		
Tap rewashering						18		154
Total	4,451	22,4745			678			

In 2005/06 three different toilet devices have been tested, all these through our Domestic Audits Which Approach? project described below (Ewan Group, 2006b). The variflush and ecoflush devices both offer the options of a minimum, medium or maximum flush, with the maximum volume being equal to the toilets' existing flush. Both products interrupt the operation of the siphon within the cistern by introducing air to it. A small drill hole is made in the top of the siphon and a pipe is connected to it, to allow air into the top of the siphon to interrupt its' operation. The volume of the flush varies according to the setting the user chooses. The Dudley Turbo88 device is a siphon that can be retrofitted to a wide range of toilets. This device can be set to allow for a wide variation of flush volumes, with the potential to reduce a 9 litre flush to a 6 litre flush. It also allows the toilet to be converted to a dual flush system with the full flush equal to the original flush of the toilet. All three devices are simple to use once installed. In 2006/7 we trialled another new retrofit device, the ecoBETA and this project is described below. Our 2006/7 Toolkit project also involved some new products such as ecosave to detect internal leaks and a bath volume indicator.

5.1.4. Audits

Over the last five years ESW's audit programme has been significantly developed. Major projects have continued to be run on an annual basis and the programme is regular reviewed to increase customer engagement. ESW began the last AMP period with the continuation of well proven self audit project, and additionally compared alternative approaches on a like-for-like basis, examining the projected ongoing annual savings. With the promotion of a variety of new products, ESW returned to some single device trials and have evolved innovative ways of combining the successful educational aspects of self audits with the potential for higher savings and longer sustainability from retrofits. Details of these projects and how these they have influenced Company strategy are outlined below.

Around one-third of the households in ESW have now been approached with the offer of an audit project. The graph below shows the take-up over time.


Customers Offered Audits
Full/Retrofit Audits and Self Audit Packs Provided
Audits Completed
Households
300000
250000
200000
150000
100000
50000
0
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08

Self Audits

Romford

Following on from the 2003/04 self-audit project carried out in Brentwood the project (H_20 Water Service Ltd, 2004) was expanded in 2004/5 to include over 40,000 more customers in the areas around Romford. The audits took place between March and September 2004, with a summary report produced in December 2004 (H_20 Water Service Ltd, 2004).

The objectives of this project were twofold:

- To promote the issues associated with our current water resources and ever-increasing water demand.
- To advise and encourage customers on how they can make their home more water efficient through the provision of a pack and 'tools' to allow informed assessments of water use and potential areas of waste and action.

The project has concentrated on potential savings from toilet flushing, showering and using garden products such as a spray hose gun and waterbutt, for this is where the greatest benefits were expected.

44,360 customers were contacted and of these 23,786 households accepted a pack, comprising of a number of items for the customer to use or fit to bring about greater appreciation of water usage and water savings. The pack included the following:

- 1 Save-a-flush (more could be requested)
- Dripping tap flow gauge
- Shower flow gauge
- Shower timer
- Hose gun
- Water storage crystals
- Shower hat
- Beaker for teeth cleaning
- Audit booklet which explained how each of the above could be used and how they save water. The consumption associated with a dripping tap or showering is related to other water uses to provide a meaningful context.
- Using water wisely leaflet containing tips for the home and garden

A washing machine magnet was sent out with the initial contact letter and a tea towel was sent if a questionnaire was returned. Both of these have a water efficiency message trying once more to promote efficient use of water.

In order to promote the use of a waterbutt, 160 rainsaver kits were given away each month as part of a free prize draw. In total 964 waterbutt kits were given away to customers who had completed an audit.

The customer could request further save-a-flushes and information on various issues, for example leaflets for children, or further information on water conscious gardening. This further information aims to educate customers into how they can change their habits and use water wisely.

A total of 17,882 customers returned their questionnaire forms.

The table below summarises the savings from the self-audit project.

Water saving activity	Water saving (litre/day)
Save-a-flush	161,344
Turning the tap off when cleaning teeth	29,906
Trigger hose gun	26,242
Showering	21,916
Mending dripping taps	782.4
Total water savings calculated	240,190

The above total savings gave an average saving of 11.29 litres per audited property per day.

Customer Feedback

In order to evaluate the self-audit project a follow up questionnaire was sent to customers involved with the project. A sample of 5% of the total population was sampled, with a return rate of 21%. From the replies, 80% of customers did complete an audit form even though they did not send it to ESW. This is expected to be an over estimate as a customer would be more likely to respond to a follow-up survey if they had completed the initial audit. The main reason customers carried out the audit was to provide information to ESW and to save water. The customers were asked to review the contents of the audit pack. The most useful item was the hose gun, with over 60% of customer using it. The shower flow-measuring bag was also seen as a very useful item. Generally customers were very positive about the project with 63% of customer expecting their water use has reduced as a result of the project.

Water Audit Evaluation Research

UPM (UPM, 2004) was asked to review and evaluate the current processes used to carry out the self-audit project. They looked at each aspect of the audit process from the contents of the pack itself to the methodology of contacting the customers. They provided important feedback and recommendations of how the efficiency of the project could be improved to ensure maximum results. Information obtained from this research was used to improve the design of our next self audit project. One of the findings was the potential for cost saving by using telephone recruitment so this was trialled in the Thurrock project.

Domestic Self Audits – Thurrock 2005/6

The project took place in the Thurrock area of South Essex from August 2005 until January 2006 (Ewan Group, 2006a). A total of 31,571 customers were contacted via letter introducing them to the project and asking them to contact ESW if they were interested in taking part using the local rate phone number provided. If nothing was heard from the customers, they were contacted by telephone within 14 days of the notification letter being sent. An appointment was made to deliver the audit pack and to encourage them to complete and return the audit form. This methodology resulted in a relatively low audit form return rate (16.9% return rate with respect to letters delivered). This was partly because we only had telephone numbers for a proportion of the customers. Indeed, as there was a significant proportion of Council housing for many addresses we also had no names. It was therefore essential to re-evaluate this method in order to increase the completion rate of audits. It was decided to send a letter regarding the project and informing the customer we would be visiting to deliver the pack over the next few days. This approach proved more successful (40.3% return rate of the completed audit forms) as it allowed face-to-face contact with the customers and did not require the customer to telephone to initiate the pack delivery. In total 11,578 audit packs were delivered. The pack included the following:

- 1 Save-a-flush (more could be requested)
- Dripping tap flow gauge
- Shower flow gauge
- Shower timer
- Hose gun
- Water storage crystals
- Shower hat
- Beaker for teeth cleaning
- Audit booklet which explains how each of the above can be used and save water, this also contained the audit form to complete and return.
- Using water wisely leaflet containing tips for the home and garden

A washing machine magnet (with a water efficiency message) was sent out with the initial contact letter, this was used as a visual reminder that the customer had been sent an introduction letter. The same imagery is also used on badges worn by our agents, which in addition to identification badges helps to verify their connection with the project.

In order to encourage the completion of the audit pack two incentives were used. The first was the potential to win £100 cash or runner up prizes of £20 Tesco voucher. The prize draw for this was held at the end of the project in January 06. The second was to win a rainsaver kit, 150 rainsaver kits were given away each month. In total 907 waterbutt kits were given away to customers who had completed an audit.

The customer could request further save-a-flushes and information on various issues, for example leaflets for children, or further information on water conscious gardening. This further information aims to educate customers into how they can change their habits and use water wisely.

A total of 8,707 customers returned their questionnaire forms; this is a return rate of 75% of the customers who accepted an audit pack. Compared with previous projects with an average return rate of just 64%, this is a large increase in the percentage number of forms returned. The high return rate was encouraged by lessons learnt from earlier projects facilitating the return of the forms. Customers could post them or leave them on the doorstep for collection. They were also told when someone would come to collect them and left compliment slips to remind them. No difference in participation rates was seen between measured and unmeasured customers. 75.1% of measured customers who received a pack returned their form and 75.2% of unmeasured completed and returned their form.

The project has concentrated on potential savings from toilet flushing, showering turning the tap off when brushing teeth and using garden products such as a spray hose gun and waterbutt, for this is where the greatest benefits were expected. An average saving of 15.3 litres per audited property per day was found.

In order to evaluate our self-audit project, a follow-up questionnaire was sent to customers involved with the project. Three questionnaires were designed each with a different focus, the first aimed to gain an understanding of how the pack helped customers to reassess their water use, the seconded focused on the contents of the pack and how useful customers found the devices. The third was sent to customers who received an audit pack but did not return their form, the aim was to find out why they did not complete the audit or whether they completed sections of the audit e.g. installation of the save-a-flush. Each questionnaire was sent to 200 customers (600 customers contacted in total), and a return rate of 24% was achieved. The main reason customers carried out the audit was to reduce their water use and provide

ESW with information. With regards to the contents of the pack, the garden hose gun was rated as the best item (average rating 4.37 out of 5), although the tea towel, shower timer and water storage crystals were used by the most customers. 93% of customers stated that the information leaflets were useful and informative, and 98% answered that the pack and its contents were easy to use and understand. Of the customers who did not return the audit form some comments included:

- that they did not find the project a priority
- they forgot about the project

A few customers completed the audit but did not send the forms back.

Generally, customers were very positive about the project, with 82% of customers stating that they think their household consumption has decreased as a result of the project.

These take-up and return rates are ESW's highest ever, signifying a very successful project. This is likely to be the result of many years of experience with this type of project and the emphasis placed on project reviews and evaluation. The follow-up research completed after the projects to review what had motivated customers, ascertain their views on all aspects of the project from the appointment or delivery process through to product selection and literature, has enabled a delivery process to be developed with a highly significant engagement level.

Do It Yourself Audits

For financial reasons our self audit projects can only reach a limited number of customers each year, so a least cost 'Do It Yourself' self audit pack has been developed with clear messages and instructions on how to carry out an audit yourself using tools (e.g. jug. watch etc) readily found in the home. This small DIY self audit pack includes:

- Save-a-flush (more can be requested)
- Tea towel
- Washing machine magnet
- Audit Booklet explaining how to carry out a self-audit. Consumption through dripping taps or showering is related to other water uses to provide a context.

Information on how to receive a DIY audit is available on the company website and within company magazines such as the Source magazine. 747 packs were distributed in 2004/05. The majority of these were sent to customers as part of the water use pledge scheme. A total of 174 questionnaires have been completed and returned. This gave a return rate of 24% compared with the previous year of just 8%.

In 2005/6 245 packs have been distributed. The majority of these were again sent to customers as part of the water use pledge scheme. A total of 44 questionnaires have been completed and returned. The gives a return rate of 18%. In 2006/7 513 packs were distributed.
The main savings associated with the distribution of DIY packs come from the installation of a save-a-flush. The pack aims to help encourage customers to think about the amount of water they waste and lead to a change in their water usage habits and behaviour. This is a long term saving that can only be measured by customer attitudes surveys, showing if there has been a change in perceptions with regards to water efficiency and its importance.

Domestic Audits – Which approach? 2006/7

Concurrent with the delivery of the Thurrock audit project in 2006/7, we felt it was time to undertake a wider review of our approach. The company has had an active domestic water audit programmed since 1997. Since then many different types of audits have been trialled/rolled out with different approaches and delivery methods. All audits have however had the same aim of encouraging customers to think about how much water they use in the homes and how they can reduce the amount of water they waste. The methods of delivery have ranged from posting an audit pack containing instructions on how to complete the audit to delivery of the pack by hand with a larger amount of customer interaction. Audits were also trailed where by the Company helped the customer to complete the audit by installing the save-a-flush and measuring the shower flow rate. Each of these methods has taken place as a discrete project. Independently the water savings had been estimated and the costs of each project evaluate. There had been no directly like-for-like comparison between each of the methods of audit. It was therefore decided to analyse the costs, water savings and ease of delivery of a range of audit types and compare them for matching customer groups. The potential long-term water savings of each method also needed to be analysed so loggers collecting 15 minute consumptions were used.

Six audit types were selected for trial – retrofit, full audits, self audits, childrens' audit, year-long education, and one-off education (Ewan Group, 2006b). The retrofit audit involved retrofitting single flush WCs with either a dual flush or variable flush device. Water efficient showerheads were also installed if appropriate. The Full audit, self audit and children's audits were all based around delivery of the self water audit pack used in the Thurrock project. The contractor working on the companies' behalf would complete the full audit with the customer present. The self-audit was carried out in the same way as the Thurrock audits. The children's audit was aimed at children between 7 and 11 years old. The contents of the pack were the same expect for a specially designed children's leaflet. The year-long education audit started with a visit to examine how the customer uses water at home. Letters were then sent to them on a monthly basis remaining them of water efficiency messages. The final type of audit was the one off education audit. Customers were visited in the same way as the year-long education audit, and there has been no further contact.

A total of 924 customers in the Chelmsford area were contacted via letter regarding the project. In order to decide which audit would be trialled on each customer an initial survey of the property took place. 164 initial audits took place and from these the following audit took place.

Retro fit audit – 20
Full audits – 19
Self audit packs delivered – 20
Childrens' packs delivered – 13
Year round education audit – 20
On off education audit – 20

The following table shows the average savings for each audit:

	No. of properties	Total saving for all props/day	Savings (l/prop/day)	% saving per prop day
Retro Fit	17	346.4	20.4	9.56%
Full	19	152.8	8.0	5.70%
Self	12	48.4	4.0	2.82%
Children	2	+17.2	+8.6	+3.60%
Year Long	19	128.6	6.8	3.91%
One off	17	92.3	5.1	4.18%
Combined (yearlong + one off)	36	220.9	6.1	4.02%

The retrofit audit was the most successful in terms of water savings. 20.38 litres per property per day equates to an average saving in total household consumption of 9.56%. Undertaking the other audits resulted in average savings ranging between 2.82 – 5.7%. The total daily saving for all properties involved in the project was 0.75 m3/day whilst the average saving per property per day was 5.94 l/prop/day.

Metered customers involved in the project had the opportunity to save water and therefore money. The annual financial savings per property based on the unit cost of water (2005/6 and 2006/7 meter tariffs) in our Essex area are shown below.

Audit type	Financial Saving
Retrofit	£6.03
Full	£2.38
Self	£1.19
One-off visit	£1.50
Year-long contact	£2.00

This project has also saved the company £14.33 per annum through the reduced supply of water and therefore the reduced demand on energy and chemicals for the plumbing and treatment processes.

Follow-up analysis of logger data revealed substantial savings in relation to all but one of the audit types.

Audit type	Average saving (l/prop/day)	% Saving	Cost of audit per property
Retrofit	20.38	9.56	£181.92
Full	8.04	5.7	£178.86
Self	4.03	2.82	£49.03
One-off visit	5.06	3.75	£67.50
Year-long educational	6.77	3.91	£67.50
Children's	+8.62	+3.6	£77.87

The sample numbers involved were necessarily quite small, so the Contractor was asked to price the cost of completing each type of project for 10,000 properties, to be more representative of potential roll-out costs.

The following table shows the unit cost per m3 assuming 10,000 of each audit are completed. The total costs used have been estimated based on the actual costs to complete this small trial project. The following table show the measured savings from year one.

Audit Type	Total water saved (Ml) (assuming 10,000 audits completed)	Total cost (£)	Unit cost per m3
Retrofit	74.39 Ml	£1,410,112.64	£18.96 /m3
Full	29.35 Ml	£1,117,844.17	£38.09 /m3
Self	14.7 Ml	£263,317.89	£17.91 /m3
One visits	18.45 Ml	£467,717.26	£25.35 /m3
Year long contact	24.71 Ml	£467,717.26	£18.93 /m3

An AISC was derived for each type of audit based on a larger scale project of completing 10,000 of each audit. For all audits an interest rate of 8% was assumed. The actual costs from this project were used to make informed decisions on the cost to complete 10,000 audits. The savings per property measured in this project have been assumed to remain the same for a larger project.

Audit Type	Water savings (l/prop/day)	Total cost (£)	AISC (pence/m3)
Retrofit	20.38	£1,410,112.64	2.616
Full	8.04	£1,117,844.17	5.256
Self	4.03	£263,317.89	2.469
One visits	5.06	£467,717.26	3.497
Year long contact	6.77	£467,717.26	2.612

One of the main objectives of this project was to examine the cost effectiveness of rolling out each type of audit. The three audits with the lowest unit cost per m3 were the retro fit, self and year long contact audits. Although the retrofit audit potentially saves the most water it is very expensive to carry out. The self audit is much cheaper but does not save as much water as the other audits. The emphasis with the self audit is on the customers carrying out the audit, this audit also aims to influence longer term behaviour changes which would not be picked up until the years following the audit. The year long audit is again a low-cost method of delivering audits and although the water saved was not insignificant; following up the audit with monthly contact is both time consuming and potentially expensive when targeting 10,000 customers. This project implies the best method of audit is one that combines retrofitting of devices, tips and ways customers can save water for themselves and continued contact into the future to help sustain the savings achieved with the initial audit.

This led to a major rethink concerning ESW's audit strategy. A new project design was needed which could combine the benefits of the retrofit and self audit approaches but also be innovative and effective in providing the products most suited to customers' needs. Previous evaluations of our "Full" audits (Moulsham, Hartismere, Burnham-on-Crouch, Silver End and Witham) had demonstrated the potential for a high cost per property in properties with low perpensity for the products to be fitted e.g. no garden, no dripping taps, an efficient WC. However, the range of products available had changed significantly since those earlier projects, although the requirement of many for high pressure water systems is a major restriction. After much evaluation a new approach was developed.

Water Saving Toolkit 2006/7

Rather than giving customers a standard pack of water saving products, it was desirable to allow the customer more choice on what they received, and to control costs by only giving away products which would be valued and used by the customer, and to promote a sense of value to the products. We therefore devised a scheme whereby customers were given a limit of 30 credits in which to 'spend' from a list of products allowing them to create their personal pack to suit their needs. Each product was assigned a credit rating. For example, a water butt kit was 15 credits whilst a Save-a-flush was 5 credits. The list of products included items that needed a plumber to fit (e.g. retrofit dual flush devices and mending dripping taps). Customers also had the choice of more educational products such as a children's activity pack or a digital shower timer to help encourage them to reduce the time they spend in the shower.

The recommended retail price was included as an indication of the "true" value of the products, although we subsequently learnt that for some customers this caused confusion and they were not clear that the project was free to customers. The products were described in a Toolkit pack, which also included a technical sheet to explain what products were limited by the plumbing system or pressure, and an application form.

Ewan Group (now Mouchel) was appointed to recruit the customers, deliver and install the products and collect consumption data. Prior to the project starting, the plumbers delivering the toolkits visited Hanningfield for a training day. The product suppliers were invited to provide technical training.

In October 2006, 5,378 customers in the North Chelmsford area of Essex were mailed to invite them to take part (Mouchel, 2007). A reply date was specified to promote early return of the application form and those not replying promptly were re-mailed with a reminder letter. The application form including the request for a telephone number and following receipt of the applications, customers were telephoned to make an appointment. During this call, various questions were asked to try to ensure suitability of the products. Depending on the products selected, either a pack of non-plumbing products was delivered by a field agent, or for plumbing devices an appointment was made for the plumber to call and fit the products. The plumbers carried spare products such that alternatives could be provided if a chosen item could not be fitted for any reason.

In total, 1,073 customers received devices; 650 of these needed a plumber to install devices. The remaining 423 visits involved the delivery of devices (e.g. shower timer and water butt) and the customer then completing the audit.

The area of supply was selected as there was a variety of ages and types of houses. North Chelmsford in Essex had a good mix of house ranging from those built over 100 years ago to brand new houses built in the last five years. We also hadn't delivered a targeted water efficiency message in this area before. The area was 57% metered, although all customers including unmeasured properties were invited to take part.

Following the completion of work, an information pack was left with the customer. The pack included further information to customers relating to refurbishing a bathroom, designing a garden and buying a washing machine, with water efficiency in mind. In addition to this there was a competition entry form to win a water efficient dishwasher. A customer satisfaction survey was also included for customers to fill out and return to ESW. 93 customers completed and returned the satisfaction survey, representing a return rate of 8.7%.

Question on Satisfaction Survey	Number of responses to question	Satisfaction
Was the information provided helpful?	92	98%
Were you happy with the telephone appointment service?	93	95%
Was the person that made the appointment courteous?	92	97%
Was the appointment kept and on time?	93	85%
Are you happy with the products you have received?	91	89%

In order to measure the savings from the Toolkit project 200 data loggers were installed on households to measure the change in consumption following the audit taking place. Meter readings were also taken on all externally metered properties before and after the audits were completed. Savings were attempted to be measured from unmeasured properties but it was not possible to identify any which had a pre-installed meter chamber and wished to take part in the project. For all other properties assumptions have been made regarding the savings achieved. Some of these savings are potential savings e.g. savings associated with water butts as these will not been seen until the summer. Others are based on measurements taken at each property. For example, flow rates were measured before and after a showerhead was fitted, and before and after a tap insert was fitted. The size of cistern was measured and dripping tap flow rates.

There were three different methods of calculating water savings:

- An indirect calculation of theoretical savings. Performed on a per property basis dependent on which products had been fitted and utilising the measurements taken by plumbers.
- A direct calculation taken from reading water meters to give actual water savings
- Direct interpretation of data collected by flow loggers

The table below shows a summary of the savings resulting from each method and the saving from combining all methods of calculation.

Method to calculate saving	**Non plumbing devices only (l/prop/day)**	**Plumbing devices (l/prop/day)**	**All properties (l/prop/day)**	**All properties (Ml/day)**
Theoretical	8.86	18.34	14.55	0.016
Meter readings	0.73	4.24	2.62	0.003
Logger data	6.95	15.79	12.57	0.013
Combined	7.21	18.27	13.85	0.015

As shown above, analysis of results provided three sets of data based on assumptions, meter reads and logger data. These datasets were combined to provide an overall saving.

In calculating the change in consumption for each property, it was decided that where logger data was available, this would be used first. The meter data was then used next where available. If neither logger nor meter data was available e.g. the case with all unmeasured properties, the theoretical saving based on assumptions was used.

Combining the datasets provided the average savings shown below.

	No. of properties	Saving (l/prop/day)	Study area Saving (Ml/day)
All properties	1,073	13.85	0.015
Properties with plumbing products	644	18.27	0.012
Properties with non-plumbing products	429	7.21	0.003

The total cost of the project equates to £146 per property that completed an audit. Our payment method was via a unit rate for the installation of each product, plus various additions such as project management. This was designed to encourage plumbers to fit products wherever possible. Performance targets were also set.

A cost benefit analysis was undertaken of the 19 products and services offered to customers through the Toolkits project. Products were also ranked by ease of delivery, cost/benefit, customer take-up and potential water saving. Using these rankings, the Save-a-flush, showerhead and water butt, were the most appropriate devices for use in full audit style water efficiency projects. The tap inserts, beaker and tap re-washering also scored highly. The least appropriate products to the project were the leak survey, shower flow bags, Ecosave and dripping taps.
It was concluded that overall, the choice of potential products and services had probably been unnecessarily wide and caused unwanted complexities for the Contractor.

Focus groups

Utilities Project Management Ltd (UPM) was commissioned by ESW to organise and run discussion groups aimed at researching the opinions of the customers that participated in the project (UPM, 2007a). The focus groups concentrated on similar issues to the follow-up questionnaire but provided the opportunity to promote discussion and therefore more detailed responses from the customers. The focus groups aimed to meet the following objectives by establishing:

- General satisfaction with the project
- The effectiveness of literature
- The need for incentives and why entries for the free dishwasher competition were limited
- Possible grouping of the products into a restricted set of choices
- Issues arising from products requested not being fitted
- Why customers have/have not participated
- Expectations/concerns
- Operation of the project

ESW and UPM agreed to run four focus groups with a maximum attendance of ten customers per meeting. In essence, customers were selected at random. However, a selection criteria was agreed to form the groupings where practical. This was done with the aim of allowing discussions to develop between customers in a 'similar' situation. The groups were formed using the following criteria; when the customer participated in the project (i.e. before or after Christmas 2007), whether the household was high or low occupancy (families/sharers and singles/couples respectively), and whether the customer had chosen plumbing products that required plumbing skills.

UPM were provided with a database with customer details and the necessary information to select the groups as described above. 280 customers were contacted by UPM via telephone to invite them to take part. To encourage participation, customers were recruited by overtly marketing a recognition payment of a £15 major high street store voucher.

42 customers agreed to attend the discussion groups. Four customers cancelled prior to the meeting. Of the remaining 38 customers, 24 attended on 30th May and 1st June 2007.

The findings, in summary were:

Participants – in general, all four groups were very satisfied with the intention, presentation and conduct of the project.

Introductory information pack - all but one participant has kept the introductory information pack for future reference. The pack was considered as motivational in causing those attending to respond. It was suggested that the 'free' aspect of the project needed to be emphasised more from the beginning. The point system was deemed successful and was easily understood. There was slight concern about the amount of paper and card used. Most thought that they had not received the follow-up information pack. It was suggested that the two packs are combined for future projects.

Incentives – the dishwasher was not considered necessary or a suitable prize. Many thought the initial offer of free products was enough of an incentive. The offer of a free water butt would be a very important element to get people to respond. Participants were unsure of the relevance of the dishwasher competition sheet. A washing machine would be a better prize. Or allowing the winner to have everything they wanted from the list of products.

Grouping of products – Participants did not want the products to be grouped and liked being able to exercise preferences.

Why customers participated – participants saw the project as a 'free', 'something for nothing' offer from ESW. Concern for the environment and the fact that a professional plumber would fit the devices.

Why customers may not have participated – two customers specifically chose products that would not affect their plumbing system.

Negative issues – the water butt delivery appeared to be the main concern. The time taken to deliver and the fact that it was not delivered at the time of visit was not satisfactory. Also, customers stated that they were not initially aware that there was catch involved.

Recommendations were made by UPM. The primary suggestion was to use a form of quality assessment to assess the level of service given by the plumbers. This should be performed throughout the duration of the project, either by visiting properties after a visit has been completed, or through carrying out telephone customer satisfaction spot checks. This would facilitate timely finding out about delivery of information and products, as well as customer care.

Follow up questionnaire

As well as the focus group ESW sent questionnaires to customers to find out what they thought of the Water Saving Toolkit (ESW, 2007b). The questionnaire aimed to meet the following objectives:

- To assess the customers' views on the products and services that they had fitted/carried out, and of those that were offered in the project.
- To assess the customers' views and opinions of the introductory information pack, and how the pack influenced their willingness to participate in the project.
- To establish whether customers would have preferred the products and services offered in groups, with the development of the next project in mind.
- To understand how participating customers' water use might have changed as a result of taking part in the project.

Of the 1,073 customers who took part in the project, 934 customers were sent a follow-up questionnaire. This represented 87%. Unfortunately, the questionnaire formatting tool (Access 2003) did not allow the inclusion of customers that requested only one product or service. Therefore, 139 customers did not receive a questionnaire. The questionnaires were mailed between 4th and 8th May 2007. An internal deadline of 15th June was set, allowing the customers six weeks to complete and return the questionnaires.
Every customer was asked the same 'general' questions. These focused on the introductory information pack, why they participated in the project, whether they would have preferred to have been offered groups of products, and their water use since having participated. Then, each customer was asked a range of questions depending on the specific products and services they received. These questions aimed to discover what customer thought about the products and services, whether they continued to use the devices, and if appropriate why the products were not being used. Where possible, the answers were factored into the calculations of the water savings achieved by undertaking the project.

The following points summarise the main findings from the follow-up research:

- 48.6% of customers completed and returned the questionnaire.
- 52% of customers took part in the project to save water.
- 94.1% of customers thought the introductory information pack provided about the 'right amount of information'.
- 84.6% of customers thought the range of products and services on offer in the project was large enough.
- When customers were asked whether they would have preferred the products and services offered in groups, 82.6% replied 'no'.
- Several customers would have preferred not to have been limited to one toilet device, or one water butt.

- 76.2% of customers thought that they now use less water having participated in the project.
- Only 59.5% of customers could remember having received the extra information pack at the end of the project.

Several recommendations could be made based on the result of the follow-up research. The following points provide a summary of the key recommendations made in the full report:

- Multiple products – remove the limitation of each household only being able to have one Dudley Turbo 88, Variflush or water butt.
- Introductory information pack – include more pictures, enhance the 'free' message so that it is clearer and condense the information so that less paper/card is used thereby boosting the environmental credentials of the project.
- Water butts – revise the delivery and fitting methodology associated with the water butt kit. Delivering the water butt at the time of audit and the plumber fitting the water butt would reduce customer dissatisfaction.
- Quality assessment – some form of plumber audit needs to take place to ensure that the plumbers are undertaking each aspect of their work to the highest quality and maintaining the level of service expected by customers.
- Additional products – including greywater recycling and car washing products to cover these areas of water use.

The follow-up questionnaire proved to be a successful tool in gauging the level of customer satisfaction and providing ESW with the recommended improvements required to improve the next project.

In addition to the evaluation described above, Atkins was commissioned to undertake further evaluation and statistical analysis of the results (Atkins, 2007b). A number of recommendations were made, including "taking a longer 'before and after' period to try to smooth out some of the variability in demand ('white noise') and increase the confidence in the overall savings."

Furthermore, ESW has monitored the sustainability of the project by looking at meter readings following the audits. Analysis has shown that the saving achieved immediately after the audits have been maintained, albeit at 6% less six months later.

There were many aspects of the Water Saving Toolkit project which we have felt has made it our most successful to date, but perhaps the one element from the Self Audits which was not carried forward so well was the emphasis on behavioural change. We hoped that the Toolkit brochure and the process of product selection went some way towards this, along with messages from the plumbers and follow-up literature.

H_2eco

H_2eco is another innovative progression in ESW's audit approach. It combines the best of the Water Savings Toolkit Project and the Thurrock self audits. It builds upon the lessons learnt from the evaluation of both these projects.

H_2eco is essentially a self-audit followed up by the (free) provision and fitting of products identified through the self audit process as wanted, applicable and appropriate.

The Water Saving Toolkit project has a huge success with customers but was complicated to deliver and many customers were left disappointed as the number of products they could have was limited. ESW also wanted to draw together water efficiency with other environmental messages.

ESW wanted to keep with the idea of customers being able to choose from a list of products, while still educating them about their water use. Similarly, the Company wanted to provide both products that need to be fitted and those that encourage behavioural changes.

The H_2eco project (phase 1) was based on the concept of customers working through the self audit process by completing a workbook. The workbook asked a series of questions about their property, their appliances, how they currently use water. The workbook also explained how they could use less in the future with the help of ESW's advice and a range of products. The aim was to help the cunstomer make informed decisions on which water efficiency products will suit them and their home. To accompany the workbook a five minute shower timer and a shower flow bag were sent. This enabled the customer to measure the flow rate of their shower to assess whether an aerated showerhead was suitable for their home.

The design of the information booklet was developed in a workshop between ESW and Mouchel using knowledge and experience taken from previous projects particularly the Water Savings Toolkits project (2007). As this project was to include the customer in the audit process, the questions were written in such a way that they were able to guide the customer through the audit process and enable the customer to provide correct and useful answers. The questions had to be very specific in the information that they were asking to establish the suitability of the products for each individual property. In this way the application for products combined suitability and customer choice.
The most functional way of doing this was to design the workbook in the style of a flow chart. By doing this the customer was visually led through the questions in each section, in an easy to follow manner. Arrows were used between questions to draw the customers' attention to the next relevant question and extra information was included around the questions to aid understanding of the question.

Photographic aids were also utilised throughout the information booklet again providing assistance for the customer. On previous audits this data was collected by technicians or plumbers but as H_2eco proposed to utilise the audit process to give the customer greater understanding of the project and its aims, the information booklet and workbook took the place of the technician or plumber.

The information included technical information on toilet types and other specifications required for each of the products provided and allowed the customer to make decisions about which products and services would be the most appropriate for their needs and therefore involve them in the process of saving water.

In a change to previous projects the quantity of products available to each customer was virtually unlimited. For example with the ecoBETA, if the customer stated that they had seven toilets then seven toilet products were made available to them. In cases where the product ordered was unsuitable, an alternative was offered, (if available). Where no alternative product was suitable advice was given to the customer on what action to take next. Where a choice of product was available to address one water use e.g. the ecoBETA and Save-a-flush for wcs, the workbook first offered the primary water saving product, then the alternative, then where neither if applicable, advice specific to that water use,

To minimise the effort required by the customer the workbook was designed so that once completed the customer could fold and seal it to be sent back as return address and pre paid postage were printed on the back page meaning no envelope was required, reducing waste and removing another potential obstacle to up take. However, if customers preferred they could call a dedicated local rate telephone number and place the order over the phone.

Mouchel was appointed to recruit the customers, deliver and install the products and collect consumption data. Prior to the project starting, the plumbers delivering the toolkits visited Hanningfield for a training day.

In December 2007, 7,524 customers in the Chelmsford area of Essex were invited to take part. Once they completed and returned the workbook they were telephoned to arrange a suitable appointment to deliver and install the products and devices.

The area of supply was selected as there was a variety of ages and types of houses. North West Chelmsford in Essex had a good mix of house ranging from those built over 100 years ago to brand new houses built in the last 5 years. Also we hadn’t delivered a targeted water efficiency message in this specific area before. The area was 61% metered, although all customers including unmeasured properties were invited to take part.

Customers could chose from the following list of products:

Products to be fitted	**Products to be delivered**
ecoBETA dual flush device	Children's detective pack
Save-a-flush	Bath measure
Tapmagic tap insert	Garden water saving crystals
Miracle tap adaptor for kitchen taps	Water butt
Re-washering dripping taps	Hose gun
Aerated showerhead	

Each customer also received an advice leaflet pack giving them further information on saving water and linking this to potential energy savings too.

The delivery of this project drew on the combined knowledge of both organisations in order to make improvements year on year, this project benefited from advances in:-

- Up to date reporting and monitoring enabling greater efficiency in the management of the project on a weekly basis.
- Literature sent to each customer including layout and content assisting the customer to complete the home audit more accurately by increasing their understanding about the products and services on offer. To ensure that waste products were kept to a minimum the application form and information booklet were reduced to A5 size and printed on recycled paper. The content was also refined and reduced to efficiently inform the customer without including unnecessary information which resulted in the use of less paper per application pack.
- Reduction in mileage, where possible by grouping plumber appointments and meter readings by post code.
- Service Level Agreements to control customer response times improving the overall service to the customer. Contacting customers within five days of returning their initial application either by telephone or letter ensured that they did not loose interest from extended periods without any contact regarding the project. Arranging appointments over a three month period also retained interest leaving each with a positive and educational experience.
- Tighter stock control from weekly monitoring of stock to provide an accurate schedule for re-ordering of appropriate quantities. Smarter database utilisation providing greater levels of automation reducing administrative time and reducing project costs

The project was delivered by Mouchel. 1,582 customers applied to take part, with the target being 1,500. In total, 1,495 customers ultimately participated in the project and had products delivered and/or installed representing a project take-up rate of 20%.

In order to measure the savings from the H_2eco project 193 data loggers were installed on households to measure the change in consumption following the audit taking place. Meter readings were also taken on all externally metered properties 3 weeks before and after the audits were completed. We attempted to measure savings from unmeasured properties but were unable to identify any which had a pre-installed meter chamber and wished to take part in the project.

Detailed flow rate measurements were also taken before after fitting aerated showerheads, tap inserts and the Miracle tap adaptor, providing a substantial dataset for the calculation of savings for unmeasured properties. Cistern measurements, including a water depth for the short and full flush associated with the ecoBETA were also collected to further advance this ‘measurement by proxy’ means of calculating water savings.

An average water saving of 30.55 litres per property per day was calculated based on using a combination of the three measurement techniques as detailed above.

Throughout the project, each plumber was completing between six-eight appointments per day – considerably higher than the number achieved by other industry projects.

The table below summarises the results from the project.

Key Result		
Total customers invited to participate	7,524	
Applications received	1,582 (21% of mailing)	
Metered vs. unmeasured	Of those that applied 62% were Metered (930) 38% were Unmeasured (565)	
Audits completed	1,495	
Product	**Quantity Fitted**	**Water saved L/property/day**
ecoBETA	903	48.3
Aerated shower head	301	36.8
Save-a-flush	524	13.8

Tap inserts	635	19.6
Kitchen tap insert	573	13.7
Tap re-washering	159	10.6
Bath measure	535	4.94
Shower Timer	1495	2.45
Water butt (standard)	985	1.90
Hose gun	1,026	1.51
Crystals	1,263	0.02
Children detective kit	684	Undetermined
Shower Flow Bag	1495	Undetermined
Savings		**30.55 l/prop/day**

Levels of customer satisfaction were determined through 2 approaches. UPM were commissioned by ESW to monitor customer satisfaction during the delivery of the audits. Unlike with previous projects, these surveys are being undertaken concurrently with the process. This means that there are no recall problems, customers not choosing to take part can be asked why, and generally, more valuable feedback can be gained and performance monitored. Each customer was also asked to complete a postal satisfaction survey. In addition, following completion of the project, two focus groups were arranged with the aim of providing an atmosphere whereby discussions about the project could be developed. 17 customers took part in the research. The focus groups showed that there was a high level of interest in reducing water usage and that the motivations were not purely financial, but linked to environmental concerns. Several constructive criticisms came from the research.

We also showed customers draft copies of the new leaflets to gather their views. They provided some very valuable feedback which was included in the final version. These focus groups were a great opportunity to work with our customers to help develop and improve our approach to promoting water efficiency.

Phase 2

Phase 2 of the H_2eco project represented a natural progression from Phase 1 with alterations made based on the feedback from customers (through the satisfaction surveys, through UPM's findings and through the focus groups) and through recommendations made by Mouchel within the project report. The basis of the project was to remain the same as for Phase 1, but taking into account the following comments/suggestions:

- The workbook and information leaflet used in Phase 1 were combined to produce a shorter and more succinct workbook. Customers in the focus groups suggested that a 'shorter leaflet which concentrates on just the key points should be considered…making the information more accessible and using less paper', should be used. The combined workbooks were printed on uncoated and thinner paper, which along with being printed on environmentally friendly paper and using vegetable-based inks, enhanced the environmental credentials of the project.

- The number of images included in the workbook was increased. The relevancy of the illustrations was also reviewed in view of comments made by customers in the focus groups.
- The messages about the project being 'free' were reviewed to ensure that customers did not think that there were any catch's involved in taking part.
- Meter reads and logger installations/removals were carried 22 days (21 days in Phase 1) before and after the audit date to ensure that there was a minimum of 3 weeks worth of data available for analysis.
- Sending the shower timers within the initial mailing for Phase 1 caused problems with Royal Mail. There were also several occurrences where the letters were not delivered due to not fitting through letterboxes. It was decided that the shower timers would be delivered to customers during the audit.

In May 2008, 7,306 customers in a different area of Chelmsford were mailed and invited to take part in the project. 1,439 customers took part in the project having water-saving products delivered and/or installed, representing a return rate of 20%. The same method of calculating the savings was used as described in Phase 1(meter reads taken at all externally metered properties, 200 loggers installed and measurement by proxy). All participating properties saved on average 17.38 litres per property per day.

The table below shows the number of products installed through delivering the project:

Product	**Number delivered and/or installed**
ecoBETA	370
Save-a-flush	427
Aerated showerhead	169
Tap inserts	209
Miracle Tap Adaptor	314
Tap re-washering service	121
Bath measure	578
Water butt	1094
Water saving crystals	1168
Hose gun	991
Children's activity pack	756
Shower flow bags	7306
Shower timers	1439

Both Phase 1 and Phase 2 were deemed great successes by the customers and the results/recommendations have been taken forward to influence the Phase 3 trial currently being carried out.

Phase 3 trial

Phase 3 of H_2eco, a smaller project aimed at trialling a new approach before carrying out a large-scale Phase 4 in the summer, is currently being undertaken. The trial will provide an opportunity to test the most recent developments in the way we deliver our home survey projects.

2,492 customers in Great Baddow and Galleywood were mailed an introductory letter explaining the project at the end of January 2009. We aim to completed 250 audits. The customer will be required to respond to the letter by telephoning a dedicated project hotline to request an H_2eco survey pack. The pack, which will include the H_2eco survey booklet, a pen, shower flow bag, dripping tap gauge, tape measure and tea towel, aims to take the customer around the home and garden to show where water is being used.

The project will differ to Phase 1 and 2 in that it requires the customer to undertake a detailed home survey in order to be eligible for water saving products to be fitted. Upon completion and return of the survey book, the customer will be sent a personalised 'Water Savers Report' detailing the following:

- what products are suitable for their home based on the customers' answers provided in the survey,
- how much water they are currently using and a comparison against an average user,
- the monetary value of the products that they could potentially have fitted,
- the potential water savings that the customer could see if the products suggested by ESW can be fitted.

Following sending the Water Savers Report, the customer will be telephoned to arrange a suitable time for a plumber to visit the property and fit the water-saving products free of charge.

This innovative approach will provide a number of benefits. It will allow the plumber to encourage the customer to have more products fitted. An area of concern in previous projects has been that customers are put off having products such as the ecoBETA and the tap inserts fitted due to the need to involve plumbing system changes. This new approach will allow the plumber to demonstrate the devices to the customer and discuss any concerns, ultimately increasing the number of products we can fit whilst visiting. The new approach will also emphasise the self-audit side of the project fully.

Through Phase 1 and 2, it was felt that many customers used the survey forms as a 'shopping list', essentially ticking the products they wanted and not completing the entire form. This meant that the educational side of the project was being lost slightly. This approach and the requirement of more information/measurements from the customer will emphasise the educational side of the project further.

The delivery of this trial project will be completed by the end of March 2009.

5.1.5. Modelling water audit savings

In 2001 ESW commissioned Tynemarch Systems Engineering (2002) to develop a model for household audits, to predict the decay in savings over time on a component basis. This was calibrated during development using data from three audit projects. During 2006-7 ESW extended the model to include the savings from every audit completed between 1997 and 2006. The model is used to determine the sustainability of savings associated with audit projects.

The model involves parameters which have been calibrated using data collected during the projects. The calibration has been reviewed using additional data. Thus, some of the values selected by Tynemarch have now been reset, as later surveys relating to the early projects have provided estimates of the parameters. The forecasts of savings have been combined to demonstrate the ongoing impact and the economics of each of the audit projects has been evaluated by linking to an AISC model.

Properties provided with self audit packs in Southend in 2001 were revisited with data loggers fitted to their meters this year. The data was compared with that collected in 2001 to validate the forecasts of water savings. Although the model was developed for the very reason that monitoring the sustainability of many of the measures is difficult and uncertain from flow measurements the analysis has demonstrated that the model forecasts are reasonable.

5.1.6. Retrofit Projects

Retrofitting of variable flush devices to existing toilets

In 2003/4 the Company participated in a project with eight other water companies and the Environment Agency aimed at evaluating the costs and benefits of retrofitting dual flush mechanisms in toilets. This follows on from the successful project carried out by the Company in association with BRE (BRE, 2003). Instead of changing the entire WC, as previously, the current project is aimed at considering the benefits that can be achieved through changing the flushing mechanism only, in order to see if this is a simpler yet efficient solution.

The aim was for all companies to install data loggers and monitor consumption for the same time period prior to fitting the mechanisms and for a set period after fitting. The Company recruited 30 properties and installed a total of 50 devices. Data analysed has occurred on both a company specific level and looking at the combined data for all companies. Using the combined data set from all companies the average saving on total consumption was 8.5% or 20.75 l/property/day (sample size = 136 properties). These figures were based on daily average water consumption and a comparison between before and after averages. For ESW data set only a saving of 7.6% was seen (ESW, 2007c). From this analysis it could not be concluded that any change in consumption was solely due to the change in toilet device. However, as flow rates were recorded at every 15-minute period, analysis of the lower flows associated with toilet flushing (3 –15 litres) were undertaken. By comparing the frequency of lower flows a more certain conclusion could be made concerning the actual amount of water saved due to the installation of the dual flush device.
Following installation, an average water saving of 4.3% per property was found. Feedback questionnaires were sent to each customer to gather their views and opinions of the devices and how well they felt they worked. Very positive feedback was received. A focus group was held with seven households in order to understand in more depth their views. The main conclusions were that the participants considered the need to conserve water in the region as very important and that the devices were a suitable method of saving water. With respect to the devices, it was suggested that a range of colours and designs be available and that a more detailed survey of the toilets be completed beforehand to ensure that the devices are not installed on malfunctioning toilets. The focus group provided many useful comments and suggestions for future work.

A further follow-up questionnaire was sent to the participants later in 2004, with the aim of establishing the robustness and effectiveness of the devices with time. Seven of the 26 properties that replied had removed their device/s either because they were unhappy or because they had their bathrooms refitted. Aside from these, only five had experienced reliability problems whilst the 81% stated that they would buy a dual flush cistern in the future.

Our 2005 analysis covered consumptions until August 2005. This provided a substantial amount of information over an 18 month period, and specifically for the same six-week period in 2005. Unfortunately, due to logger failure and property vacancy, the sample size was reduced from 26 properties in 2004 to seven in 2005. Analysis of the same six-week period revealed continuing savings of 0.41% compared with those in 2004. Although there were continued savings they had significantly reduced, although this was based on a very small sample.

In 2006, two years after the devices had been fitted; the savings were still evident at 4.4%, thereby showing positive long-term results. To date, nine of the 30 customers have removed the devices for varying reasons (primarily due to replacing bathroom suites). In May 2006, follow-up informal interviews/discussions took place with the customers. Ten customers agreed to take part. The informal interviews provided in-depth views concerning opinions and behavioural patterns. It became obvious that a large proportion of customers did not use the devices to their full potential and simply used the one setting they found most suitable. It was obvious that customer tended to get set into a routine and needed a reminder of how to use the devices correctly.

Monitoring and analysis continued over the same six-week periods (19th Feb to 1st April) in 2007 and 2008. Again, analysis of the 2008 data showed continued long-term savings in toilet flushing consumption of 6.6% per property.

To assess the savings robustly, it was important to establish whether the devices were still fitted and being used within the participating properties. Similarly, it was important to ascertain whether the occupancy had changed. In order to do this, a telephone call was made to each customer. The telephone calls were made on 9th July 2007. No contact was made with several customers. A second telephone contact was attempted on the 10th July. Six customers were contacted. The remaining ten customers were sent a short questionnaire in July 2007. Seven customers returned their questionnaires.

By 2008. 11 properties have removed their device/s since the initial project in 2004. The table below provides an insight as to why the devices have been removed.

Reason for removal	No. props
Device broken/faulty/unreliable	1
Changed toilet/new bathroom suite	4
Wasn't happy with device (performance of visual aesthetics)	2
Unknown	4

It can be seen that four customers removed their devices in line with installing new bathrooms suites and dual-flush toilets being installed. Three of the customers stated when the devices removed; December 2004, December 2005 and November 2006 respectively. The variation in time since the initial project does not indicate any problem with the devices, but rather the 'natural' rate at which customers replace toilets/bathrooms.

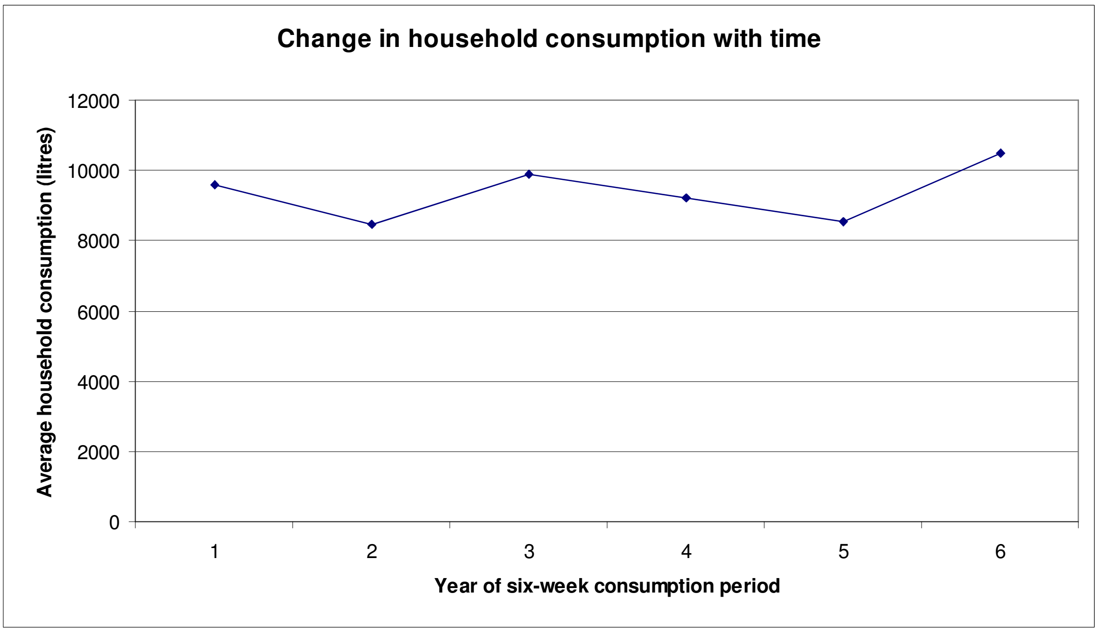
In 2006, ten customers participated in an informal interview/discussion form of follow-up research. An interesting point resulting from the discussions concerned an obvious degradation of the robustness of devices after extensive use in one property (687450). Three Variflush devices were installed in 2004. After two years, two of the devices were showing signs of breakage and wear and tear. The family of four used one of the devices consistently; this device was failing on a regular basis.

All three of the devices were removed and replaced with new Variflush devices in February 2007. The devices were replaced with the aim of assessing whether installing the new devices would result in toilet flushing consumption reducing. Unfortunately, the logger and meter reliability check showed a variation greater than +/- 5%. Therefore, the 2007 six-week period consumption and the control period consumption could not be compared.

Total household consumption was derived from the 15-minute logger download data. By looking only at the eight properties with data suitable for analysis in 2008, it was possible to assess how their household consumption had changed with time.

The total consumption of all eight properties in the 2004 control period was 76.9m^3. The following six weeks (2004) showed an 11.8% reduction to 67.8m^3. In 2008, the same eight properties consumed 84.0m^3, showing an increase in total household consumption of 9.3%.

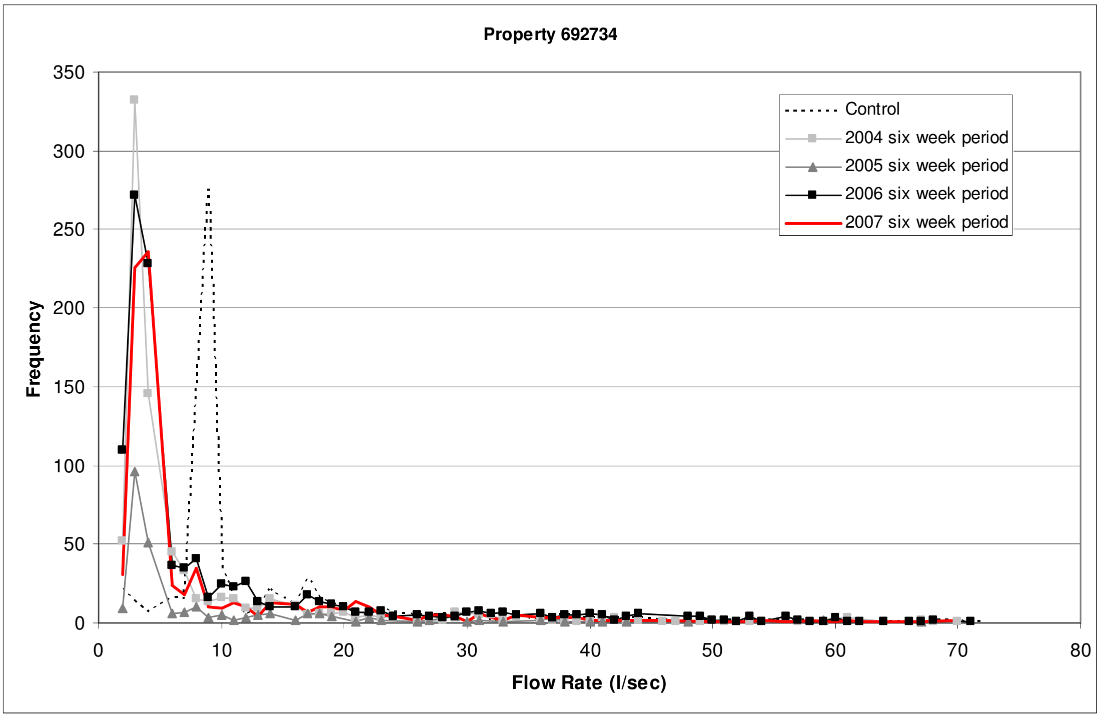
Analysing the average household consumption of the nine properties over the six-week periods reveals the change in consumption showed in the figure below.



Analysing total household consumption is not the most reliable method of establishing the effects of retrofitting the toilets. Factors such as affluence, changes in water using appliances and weather may influence the total household consumption and could potentially mask the effects of the toilet retrofit device.

Therefore, it is important to look at the water consumption attributed to toilet flushing.

The 15-minute consumption data for each property was displayed using a frequency curve to allow identification of the toilet flushing peaks. The graph below provides an example of the frequency curve for property 692734. When displayed graphically, it is easy to define the 'previous' toilet flushing volume at 9 litres for the control period and the 'after' flushing volume remaining at 3/4 litres for the 2004, 2005, 2006, 2007 and 2008 six-week periods.



Using the graphs, it was possible to derive the toilet flushing consumption. Multiplying the number of events by the volume at the peak provided the consumption of water used by toilet over the six-week period. The points either side of the peak were also included in the calculations to include the toilet flushes that straddled the 15-minute periods.

Performing the above analysis revealed toilet flushing consumptions as shown in the following table.

Six-week monitoring period	Consumption (litres)
2004 control	4004
2004	1580
2005	492
2006	2056
2007	1766
2008	1930

The above analysis was carried out for all eight properties. Frequency curves were compiled of each individual property and the toilet flushing consumption was calculated from these curves.

FOLLOW-UP 2008

	Control Period			2004		2008		Savings 2008		
Property No	No Events	Total (litres)	Total Household Consumption (litres)	No Events	Total (litres)	No Events	Total (litres)	Difference between 'baseline' and '2006' (l)	(l/hd/day)	15 min data (%)
684745	67	472	1452	69	439	55	488	16	0.4	1.1%
684775	202	1814	4490	179	1380	131	1044	-770	-18.3	-17.1%
688359	238	1913	8324	247	1354	242	1469	-444	-10.6	-5.3%
688377	230	2075	26012	226	1775	244	1738	-337	-8.0	-1.3%
698651	51	600	2034	46	343	40	320	-280	-6.7	-13.8%
689842	208	1920	7536	113	1045	181	1665	-255	-6.1	-3.4%
692851	151	1359	4191	182	1187	162	878	-481	-11.5	-11.5%
687685	260	2374	22847	171	1236	287	2082	-292	-7.0	-1.3%
								Average	-8.5	-6.6%

As can be seen in the above table, the average saving four years after fitting the toilet retrofit devices was 6.6%, or 8.5 litres per property per day.

The table below shows how the savings have changed with time since installing the devices.

Six-week monitoring period	Sample size	Average saving	Av. saving (l/pr/day)
2005	12	3.3%	4.4
2006	5	4.4%	9.9
2007	11	6.1%	12.7
2008	11	6.6%	8.5

The table below shows how the savings have changed with time since installing the devices.

Six-week monitoring period	Sample size	Average saving	Av. saving (l/pr/day)
2004	28	4.3%	*
2005	12	3.3%	4.4
2006	5	4.4%	9.9
2007	11	6.1%	12.7
2008	11	606%	8.5

* Note: the 4.3% saving in 2004 equated to a saving of 1.5 litres per flush

Two properties (688359 and 688377) told ESW that they had removed one of their two devices due to the device being faulty and a new bathroom having been fitted respectively. Removing these properties from analysis revealed an increase in the average savings reported above to 6.5%.

The short questionnaire asked the customers whether there had been a change in occupancy in the last year. Seven customers returned their questionnaire (see section 5) and none reported a change in occupancy.

Similarly, when telephoned, the customer was asked whether there had been a change in occupancy. Six customers were contacted by this method and none reported a change in occupancy.

Analysis of the 2008 six week period consumption data revealed that the 4.3% savings noticed in the initial 2004 project had continued, and actually increased, at 6.6%. The 6.6% saving in 2008 equates to an average of 8.5 litres per property per day. Below is a summary of how the savings in toilet flushing consumption (both total household and toilet flushing) has changed with time.

2004

8.5% Savings in total consumption - Environment Agency (136 Properties)

7.9% Savings in total consumption – ESW (26 Properties)
(was 8.1% when not including properties with no change in peaks)

4.3% Savings in toilet flushing consumption – ESW (26 Properties)
(was 6.7% when not including properties with no change in peaks)

↓

2005

5.0% Savings in total consumption – ESW (12 Properties)
(the 2004 average saving for the same 12 properties was 11%)

3.3% Savings in toilet flushing consumption – ESW (13 Properties)
(the 2004 average saving for the same 13 properties was 5%)

↓

2006

17.2% Increase in total consumption – ESW (5 Properties)
(the 2004 average for the same 5 properties showed a 16.2% saving)

4.4% Savings in toilet flushing consumption – ESW (5 Properties)
(the 2004 average saving for the same 5 properties was 7.6%)

↓

2007

13.1% Reduction in total consumption – ESW (11 Properties)
(the 2004 average for the same 11 properties showed a 14.6% saving)

6.1% Savings in toilet flushing consumption – ESW (11 Properties)
(the 2004 average saving for the same 5 properties was 7.9%)

↓

2008

3.2% decrease in total consumption – ESW (8 Properties)
(the 2004 average for the same 8 properties showed a 3.2% saving)

6.6% Savings in toilet flushing consumption – ESW (8 Properties)
(the 2004 savings for the same 8 properties was 6.6%)

EcoBETA

In September 2006 Essex & Suffolk Water were given the opportunity to trial a dual flush retrofit device designed by a Danish company called ecoBETA. The device (called ecoBETA dual flush) transforms a standard siphon single flush toilet into a dual flush toilet.

A total of 37 ecoBETA dual flush devices were installed in 15 households in Suffolk. The water consumption of each household participating in the trial was monitored throughout the course of the project (ESW, 2006a).

There were a few households which had been selected to have an ecoBETA device installed but the device was unable to be installed because of problems with the toilets. One of the reasons why the device could not be installed was because the toilet cistern was too narrow. Since this trial the ecoBETA dual flush device has been designed to allow it to be installed in narrower cisterns.

Customer follow up questionnaires were sent to all who took part. This questionnaire asked a range of questions about the device. The questionnaire also gave the opportunity to find out if there was any reason (other than the device being installed) why the households' water consumption may have changed over the last few weeks. Very positive feedback was received with 100% of customers left happy with the device and saying they would recommend it to others.

Consumption from each property was monitored using logger and meter data for a period before and after the devices were installed. From this data an average per property per day saving of 35 litres was recorded.

With such a high saving, it was appropriate that we undertake a larger project to confirm that these results were repeatable.

Chelmsford ecoBETA

Following a successful trial of the ecoBETA dual flush device carried out in Suffolk in October 2006, it was decided to roll out the offer of the device to customers living in the Chelmsford area of Essex. As well as installing the dual flush device for customers we wanted them to also think about their overall water use so we also delivered a self audit packs at the same time as the retrofit. This way, the customers would receive a lasting technology change as well as being encouraged to assess how they use water and make changes to their behaviour.

In April 2007, 4,878 customers were sent a letter and questionnaire inviting them to take part. The questionnaire aimed to gather information about the property and toilets. This enabled us to assess the suitability of the device before visiting the property. 910 customers applied; a take up rate of 18.7%. Of these, 9% were not suitable for the retrofit and so received an audit pack in the post. The remaining customers were called to arrange an appointment to install the devices.

The project was managed by Mouchel who arranged the appointments and visited the properties to install the devices. 553 customers had devices installed between April and July 2007, with a total of 1,010 ecoBETA devices fitted as part of the project. Each customer also received their self audit pack. 187 customers completed and returned the self audit form.

To calculate the savings achieved, meter readings were taken at all metered properties three weeks before the ecoBETAs were installed. A reading was also taken on the day the visit was made and again three weeks later. The water savings were calculated by looking at the consumption before and after the devices were installed. 42 properties also had data loggers installed to gather more detailed consumptions. Combining all the data collected gave an overall saving of 31 litres/property/day.

During August, each customer who had a device installed was sent a questionnaire to gather their views on the project. We also took this opportunity to thank them for taking part. 346 customers have returned the questionnaire. This has provided useful feedback to guide future projects.

In November 2008, 140 customers took part in a follow-up research programme aimed at investigating how the ecoBETA devices worked a year following installation. A plumber visited each participant and carried out a thorough inspection of the ecoBETA's installed within the property. These inspections were carried out in order to ascertain whether the devices were working correctly and whether any alterations were required. Customers were also asked a series of simple questions aimed at establishing their views on the device/s having used it for over a year.

Detailed flush volume measurements were also collected during the visit. An innovative method was devised in order to collect these measurements which involved the plumber measuring the exact volume of water required for both flush settings. These visits also provided the opportunity to measure the depth of water left in the cistern after a full flush – a measurement that will provide an insight into the effectiveness of cistern displacement devices.

The results of this project, including the customers' views, the functionality of the devices and the flush volume measurements are currently being analysed.

Domestic Water Savings Project 2005/6

A small pilot project was run to test the potential water savings in domestic properties following the installation of water efficient products supplied by

Pure World Technologies (ESW, 2006b). The devices tested were tap aerators (installed on both kitchen and bathroom taps), water efficient showerheads and save-a-flush bags. A total of 50 customers were contacted via letter asking for their participation in the project. Unfortunately only ten of these customers agreed to trial the devices. The main reasons for the low uptake were due to problems contacting customers and reluctance of customers to change the appliances currently installed in their house. The table below shows the total number of devices installed.

Device	Number installed
Tap aerator	2
Shower head	9
Save – a- flush	9

The majority of the properties, which were willing to take part in the project, could not have the tap aerators installed, as they did not fit the taps, which was surprising as they were marketed as being able to fit most modern taps.

The results from this project were disappointing with only three properties showing possible water savings. However, due to the variation in water consumption shown by the control houses is was hard to conclude whether these properties had actually saved water because of the devices installed.

Effects on water use through increased customer contact 2005/6

With the number of customers paying by a measured charge increasing it is important to know what affects customers total water consumption and ways this can be decreased. Measured customers receive a bill on a six monthly cycle based on their consumption for that period. Unless customers opt to read their water meter on a regular basis their bill is the only time they will receive information about the volume of water they use. With the majority of customers paying by direct debit most customers rarely study their bills to see how much water they have used.

5.1.7. Other Projects

Showers

In 2005/6 Per Capita Solutions Ltd undertook research into customer usage of showers and the types of plumbing systems used with particular showers (Per Capita Solutions, 2006). A sample of 328 random customers across our Essex supply area was taken and doorstep interviews took place. Detailed information was gathered regarding the number of showers within households, which are used most frequently, which showers are used in conjunction with which plumbing systems, the number of shower taken per person per week and the reasons why the showers were chosen. An average flow rate of 6.5 litres per minute was also established from 175 properties.

82% of the surveyed properties had one shower, 16% had two, 1% had three and less than 1% had more than three. Half of the detached houses have two showers or more. Other property types are dominated by only one shower. 94% of all showers are used and 65% of respondents had fitted the showers themselves. 23% of showers were power showers and these are the most common in en-suite bathrooms, whereas 90% of electric showers are installed in main bathrooms and account for 32% of all showers. Flow rate and price were cited as the most important factors in the choice of a shower. Only 6% of installed showers have “environmental” or “water efficient” settings and 68% of these were installed in unmeasured properties. 84% said that in general they prefer to take a shower rather than a bath and 19% said they change their bathing habits to showers in the summer.

Water wise meter readings project 2006/7

A project took place with customers in the Chancellor Park area of Chelmsford, Essex informing them on a monthly basis of how much water they use (ESW, 2006c).

The project objectives were:

- To increase customers' awareness of how much water their household uses.
- To help customers understand how much water they use in relation to other households of a similar size.
- To increase customers' awareness of how much water various appliances in the home use.
- To determine whether customers reduce their water consumption because they are aware of how much water they use.
- To determine whether it is worthwhile including additional information on customers' water bills to help them understand how much water their household uses.

Households were recruited from three roads in a relatively new housing estate in Chelmsford. At the beginning of October 2005 the households were sent a letter inviting them to participate in the project. If they wished to participate they were required to complete a short questionnaire, which asked for some information about the people living in their house.

In total 43 households participated, they each had their water use monitored throughout the one year course of the project. To monitor the households' water use meter readings were taken at four week intervals.

The households received information about their household's water consumption on a regular basis in the form of personalised letters. They were told how much water their household used and from this their daily water consumption was calculated. Additional information was also given to the household help understanding of their water consumption. Their consumptions were additionally presented in different formats such as graphs comparing the last month with their initial consumption, and the change in consumption. Most successful was their change in consumption compared with the household that had shown the greatest reduction.

At the end of the year, the results showed that on average a saving of 22 litres per property per day was achieved by giving customers information on how much water their household uses. A customer feedback questionnaire sent to participating customers at the end of the project, gave a positive response about the project and the majority found the project very useful.

Home Mover's Scheme

The Home mover's scheme was implemented as a ten week trial between January and March 2008. The aim was to provide customers with water efficiency advice and information as well as informing them of where they can purchase water efficiency product for their home, at a time when they are open to making simple changes in their lifestyle.

A letter was sent to each customer moving into their new home four weeks after having been notified of their move. Enclosed with the letter was a voucher that could be spent by the customer on water-saving products at a co-branded arm of the Water Group Promotion website. £5 vouchers were offered for the first half of the trial. This was increased to £10 for the second half of the trial. Also enclosed with each letter was a 5-minute shower timer and a Using Water Wisely information leaflets.

The project resulted in 55 customers purchasing a variety of water-saving products (ranging from water storing crystals to a car wash kit). The trial resulted in total water savings of 13.71 m^3/day, largely as a result of the shower timers included within the mailing. Those properties that went on to purchase products saved on average 9.60 l/prop/day.

Following the trial, follow-up questionnaires have been sent to all customers that did not use the voucher to purchase water-saving products. The aim of doing so is to provide the background information required to make improvements to the scheme for rolling out on a permanent basis. The results are currently being analysed, but interim analysis shows that increasing the voucher value to £20 and increasing the range of products on offer would encourage more people to spend the voucher.

5.1.8. Research projects

Identiflow

Working jointly with WRc the company has used Identiflow to gather a baseline consumption of new properties during February and March 2006 (WRc, 2006a). Consumptions were recorded at 1-second intervals and as low as 0.01litre per second. 22 domestic metered properties were monitored for 28 days with the aim of having twenty properties each with 14 days of suitable data. WRc were successful in collecting the required consumption information from the twenty properties. The properties were selected, using Acorn profiles, to best represent the type of housing to be built in the Thames Gateway.

The results included the following observations:

- The range of values for personal bathing is very large (10-280 l/d)
- There were some extreme values for internal tap use (10 and 132 l/d) and for toilets (6 and 142 l/d)
- One property had a very low daily total of 35 l
- Three properties had nearly continuous low flow each day of 40-90 l/d (these are to be investigated)
- One property had no washing machine usage over the two weeks
- There were two properties with an average toilet use between once and twice a day.
- One washing machine consumed 192 l/ per cycle.
- Of the 20 properties, 17 produced an average flush volume of more than 6 litres and nine of these were more than 8 litres.

These results suggested that new homes are not as efficient as widely believed and that the benefits of lower flush toilets are not being fully realised.

Water Efficient New Homes– Phase 2

In 1997 the Company began a project (Water Efficient New Homes–phase 1) with the Building Research Establishment (BRE) involving a small development of new Housing Association homes in Heybridge, Essex. 12 homes were fitted with water efficient appliances and point of use metering was installed in these and in 12 control homes to allow potential water savings to be measured. This phase of the Heybridge project demonstrated that water savings of 5% per person could be achieved by the fitting of water efficient appliances (BRE, 2000).

In January 2006 Phase 2 of the Heybridge project started. This phase aims to provide the opportunity to look in more depth at the social dimensions of the savings achieved in phase 1 of the project and to develop strategies for further water efficiency measures, while learning about the broader implications for promoting water efficiency.

Since 1998 data loggers have been collecting water consumption data from the external water meters of each property. This data provides a good baseline for phase 2 of the project. In February 2006 work began on the point-of-use meters to ensure they were all working correctly. Weekly monitoring of these meters will occur throughout the project.

In 2006 we commissioned two projects involving the 12 water efficient and 12 control homes. The first involved re-surveying the homes to identify what changes in water fittings may have taken place, and to decommission the internal meters and data collection system.

The second, started in February 2006 and involved the University of Bradford Pennine Water Group and Lancaster University Centre for Sustainable Water Management, who were invited to carry out a study to investigate how and why customers use water in the home and garden and how customers interact with water efficient devices.

The objectives of this 2006 study were:

- To collect and analyse qualitative data concerning participants' accounts of their water practices, examining patterns and variations between household members and between different households;
- To collect and analyse data concerning participants' perceptions of opportunities and barriers to changing their water use practices to be more water efficient, again examining patterns and variations in these accounts;
- On the basis of the data collected, to identify possible entry points to encourage greater water savings; and
- After a further period of monitoring to establish any changes in consumption, we will then provide some water saving devices and monitor and evaluate.

The researchers undertook in-depth qualitative interviews in order to analyse patterns and variability in householders' accounts of water practices (Knamiller *et al.*, 2006). Only 19 of the houses were willing to participate in the project.

The interviews were in three sections. The interviews began with word association. This was followed by questions, which were designed to enable us to understand the meaning of different practices e.g. why people use a shower. This part of the interview used the point-of-use water consumption data, which had previously been collected. Finally the interview involved reflection with the householder about their attitudes to water savings and the ways they think their household could improve on water consumption.

A number of patterns in everyday practices of using water were identified. For example, showering happens in the morning whereas there may be showering or bathing in the evening; two washes a day is common for adults and teenagers; young children have baths rather than showers; single parents with young children often bath in the evening.

Variation in everyday water usage was also examined. It was found that households may undertake the same water using activities and yet the way in which they do the activity, and the reasons for it, can differ widely. The interviews identified the variation across different micro-components. For example, in relation to clothes washing variations included frequency, method of washing and reason for washing.

The interviews found a lack of awareness and knowledge associated with water use. Many people were unsure of the equipment in their home or the water consumption of each item.

The results collected from the interviews are both illuminating and frustrating. They are illuminating in so far as they have demonstrated the rich diversity of ways in which water is use is situated within the context of householders' everyday lives. This goes some way to explaining why the introduction of water efficient technologies into domestic settings does not result in an equivalent decline in water use as found in laboratory type experiments. The frustration emerges in so far as there is no clear cut implication of these findings for how water savings should be developed in Heybridge, nor water saving campaigns more generally.

Analysis of the recent water consumption data has demonstrated that the original 5% difference between the water efficient and control houses has now become no difference (ESW, 2008b). Consumptions have increased by an average 4% per annum – well above the expected rate. This demonstrates clearly that fitting water efficient appliances in new homes needs to be supported by ongoing information and by behavioural change, with mechanisms in place to ensure that any replacement plumbing will also be water efficient, if the benefits are to be maintained. Only three of the homes had seen changes in tenancy and the maintenance level of the water efficient fittings has been higher than normal levels. Some fittings particularly taps had been replaced and many of the homes have fitted outside taps. There was also some evidence of a lack of awareness that the toilets are dual flush (some have handles not the more common buttons).

These findings are particularly of concern to us in relation to the assumption of sustained savings arising from the Code for Sustainable Homes.

CIRIA RP647 Key Performance Indicators and Benchmarking for Water Use in Buildings

CIRIA completed research into establishing water key performance indicators and benchmarks for offices and hotels in 2005 (CIRIA, 2006). The project resulted in a methodology report and an accompanying guidance report for property owners and managers.

The report provides a basis whereby property managers, owners and operators can compare their water use performance with other similar buildings. After identifying the apparent lack of suitable benchmarking information, the project aimed to provide national trends, against which the water consumption of particular buildings could be compared. The report would be of fundamental importance to property managers and owners, but also to water companies and regulators through which company specific benchmarks can be developed. A KPI (Key Performance Indicator) is the measure of performance associated with an activity or process. A Benchmark is a level of performance achieved for a specific business process or activity.

The distinction between the two is that the KPI is the actual measure of performance, whereas the benchmark is a target performance.

The project looked specifically at hotels and offices. The hotels were categorised depending on whether they had swimming pools or not and were regarded as being operational for 365 days per annum. The water consumption in offices was represented by employee and by floor space. 253 days was regarded as the number of working days per annum. It was apparent that the presence of a swimming pool has a marked influence on the water consumption of a hotel. The presence of a pool significantly increased the water consumption on all occasions. In order to provide appropriate guidance to the office sector, it would be most useful to provide the 'typical benchmark' only, with the aim of encouraging facility managers to aim for a lower figure than this.

An accompanying report provided a simple guide for the use of property owners or managers. Guidance is also provided about how to improve water consumption to reduce water and sewerage bills, and provides signposts for more detailed advice.

The consequent recommended benchmarks are as follows: (Hotels shown in table above, and offices in table below).

Category	Hotel Rating	Swimming Pool	No. Hotels In Category	Benchmarks (m3/bedspace/annum)		
				Best Practice	Typical	Above average
Cat 1	1 Star	Yes	0	None		
Cat 1	1 Star	No	7	4	8.5	15
Cat 2	2 or 3 Star	Yes	18	25	55	183
Cat 2	2 or 3 Star	No	94	10	22	48
Cat 3	4 or 5 Star	Yes	8	65	130	222
Cat 3	4 or 5 Star	No	56	15	31	66
Other	No Rating	Yes	11	45	89	169
Other	No Rating	No	85	12	29	72

		Cubic metres per year	Litres per day
Typical Use	By Employee	4.0 m3/employee/annum	15.0 litres/employee/day
	By Area	0.6 m3/m2/annum	2.3 litres/m2/day
Best Practice Use	By Employee	2.0 m3/employee/annum	7.7 litres/employee/day
	By Area	0.4 m3/m2/annum	1.5 litres/m2/day
Excessive Use	By Employee	7.0 m3/employee/annum	27.0 litres/employee/day
	By Area	0.8 m3/m2/annum	3.1 litres/m2/day

Identiflow monitoring of households with direct and indirect plumbing

Essex & Suffolk Water worked with WRc in 2006/7 to research micro-component consumption in mains fed (direct plumbing) and cistern fed (indirect plumbing) homes (WRc, 2006b).

A sample of twenty two households (ten directly and ten indirectly plumbed) were selected to be monitored for up to four weeks using WRc's Identiflow monitoring system.
Seventeen of these households provided adequate data for analysis. The main conclusion from the project was that the average volume of water used per use for all appliances except the showers was greater for indirectly plumbed properties. This was not the expected results. It seems highly likely that these results are due to factors other than the plumbing system, for example house type, occupancy, and mains pressure. The mains pressure of the two groups of households was investigated and it was found that the indirectly plumbed households had higher mains pressure, which provides some explanation for the results.

Other key findings included:

- Large plumbing losses and / or customer side leakage was identified in eleven of the households.
- Fifteen of the households exhibited average toilet flush volume of greater than 6 litres, which is the regulatory flushing volume.

WRc Increasing the Value of Domestic Water use data for Demand Management.

Household water demand, both internal and external, consists of a number o9f mircocomponents. Knowledge of these microcomponent uses, both currently and in the future, will provide more reliable demand forecasts. Using a purpose written software (Identiflow) the water used for each component can be measured and analysed. The aim of the project was to investigate and understand the variability in microcomponent data and to improve the estimation of annual average figures. The project also investigated the mircocomponents of legitimate night use.

WaND

ESW was a sponsor of the water and new developments (WaND) project. In 2004/5 we provided consumption data for analysis within the larger dataset held and attended a workshop on Customer Perception. This provided a useful alternative view of our water efficiency activity and particularly the ways in which we approach our projects and interface with customers. A number of learning points were gained.

Through this network we worked with researchers from Bradford University in 2005/6 to investigate changes in customer attitudes following a self-audit. An in depth ‘one to one’ interview took place with each customer to gauge their views and options on water and how they use it within their homes. A home water audit was then delivered in the same way as the Thurrock audit project. Following this a further interview took place to see if any changes in their attitudes had occurred. 17 customers from two cul de sacs in Essex were contacted via letter, seven initial interviews took place. All customers were delivered a water audit. Follow up interviews took place and comparisons between the two were analysed.

Code for Sustainable Homes (CSH)

ESW has also been interested in the development and now implementation of the code. Working in partnership with the NHBC, a project has been set up to carry out a preliminary study into whether water use targets set out in the Code achieve the planned water savings.

The Code (CLG, 2006) sets out targets for water for each level as follows:

Level 1 and 2	120 litres per person per day
Level 3 and 4	105
Level 5 and 6	80

Although the Code has in general been well received, the CSH water standards, reducing from 120 to 105, and then to 80 litres/person/day, will pose a great challenge. Designing a house to a standard does not automatically mean the residents conform to a Code consumption. As the average consumption in the UK is 150 l/p/d and is rising in some areas, evidence is required to demonstrate whether the new levels can be achieved post occupation.

The water targets set in the CSH are based upon appliance specification and the limitation of the rate at which appliances may waste water. However, these CSH targets are not based upon established usage patterns. This project aims to provide evidence to demonstrate whether homes that are built to a specific CSH level will consume water at the corresponding rate.

The proposed project is intended to complement and inform another NHBC proposal entitled "NHBC Water Efficiency Guidance", which sets out to develop authoritative guidance for house builders on water efficiency. The Guidance will include aspects of the CSH regarding available products, specification, usage and recycling.

The project will:

- Determine the differences between the CSH water consumption specification and actual water consumption;
- Feed information into the development of the types of homes and the appliances being used;
- Assess the implications for developers and builders of new houses
- Evaluate the specific configurations of appliances to inform future practice concerning meeting the requirements of the CSH; and
- Develop a domestic property metering protocol.

A management steering group has been set up comprising BRE, NHBC and ESW. Housing associations and developers have been approached to find suitable sites to monitor in 2 phases. Most of the phase 1 homes now have the instrumentation installed and are occupied. Data collection has started and the first customer survey will be completed soon.

Water Efficiency Market Research

In 2007/8 UPM Ltd were commissioned to undertake research on ESW's behalf to assess the level of impact the Company's water efficiency (UPM, 2007b). Customers in four postcode areas were surveyed to represent the Essex customer base. A total of 500 telephone surveys were completed in November and December 2007. Findings included the following:

- The majority of customers (82%) claim to actively think about the amount of water they use, indicating a high level of awareness of water consumption;
- Nearly half (48%) of customers indicated that they had water saving devices in their home; and
- Without any prompting 26% recalled receiving free water saving products from ESW.

5.1.9. Focus Groups

Showering

In March 2004 three focus groups were set up to examine consumer views about showers. The results were not available in time to report last year. The project was carried out by BRE under the Market Transformation Programme with the support of the Bathroom Manufacturers Association, Essex & Suffolk Water, South West Water and Three Valleys Water. The aims were:

- How important is flowrate in determining comfort and effectiveness of showers?
- Do consumers understand that higher flowrates mean increased water consumption?
- How important is water consumption compared with comfort?
- How useful would consumers find labels which provide information about water consumption?

The focus groups were held in each of the water company areas and included metered and unmetered customers and men and women of varied ages, with difference water charges and different levels of affluence.

From the discussions high flowrate was universally seen as a key feature of a good shower, although skin pressure could be excessive and other factors such as temperature stability and area of body covered by water were important. Other aspects of showers were also seen as important such as ease of entry for less mobile people, or looks and ease of cleaning. The shower surroundings were also considered to affect comfort, with solid shower partitions preferred to shower curtains.

There was a lack of consensus on whether baths use more water than showers and whether higher flowrate showers use more water. There was also a lack of agreement about whether it is important to save water by taking showers rather than baths or by keeping showers short.

Participants believed labelling was important to inform their choice of shower at the time of purchase, but felt labels and further information may be difficult to understand, unconvincing or not trustworthy.

Metering

This project was funded by the DEFRA Market Transformation Programme and investigated the role of household water metering and pricing strategies on user behaviour and consumption. Four focus group discussions were carried out with householders in different areas of the country in March 2005. The groups were recruited so that they included metered and non-metered participants, men and women, and a range of ages. They were carried out in areas with different water charges and different levels of affluence. Each focus group had 10 - 12 participants five metered and five unmetered. Each focus group area targeted a different population in terms of affluence and tariff level. Essex & Suffolk Water and Northumbrian Water participated. A focus group was held in Chelmsford.

During the focus groups, participants discussed a number of topics in an open ended way, guided by an experienced facilitator. The discussions were tape recorded and transcribed verbatim. The transcripts were analysed to pick out key issues, to identify where differences or consensus existed and to highlight differences related to the characteristics of participants.

It should be noted that this study is qualitative rather than quantitative. The scale of the project and the number of focus groups involved do not allow any statistical significance to be attached to the findings. However the findings provide a rich source of in depth and anecdotal information that enables some inferences on trends to be drawn.

Perceptions about water meters:

There were a variety of reasons why participants had a water meter in their home but those who had actively chosen to have a meter fitted either lived alone or with a partner. The main reason for fitting a meter was for cost saving although one or two participants had chosen for environmental reasons.

All participants who had moved to a metered property or had a meter installed had noticed cost savings.

Reasons for not having changed to a meter included:

- Laziness/apathy;
- Having children/teenagers in the house;
- Lack of awareness;
- Concern about the impact on the saleability of the home; and
- Concerns about not knowing what the bill would be each quarter.

Considering water usage in the home:

- Most participants did not consider their use of water even during droughts;
- The main incentive to save water was cost although education and environmental issues also played a part;
- All participants wondered about the necessity of saving water in this country where rainfall was plentiful; and
- There were concerns about the quality of drinking water.

When questioned about strategies used to reduce water consumption: Participants varied in their knowledge of and use of strategies to reduce their water consumption, depending on their location.

Most participants knew that showers generally used less water than baths and most preferred showers to baths. They were also aware of water saving features on washing machines and dishwashers although they were confused between the energy labelling and water usage information on these items. However fewer knew about other water-saving appliances and aids such as dual flush toilets, water butts, taps and "Hippos".

Some of the respondents had made changes to their behaviour to control their use of water. Examples of such behaviours included:

- Turning off the taps when cleaning teeth;
- Washing the car with a bucket not a hose;
- Using water butts; and
- Sharing bath water.

Information provision:

- It was generally agreed that education and information were important and that more should be done in this regard by the water companies and the government.
- Most participants had gained the knowledge they had from the media rather than the water companies and felt that it should not be up to them to go out and look for information.
- Participants also required more information about appliances.

Views about the influence of water meters on consumption:

- On the whole, participants felt that water metering would make them think more about using water more efficiently.
- Some participants were concerned about the impact that metering might have on public health through people on low incomes reducing their usage to dangerous levels. Some of the metered participants did admit to not flushing the toilet each time it was used.
- Most participants had their meters fitted outside the home and all felt that this was preferable to inside as then it could be read without the reader requiring entry to the home.
- Most did not check their meter even if it was accessible.

Views about billing and pricing strategies and their impact on usage:

- The majority of participants knew exactly how much their water bills were, whether they were metered or not, although the Chelmsford group had less awareness than the others.

- Many participants without meters admitted that they did not think too much about their bills, regarding it as just one of those things they had to pay.
- Most participants did not really look at their bills in detail, just the final amount they had to pay.
- Some participants were confused about the different elements of their bill, the water, sewerage and standing charges, and did not know how these were calculated.
- Most people felt that it would be useful if the water companies provided information about their past consumption on their bills so that they could make comparisons.

5.1.10. Information Campaigns and Events

Website

The Essex & Suffolk Water Website is a dynamic communications tool which is continually reviewed and updated. Customers can find out what the Company is doing within the community to raise awareness about water resources as well as ways to be water wise in the home and garden. Customers can also order a free save-a-flush over the web which has generated a large interest from households. The Do It Yourself Audit instructions are also on the website along with contact telephone numbers to receive a pack and any further information. Details of current and future projects are available in order to inform customers of what ESW are doing with regards to water efficiency.

In November 2007 we launched our new water efficiency videos. These bring a fresh, exciting and innovative approach to web viewers to encourage them to use water wisely. 19 short videos show a variety of water efficiency messages in an eye catching style.

Gardening Initiatives

ESW continue to support the RHS Hyde Hall Dry Garden initiative, which helps to maintain and develop the garden. As a spin of from this the Company has worked with the RHS to create a small dry garden at a primary school in Witham, Essex. A further plan is to create more dry gardens across our region over the next year. This includes a garden at Meadows shopping centre in Chelmsford town centre.

One World Chelmsford

This was a one off event in 1995/96 organised by Chelmsford Borough Council to celebrate different cultures. ESW had a stand in the high street to promote water efficiency within the home and garden. Over 1000 leaflets were distributed and 67 requests for save–a-flushes and more information were received.

Water Use Pledge

Using ESW's yearly customer magazine Source, an advert was placed to encourage customers to pledge to carry out at least one water saving activity.

The four pledges were:

- To install a save-a-flush;
- Turn the tap off when brushing teeth;
- To carry out a home water audit; and
- To educate children using a specially designed children's information pack.

Customers were invited to choose their pledge and send it to ESW. On receipt of the pledge an information pack was sent to the customer to help them complete their pledges. In total 561 customers took part with over 1200 pledges made.
A follow up questionnaire was sent to each customer to gain feedback and comments on the project. This included asking for confirmation that the customer had completed their pledge e.g. fitted a save-a-flush. 400 questionnaires were returned showing that 71% of customers had completed their pledges. This figure is expected to be lower than the actual number of pledges completed as not all customers returned their questionnaire, although are likely still to have carried out a pledge. The most popular pledge was to turn the tap off while brushing teeth with 430 customers pledging to complete this.

The feedback from this project was very positive. The following comments were made by customers 'keep up the good work', 'I found the figures very interesting and informative and now thinking of having a meter installed, Thank you' and 'Excellent project'.

Water Efficiency Exhibitions and Promotional Events

ESW has been invited to promote water efficiency at a number of external events throughout 2004. These included an event held by Essex County Council in aid of World Environment Day, attending the international Scout Jamboree and a Thurrock Council Family Fun Day. The aim of each day was to promote and educate customers with regards to water efficiency issues and how they can use water wisely. Leaflets and various devices were used to support the messages and a water wise quiz and wordsearch was available for children to complete.

B&Q Gardening Project 2005/6

Along with eight other water companies across the UK a joint incentive to promote and encourage customers to think about how much water they use and waste in the garden and ways in which they can reduce the wastage. A joint leaflet was designed with the BBC gardening presenter Charlie Dimmock facing the campaign. The leaflet also included a questionnaire for the customer to complete and return to be analysed. Each customer who returned the questionnaire was automatically entered into a free prize draw to win a visit from an RHS advisor and £250 worth of B&Q vouchers. There were three competition winners, one of which was in Essex & Suffolk Water's supply area.

The project took place from 10th – 23rd April. In total ESW had seven stores in our supply area, to try and promote the project and distribute the leaflets each store was manned by an ESW employee. A total of over 130,000 leaflets were distributed across the UK with 4,000 customers completing and returning the questionnaires.

The majority of customers who completed the questionnaire were over the age of 45. Almost all the survey participants understood the importance of water efficiency and did attempt to avoid wasting water.

The results from the questionnaire also showed:

- Time spent in the garden increases with age;
- Seven in ten gardens are considered to be low maintenance;
- Nine in ten customers use a watering can although half also use a hand held hose;
- Pots and borders are most likely to be watered, between one and four times per week, and most often in the evening; and
- Plants are most often bought for their brightly coloured appearance and drought tolerant plants are not a priority.

From the questionnaire it was concluded that the water efficiency message has clearly got through to customers over the age of 45. The challenge now will be to convert those people less inclined to consider water issues.

In 2006/7 a similar campaign was organised but it aimed to give customers information about all outdoor water use and it also aimed to target a younger audience.

An A5 magazine called Summer Fun was designed for the campaign. Included in the magazine was a questionnaire for the customer to complete. By completing the questionnaire the customers had a chance to win a number of prizes. These included a holiday to Centre Parks, which will be given away in September and during June, July and August there was a draw with each winner, receiving a £100 in B&Q vouchers. Between the 6th and 21st May the Summer Fun magazine was distributed in B&Q stores.

294,000 copies of the Summer Fun magazine were distributed over the campaign period and 7,326 questionnaires were received. The results of the questionnaire are encouraging. It is clear that the water efficiency and drought messages are getting through to the public and awareness is improving significantly. Following the campaign spare leaflets were distributed to customers via post following requests for information and were available to be picked up from our Hanningfield Fishing lodge and reception.

Shower Challenge

During 2007 ESW set their customers the challenge of reducing the time spent in the shower by one minute. The campaign was focussed around a five minute shower timer used to promote the challenge and provide information on why saving water is so important. Details of the challenge were promoted in our 2007/08 billing leaflet and customer magazine (Source). To date over 1,000 customers have requested the shower timers and a further 2,200 have been distributed through summer events.

All customers requesting a shower timer have been sent a follow-up questionnaire with the aim of finding out how using the timer has influenced the time spent in the shower. Approximately 50% of customers have completed and returned the questionnaires. 65% have reduced the time spent in the shower and are now spending on average only 4.5 minutes showering!

The Environment Agency Water Efficiency Awards

ESW won a commendation in the Ofwat Economic Research Category at the 2005 Water Efficiency Awards (Environment Agency, 2005). In association with BRE a small sample of properties were retrofitted with dual flush WCs with the objective to evaluate the cost-benefits and investigate the practical issues involved. Savings of 29 litres per property per day were calculated. The cost benefit analysis showed that the savings were not sufficient to make it economical to replace a 7.5 litre flush WC before the end of its working life with a 6-litre dual flush. However as the properties were metered a reduction of £7.91 on their annual water supply bill would be seen. The judges described the project as ‘a good piece of empirical research’.

Essex & Suffolk Water entered seven projects into the Environment Agency Water Efficiency Awards 2006/7 (Environment Agency, 2007d):

- Domestic audits – Which approach?
- Retrofitting variable flush devices to existing toilets (collaborative project submitted by ESW)

- Thurrock home surveys
- Water wise meter reads
- Retrofitting variable flush devices to existing toilets – follow-up
- Domestic water savings project
- Modelling water audit savings

Four projects were shortlisted. "Domestic audits – which approach", "Retrofitting variable flush devices to existing toilets (collaborative project submitted by ESW)" and "Thurrock home surveys" were shortlisted in the Ofwat Economic Research and Innovation category. The "Water wise meter reads" project was shortlisted in the DfES Inspiring Change category.

Members of the Demand Forecasting department attended the ceremony held at the Energy Clinic on 6th March 2007, and collected three awards:

WINNER – Thurrock home survey project

The Thurrock home survey project was deemed 'a really first-class project that captured the interest of customers' by the judges' panel. The panel also commented that the project was 'just the type of research they wanted to see'.

COMMENDATION – Domestic audits – Which approach?

The judges' panel stated that this was 'a good research project that has the potential to be replicated and achieve even bigger and better results'.
JUDGES AWARD

The judging panel highlighted the need for a new award and were delighted when the Environment Agency gave them their full support and agreed to sponsor a special 'judges award' for 2007. Essex & Suffolk Water won this award in recognition of high quality entries and sustained effort and hard work. It was recognised that Essex & Suffolk Water have set a unique record over the years, have set standards for all other water companies and have showed enthusiasm and tenacity in making water efficiency a core part of their company philosophy.

5.1.11. Participation in Groups, Networks and Workshops

Watersave Network

We are continuing to support the research and information dissemination roles of this network, and value the opportunity it provides for water companies to meet with academics, businesses and other organisations.

Anglian Region Water Efficiency Group

We continue to be involved in this group comprising the East Anglian water companies and the Environment Agency.

WaterUK Water Efficiency Group

We remain active contributors to this group and Clare Ridgewell has been the moderator since 2005. It provides an opportunity for companies to exchange ideas and experiences and to jointly meet with suppliers, Regulators and others.

National Water Conservation Group

We have continued to find this a useful group to attend because of the breadth organisations involved and the opportunity this type of forum gives for developing new contacts or ideas. We have also presented some of our work to the group.

Waterwise

ESW has worked with waterwise on a range of projects. In 2006/7 this included supplying data relating to new homes consumptions pre and post the implementation of the 6 litre maximum flush volume in 2001, and waterwise also asked if we could supply data to support their WTi funded project under the “Sector Sustainability Challenge” concerning transferability of data from audit projects and we duly supplied data from the Thurrock and Witham audits. The proposed telephone survey was reviewed and the surveying took place at the end of March/beginning of April 2007.

ESW also assisted in the development in 2007 of “A Best Practice Guide for Water Efficiency Programmes” written by waterwise under contract to Defra (waterwise, 2007).

ESW worked with waterwise on their project: Evidence Base for Large-scale Water Efficiency: Optimising Water Efficiency Costs and Benefits. The aim of the Evidence Base economic project was to produce a set of scenarios for UK water company water efficiency programmes based upon best available knowledge, which can be used to inform water company investment with particular relation to the Periodic Review. Data relating to many of ESW’s projects has been provided for this work.

Local Development Frameworks

New homes have been one area where it has historically been difficult to promote water efficiency.

Starting at the roots of development, ESW has become actively involved in the Local Development Framework (LDF) process by being members of the water cycle studies – which are additional supporting documents to the LDFs and are carried out by local authorities and promoted by the Environment Agency. A water cycle study provides a plan and programme of water services infrastructure implementation. It is determined through an assessment of the environment and infrastructure capacity for water supply, sewage disposal, flood risk management, surface water drainage and water efficiency through consultation with local water companies and the Environment Agency. The provision of a water cycle study is achieved in three stages: an initial scoping study, followed by an outline strategy and finally the full strategy. They relate to the LDF and core strategy as well as development documents (e.g. site allocations). Planning applications will need to be compliant with the water cycle strategy.

To date, ESW has been involved with Braintree, Chelmsford, Maldon and Thurrock Councils in Essex and the Haven Gateway in our Suffolk Area. The level of involvement is dependant on the stage that the council is at in its LDF process. For each WCS, ESW has outlined its resource situation and encouraged water efficiency. It has proved an opportune time to further relations with councils and extend discussions to the LDF policies on water efficiency and implementation of the Code for Sustainable Homes.

Other Meetings/Workshops

ESW continue to work both locally and nationally with other water companies and have participated in the following meetings/workshops:

In 2006/7:

- Water UK, Ofwat, EA, waterwise, CCWater and DEFRA water efficiency hexapartite group.
- CLG Water Efficiency in New Buildings
- Environment Agency Targets and Benchmarks Workshop
- Environment Agency Metering and Water Stress Workshop
- DTi Strategy for Sustainable Construction Consultation Event
- Existing Building Review
- CIRIA – water management workshop
- Represented on the steering group of the IPPR project Every Drop Counts

ESW has used the following workshops/conferences to disseminate our work:

- Watersave workshop
- CIWEM conference – Encouraging the take up of water saving devices for new and existing developments

Additionally ESW has attended the waterwise conference, MTP workshop on rainwater recycling and a conference on social marking for the environment – using water wisely.

The Company has also updated our entries in the UKWIR Sustainability of Water Efficiency database.

In 2007/8 ESW has been involved in:

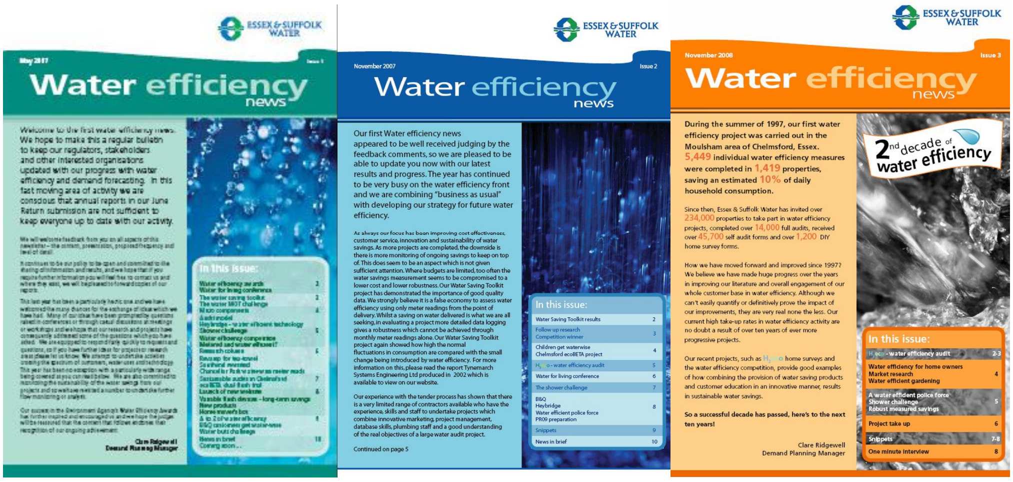
- CLG's Mandating Water Efficiency Stakeholder Workshop;
- Water UK, Ofwat, EA, waterwise, CCWater and DEFRA water efficiency hexapartite group;
- CLG Water Efficiency in Existing Buildings;
- Thames Gateway Water Neutrality;
- Global Summit on Water Efficiency speaking about our Heybridge project;
- Three Regions Climate Change Partnership; and
- Ofwat review of water efficiency targets.

Suffolk Tourism Partnership

Together with Anglian Water we have worked in partnership with the Suffolk Tourism Partnership during 2007/8 on their "Green Action of the Year" campaign. The campaign has targeted pubs and restaurants in Suffolk through a variety of means and aims to encourage owners and landlords to take the simple action of installing cistern displacement devices in their WCs.

Water Efficiency News

In May 2007 ESW distributed the first edition of Water Efficiency News. The purpose of this newsletter is to keep stakeholders and other interested organisations up to date with the Company's work. Many projects are in progress at any one time and there is now too much material to be able to rely on others to spread the word for us.



The second edition was produced in December 2007 and the third in November 2008. It is hoped that Water Efficiency News will be able to be used to disseminate results and also to draw attention to key issues or aspects that have not received sufficient attention and to provoke discussion and new research ideas.

5.1.12. Conferences

Approximately every two years, ESW has hosted a conference on the theme on water efficiency.

Water in Sustainable Communities

In April 2005 ESW hosted a national conference in London's Docklands to discuss water issues as they relate to sustainable communities.

The forecast growth in new housing for the eastern region, combined with an inevitable increase in water consumption, places particular pressure on water companies, planners, developers, regulators and environmental groups. This conference enabled delegates to explore and challenge a number of key issues including water efficiency measures, changes in policy and human behaviour, climate change.

John Reynolds, chairman of the regional planning panel of the East of England Regional Assembly warned that 'in terms of the environment, there are real, crucial issues. We are the driest region, water is scarce, and sustainability is a major issue. We have to make sure policies are sustainable and put pressure on owners of existing homes to reduce use of water and new developments to reduce their water use substantially,' he said.

With presentations from Business in the Community, Thurrock Urban Development Corporation, Office of the deputy prime minister, Environment

Agency, WWF, Defra and Northumbrian Water, the conference programme gave delegates a wealth of information and ideas.

Key findings were:

- The Sustainable Buildings Code will give a target for new houses to be 20% more water efficient without specifying how this can be achieved;
- Too little water in reservoirs combined with increased instances of flooding makes for confusing messages;
- Sustainable consumption is not the most user-friendly term. It sometimes comes across as a slightly worthy lifestyle element, away from mainstream living – but it is absolutely crucial; and
- There is a continuing need to help people understand how their behaviour affects water resources and a need for behavioural change.

Water for Living – how much is enough?

In May 2007 ESW hosted a conference in London entitled 'Water for Living – how much is enough?

The conference considered what the right balance is between resource development and demand constraint to ensure secure supplies for customers into the future.

There was a succession of excellent presentations throughout the day, starting with the keynote speaker, Ian Pearson, who was then Minister of State for Climate Change and the Environment who said that everyone has a part to play in water efficiency and meeting the challenges of climate change.

Mr Pearson then appealed to the water industry to come forward with more innovative thinking to reduce its current high energy use.

John Cuthbert, Managing Director of Northumbrian Water, emphasised that the twin track approach - demand constraint and resource development, has to be fundamental to the water resource planning process. Cost effectiveness has to be a factor in selection of solutions.

Regina Finn, Chief Executive of Ofwat called for creative thinking to be used to ensure a sustainable, long-term water sector in which water efficiency is an important tool.

It was recognised that decisions now will have long term and far reaching social and environmental consequences, so they need to be based on sound science, facts and evidence.

We also need to be realistic about what is deliverable in terms of social acceptance, affordability and physical output.

Richard Sturt from CCWater, the voice for water customers in England and Wales, gave an insight into how customers perceive water issues. He stressed how strongly they feel that it is wrong to make them feel “guilty” for that they believe is their legitimate use of water.

He also reminded us that what some class as “non-essential” amenity use is often part of the fabric that makes us a modern, civilised society.

Discussion followed around customer behaviours and how they can be changed, and to what degree. All speakers came to the conclusion that to change behaviour, customers must be involved in the process and must be able to understand and accept why the change is needed before they will buy-in and respond.

Adrian McDonald from Leeds University, made very interesting analogies between what the water sector is trying to achieve and what has happened with energy saving. His warning was not to be over reliant on demand savings to ensure a sufficient supply/demand balance.

John Devall, Water and Networks Director at Essex & Suffolk Water said: “The conference proved to be a very worthwhile event. It encouraged debate on water use and how the expectations and actions of customers have a vital role in getting the right balance between demand and the availability of water. It is essential that sensible decisions are taken to ensure sustainable supplies are provided that take into account fully the needs of the environment and customers.”

All presentations are on our website to read and download.

5.1.13. Education Strategy

The key focus of our education policy continues to be to educate young people and develop a more water aware generation of customers for the future.

Waterworld

In 2004 the Waterworld education pack was still available for schools for use in teaching key stage 2. This pack was used in 11 additional schools that year. In 2005/6 the pack was used in seven additional schools this year.

During 2005/6 we also provided general water efficiency information in the form of leaflets and activity sheets. For example, Leigh Primary School in Essex held an environmental week for which we provided six waterbutts and children’s leaflets in order to educate them about potential water savings at home.

Schools Acting to Value Energy (SAVE) scheme

In 2004/5 in partnership with Thurrock Council a school environmental education scheme was set up. The aim of this scheme was to raise awareness of various environmental issues e.g. recycling, reducing waste of resource such as electricity and water. A list of 17 tasks was complied for schools to complete. Each task was assigned a score 1 – 5 due to the difficulty and importance of each task. ESW provided two tasks for the scheme:

- To carry out a school water audit and attend a tour of Hanningfield Water Treatment Works, with a rating of 5.
- To complete a selection of worksheets based on water and water efficiency, with a rating of 2.

The number of points the schools gain from completing each task determined the level of award they received. To achieve a bronze award they needed 10 – 20 points, for a silver award 20 – 30 and for a gold award above 30 points. Thurrock council promoted the scheme to all 64 schools in their area. Any school wishing to carry out one of the ESW tasks was invited to contact ESW for further information and help in completing their task.

On our behalf Thurrock Council also distributed a pack of leaflets on water efficiency. The pack included our children's leaflet H2HoHo that looks at many aspects of water including the water cycle, how much water is used in the home and water safety. It also included a game and a pop out mobile to make. In total 33 schools were visited and a total of 330 leaflets were distributed.

Water Tower Industry Day

This is a company run day to educate secondary pupils about water production and distribution. The pupils are guided through tasks and activities which are both practical and theory based. Included in the activities is a task to calculate the average amount of water used in the household and then to calculate the potential water and money savings associated with installing a save-a-flush.

A number of these year 6 industry days took place at various schools around Essex in 2004/5 and 2005/6

New materials have included the following in 2005/6:

- An educational CD-ROM entitled h2o4u was produced and offered free of charge to all primary schools in our area. It contains a wealth of information about water and water conservation.

- An A1 sized laminated Water Cycle poster has been produced with water related messages around the water cycle for classroom walls. Smaller water cycle colouring posters have also been designed.
- Water conservation origami paper games have been produced with 8 water efficiency messages. These are being distributed at company events, tours and talks and are proving very popular with children and teachers alike as they are very tactile and the children like to learn how to fold them.

Water in the school website

Launched in January 2002 this was a joint venture between 13 water companies, Water UK and WaterAid. Located at "www.waterintheschool.co.uk", the website provides everything needed to set up and run a water conservation project in school.

Water use in the home website

The Water in the Schools website has been very well received and we have built on this success by part sponsoring and being actively involved in the development of a new educational website looking at Water in the Home (and garden). The site (www.waterfamily.co.uk) has a completely different look and feel to Water in the School, which was mainly designed as a resource for the teacher. The new site is very much child orientated (who influence their parents) and is very interactive and a lot of fun! It was officially launched on April 15th 2005. We also have copies of the game on CD-ROM and have been distributing these free of charge on request by schools.

Teenager Water Efficiency

In 2005/6 our current water efficiency material was designed either for children under 10 years of age or adults. ESW were therefore interested in building an educational programme aimed 12-14 year olds delivering the message that water efficiency is the key to the future of water consumption. This would be achieved through designing leaflets, worksheets or competitions for distribution through schools, private clubs and organisations (Girl Guides, Scouts, Cubs) etc. A project working with a group of Business Management final year students from Anglia Ruskin University and year 8 pupils from Baddow High School, Chelmsford was set up to investigate ways to promote water efficiency to teenager (ESW, 2006d). A detailed understanding was needed of the attitudes and behaviour of this age group, in both broad terms and with regards to water efficiency, both at home, school and in their outside lives. Also, how they could be motivated to be more water efficient.

The study found that 12-14 year olds did not use water particularly wisely although they were generally aware of the need to conserve water. Their parents did not influence them about how they should use water, which could be due to the parents' lack of knowledge. The students were interested in the idea of having small reminders in the bathroom to remind them to use water wisely, but a very mixed response was received when it came to being willing to learn about water efficiency. Mobile phone text and picture messages were suggested, as a way to educate this age group about water efficiency, also using pop-ups on Internet chat rooms was a popular suggestion. Students were found to be money orientated by the objects that they wanted in reward for being more water efficient.

Following this research it was recommended that water efficiency needs to be a greater part of the school curriculum. It was also recommended that the company web site should be improved, as the existing “water family” does not particularly appeal to 12-14 year olds. This age group may be motivated to take action to be more water efficient if they were to receive generous prizes. This could be investigated further as to just how effective this strategy would be.

5.1.14. Non-Household Customers

SME audits

ESW is a member of the Chelmsford Environmental Partnership (CEP), a forum from which water efficiency activities are promoted. On behalf of the company in 2004/5 ten small and medium enterprises (SMEs) were visited and a water audit completed, this was part of a larger project that also examined other resource efficiency e.g. recycling and electricity usage.

As with households it is important to try and encourage water efficiency within non-households. A total of 834 water saving devices have been distributed to non-household customers; this includes 701 save-a-flushes. 100 save-a-flushes were sent to Bradwell Power Station, 150 to various hospitals and 230 to schools as part of the EcoSchools innovative. Due to the very wide variation of size of non-household properties no assumptions on the potential water savings associated with the installation of a save-a-flush can be accurately calculated.

Water Efficiency in Hospitals

As part of Water UK and NHS Estates initiative we supported the development of an industry-wide advice for hospitals. The objective of this was to provide NHS hospitals with water efficiency information and advice to help them both evaluate their present water usage and ascertain potential areas of saving. A series of specialist leaflets were produced covering areas such as boiler house, incinerator, sterilization and disaffection units, catering wards, operating theatres etc. The leaflets were disseminated as part of a seminar, which all hospitals in the southern supply area were invited to attend.

The consultant from Ashact presented giving advice and encouragement to the hospitals concerning the amount of water they can save. The seminar was very successful with positive feedback from all that attend.

Other Audits/Device Distribution

As with households it is important to try and encourage water efficiency within non-households. Audits for commercial customers are available on request

In 2005/6 1 water audit was completed at a pub in Essex. Recommendations to install save-a-flushes and spray taps were made. No self-audit packs have been distributed to either commercial customers or institutional premises.

A total of 2383 water saving devices were distributed to non-household customers, this includes 2170 save-a-flushes. Over 1000 save-a-flushes were sent to holiday parks in Great Yarmouth, Norfolk. 400 save-a-flushes were sent to Writtle College, Chelmsford to be installed in their university halls of residence. 490 save-a-flushes were sent to schools for various events that they were carrying out such as environmental awareness weeks. Due to the very wide variation of size of non-household properties no assumptions on the potential water savings associated with the installation of a save-a-flush could be accurately calculated.

In 2006/7 two requests for audits were received and audits completed. The first took place at Essex County Council offices in Chelmsford, Essex. It was found that at the offices everything that could have been done had been and there was little scope to improve the work already completed. The second took place at a farm complex with six new holiday cottages about to be built. Advice was provided on ways to include water efficiency in these buildings. They were also interested in rainwater harvesting and using SMS metering technology to provide them with consumption data. There were however no savings from either audit to report.

Envirowise

As part of the Big Splash campaign 4,200 leaflets were distributed to commercial customers in Essex and Suffolk during December 2005. The campaign provided the opportunity for business owners and managers to gain free, hands-on advice to help them understand how much water their business currently uses and how to measure the cost savings. 10 companies responded to the leaflets via faxback, others have contacted Envirowise via the helpline or through the website but actual numbers are not currently available. One company registered to receive a water audit.

Essex Police

ESW is working with Essex Police to implement a number of water saving initiatives. To demonstrate the potential for savings, three police stations were identified for initial work and site-checks have been carried out to ascertain how savings can be achieved. Where possible, each station will have the following water savings installed:

- Tap aerators
- Aerated showerhead
- Either save-a-flush devices or EcoBETA retrofit devices

Data loggers were installed on the meters to provide a base consumption prior to the installations and post-monitoring to identify savings. The logger data quickly identified an unknown leak.

5.1.15. Strategy for Remainder of AMP4

Funded through our Base Opex ESW expect to continue a similar range of activities as those reported above. The Company's evaluation of water efficiency options has demonstrated that the projects that have been undertaken are in the most economic range. ESW will therefore continue with the annual programme of water efficiency audits through H_2eco in the remaining parts of Chelmsford, as our largest project. Other projects described above are continuing such as the project to evaluate the water savings from complying with the Code for Sustainable Homes. In addition, ESW will continue with our practice of annually undertaking projects of research value.

In place of last years' shower challenge this spring we will be launching our gardening campaign, with our billing literature. ESW has further work planned with Essex Police and hopes to trial the leakfrog product for detecting and measuring supply pipe leaks.

Alongside these new initiatives the Company will be continuing our baseload of water efficiency projects with save-a-flushes, schools, information campaigns etc.

ESW's strategy can be considered in relation to Ofwat's Good Practice Register:

Activity	ESW Service	Future Strategy
Cistern Displacement Devices (CDDs)	In 1997/98 we distributed Hippos to all our customers and the following year undertook a market research project to establish the number installed	To continue as now

Activity	ESW Service	Future Strategy
	customer views etc. Since then we have continued to offer CDDs free of charge on request, through events and as part of our audit projects. We changed to save-a-flush in 1999 as being more widely applicable. Having distributed CDDs to our entire customer base we do not feel it appropriate to repeat the exercise, particularly with the growing number of low flush and dual flush WCs now installed. The availability of CDDs has been advertised in billing leaflets, on our website, through company magazines etc. All audits have included a CDD excepting those involving a retrofit dual or variable flush device. Project follow-up surveys have provided feedback on installation rates and removal rates. Flow monitoring has provided evidence of water savings.	
Household Water Audits	ESW has had an annual programme of audits since 1997. These have included checklists, "full" (plumber) audits, self audit packs, DIY audit packs, children's audits and retrofit-based audits. The Domestic Audits – Which Approach? project provided a comparison of the cost effectiveness of the alternative types and was the basis of the latest design – the Water Savings Toolkit. Some 230,000 household customers have now been offered a household audit. 106,000 audits packs have been provided and in total 60,097 audits have been	To continue with an annual programme, and to annually develop and improve our approach.

Activity	ESW Service	Future Strategy
	completed.	
Commercial Water Audits	In 1997 we worked with all our largest customers, providing audits and follow-up services. Since then we have targeted SMEs although the interest has been extremely low. We joined with other companies to develop the Hospitals guide and distributed this and held a dissemination workshop. We have worked with Envirowise and Chelmsford Environment Partnership to promote audits for commercial customers.	Under review to ascertain how we can attract more interest from our customers. Trial planned with local authorities.
Customer education/awareness	We have provided a range of leaflets covering water in the home and garden, purchase of new appliances, replacement of bathrooms etc.	To continue with all these initiatives and extend them where possible
	In 2006/7 we redesigned our website to provide improved access to information to customers The website includes a consumption calculator and a water cost, energy and carbon calculator for showering.	
	In 2007 we introduced a statement on our metered bills to provide volume comparison information.	We are now examining how t provide more information
	Our website now includes 18 short videos to show a variety of water efficiency messages	
	Advertised local rate leaflet telephone line plus advertised telephone and email access direct to the water efficiency team	
	Financial and other incentives have been offered to encourage participation in water efficiency projects, and a water efficiency competition is currently being planned.	

Activity	ESW Service	Future Strategy
	Audit packs have been distributed at external events as well as single items including CDDs, shower timers, bookmarks, children's items	
	Schools – new 'Superheros' brand to raise awareness to children of water. Also the provision of the h2o for you – an interactive CD Rom for schools.	
	Provision of educational material e.g. CD-Rom, earlier Waterworld Pack	
	Sponsorship of RHS Hyde Hall's dry garden.	
	Promotion of water butts to all customers to be purchased from Straights plc.	
	Media campaigns including radio, TV, newspaper, bus posters	
	Regular market research tracking	
	Specific market research/surveys following projects or on specific topics e.g. showers	
	Awareness campaigns re potential pipe bursts from frost damage	
	Tours and visits to treatment works	
	We have operated pledges covering CDDs, cleaning teeth and water audits	
	We have worked with developers to promote water efficiency in new builds were possible. Initiatives have included the Water Efficient New Homes in Heybridge, a water efficient garden and discussions and advice.	
	We have worked with Local Authorities where possible. This has included briefing sessions,	

Activity	ESW Service	Future Strategy
	help with target setting, attendance at workshops and partnership arrangements for audit projects.	
	Promotion of meter option scheme	
	Selective metering on change of occupier	
	Selective metering of sprinkler and swimming pool users	
	Data loggers on major customers' meters to allow them to monitor their consumption	
	Provision of free hosepipe trigger hoses as part of audits	
Toilet Retrofitting	Projects have included variable flush retrofit project with other water companies, the Southend 2002 audits used the products Siphonmate and Delay Ecoflo valve, the Domestic Audits Which Approach? retrofits used Variflush and Dudley Turbo 88 and two Ecobeta projects have now been completed	Included in current H2eco project in progress
Toilet Replacement	Water Efficient New Homes had replacement dual flush WCs fitted	This approach proved far more problematic than expected and therefore we have no plans to revisit this.
Research	Previous projects include: Water butt savings project Micro component monitoring of new homes Micro component monitoring comparison of direct and indirectly plumbed new homes	Planned projects include WC survey and Code for Sustainable Homes We will respond with research projects as the need arises.

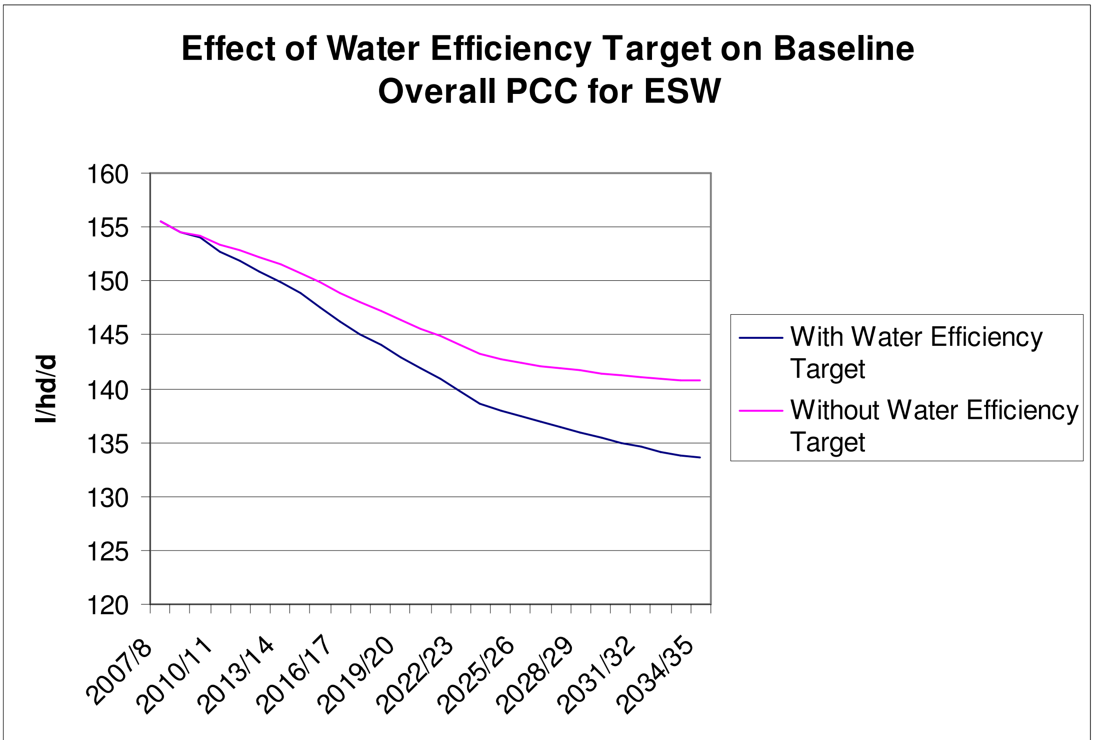
Activity	ESW Service	Future Strategy
	Market research into customers current shower types, their boilers and plumbing systems and the time they spend in the shower.	
	Water wise meter readings to investigate if customers will reduce their consumption if they are supplied with monthly meter reads.	
	Water Efficient New Homes Project at Heybridge, details are given above.	
Supply Pipe Leakage	Repairs and replacement	See Leakage section

5.1.16. Water Efficiency Targets

The Ofwat target for water efficiency is to save 1 l/prop/d for each of the five years 2010/11 – 2014/15.

For Essex & Suffolk this target equates to 0.74 Ml/d. We have assumed that 0.04 Ml/d will be saved from non-household customers and the remainder from households, apportioned between the Essex and Suffolk areas according to population, and applied equally to unmeasured and measured customers. This equates to a reduction in baseline unmeasured and metered PCC of 0.39 l/hd/d. We have applied this cumulatively from 2010/11 to the end of the planning horizon. In addition we have assumed that in 2009/10 we achieve a saving equating to 50% of the target.

The impact of this water efficiency is to reduce overall PCC for ESW by 7 l/hd/d by 2034/35.



The currently available list of assumed savings from Table 8 in Ofwat's report Water Supply and Demand Policy (2008) have been used to develop a plan for meeting the target for the five year period. This draft annual plan is our current best forecast of the most economic and effective means of meeting the target in our areas. We have taken into account that some of the low cost options such as delivery of cistern displacement devices we have already undertaken previously and therefore if repeated would be likely to be wasteful. Our appraisal has been based on our experience of projects to date and we have projected costs and uptake rates from our most recent work. Over the coming year and once Ofwat have finalised the assumed savings, we will be examining options further and also looking to pilot someof the new options and develop our reporting procedures. Details of the draft plan components are provided in Appendix B

5.2. Essex Metering

The metering strategy outlined below only refers to currently unmetered properties becoming metered. All new properties since 1989, whether households or non-households, have been required to be metered and will continue to be so as there is no other way of charging them for their water services.

AMP4

The current AMP period metering strategy has been to continue to offer optant meters to customers but also to selectively meter customers on change of occupancy of properties. The introduction of selective metering was in response to the relatively low, and declining, number of customers opting for a meter, despite the efforts of the business to promote the financial benefits of metering to stimulate optant numbers, during AMP3.

In the first two years of this AMP (AMP4) the table below compares the outturn against the forecast numbers:

	2005/06			2006/07		
	Optant	Selective	Total	Optant	Selective	Total
PR04	5,000	7,250	12,250	4,920	7,200	12,120
Actual	4,653	5,927	10,580	6,048	14,102	20,150
PR04 Cumulative	5,000	7,250	12,250	9,920	14,450	24,370
Actual Cumulative	4,653	5,927	10,580	10,701	20,029	30,730

The number of optants over the first two years has been slightly higher than forecast but seems to be settling into an average of 5,000 pa. The number of selective meters installed in 2005/06 was lower than forecast but this was due to the programme only being rolled out to the whole of Essex during October 2005. The delay in getting the selective metering in place for the whole of Essex was due to the Company having to resource up to handle the level of work and the necessity to inform all estate agents and solicitors in the Essex area of our intention to begin selective metering and to give three months notice of its introduction.

The significantly greater number of selective meters installed in 2006/07 than had been forecast was due to a number of reasons:

- When the forecasts were drawn up the numbers were calculated on the assumption that we would selectively meter a property on change of ownership not occupier. When the AMP4 period began we changed the selective metering policy to change of occupier that increases the potential number of properties to selectively meter.

- The principle during the first year (2005/06) of the programme to begin the selective metering relied on the owner/tenant notifying us they had moved in to the property, or giving us a moving in date. However we noticed there was often a long delay in customers notifying us that they had moved. This delay was not evident when a customer was moving out of a property. In this case the notification to the company was very reliable and prompt. We, therefore, changed our system to begin the selective metering process from the date the previous owner/occupier vacates the property.

- The housing market in the South East had remained stronger than had been anticipated.

The table below shows the outturn and forecast number of optant and selective meters for the remainder of this AMP4 period. The forecast is now for 25,759 optant meters, compared to the Business Plan forecast of 24,200 and 46,460 selective meters, compared to the Business Plan forecast of 35,700. This now gives a forecast outturn of total meters of 72,219 compared to the Business Plan total for AMP4 of 59,900. This increase of 12,319 meters (20.6%) above that forecast in the Business Plan, and allowed for in funding, has been accepted by the business because of the importance we attach to increasing meter penetration. The significant additional cost of the additional meters has been accommodated by diverting funds from other areas of investment within the business.

Although the outturn number is 20.6% higher than forecast for the AMP, ESW had until recently expected the number to be even higher. This was due to the significantly greater number of selective metering opportunities than we had planned for. However, the number of selective meters is largely dependent on the strength of the region's housing market. This has been very strong over the early years but has started to weaken considerably during 2008 as the economic downturn has taken effect. The previously forecast number of selectives for 2008/09 has been lowered to match the numbers seen by October 2008 and the forecast number of selectives has also been lowered for 2009/10. With our policy to selectively meter on change of occupier, not ownership, the number of properties to selectively meter has been cushioned somewhat by the increased activity in the rented market.

The predicted outturn numbers against Business Plan forecast numbers for the remainder of AMP4 are:

	2007/08		2008/09		2009/10	
	Optant	Selective	Optant	Selective	Optant	Selective
PRO4	4840	7,150	4760	7,100	4,680	7,000
Current Forecast	5,058 Outturn	9,931 Outturn	5,000	7,500	5,000	9,000

This gives the expected outturn total of meters for AMP4 as 72,219, which is 20.6% above the PR04 funded total of 59,900. At the end of AMP4 Essex should have a measured property total of 45% of the total household properties.

Baseline

Ofwat, contrary to our opinion, has stated that selective metering in Essex cannot form part of the baseline despite having selectively metered all Essex properties on change of occupier during AMP4. We have therefore

constructed the baseline demand forecast with only optant metering over the planning horizon.
Without a selective metering policy the number of forecast Optants does increase, as a certain amount of movers would opt for a meter in their newly acquired property but as metering is automatic when a selective policy is in place they do not have a chance to opt. However the moderate increase in Optants does not compensate for the large number of properties metered under a selective metering policy.
To demonstrate the need to selectively meter in AMP5 and compulsorily meter from April 2015 to December 2020, to reach universal metering the Table below compares the baseline meter penetration against the Final plan penetration.

	AMP4	AMP5	AMP6	AMP7	AMP8	AMP9
Baseline	45	54	62	67	70	73
Final	45	60	81	89	91	93

Should the baseline be followed the company would not reach Defra's vision, in Future Water, of companies operating in water stressed areas to have near universal metering by 2030. With universal metering thought to be 85%, the baseline meter penetration would only be 70%.
With our Final plan, having selective metering during AMP5 and compulsory metering through to the end of 2020, universal metering (85%) is reached in December 2020.

<u>Developing the Final Plan.</u>

For AMP5 and beyond we have developed a number of options ranging from achieving 3% pa metering increase until universal metering is reached (2023), through to universal metering by 2015 assuming compulsory metering powers from April 2010.

In developing the options we have been cognisant of the views of the Environment Agency as well as the stated policy of Defra and the positions of Ofwat and CCWater with respect to customer affordability versus security of supply and fairness of paying for water. Three options have been investigated that cover the most reasonable metering policies.

<u>Option 1</u>

For the AMP5 period (2010-2015) we would continue with our option and selective policy that should result in 78,750 meters being installed over the five year period. This would increase the percentage of measured customers from 45% at the start of the AMP to over 60% by the end.

For AMP6 ESW would propose compulsory metering in its draft Water Resource Management Plan 2014 and, if accepted by Defra, this would enable universal metering (currently estimated at 85%) to be completed by the end of 2020. This would involve the installation of 156,000 meters at an average annual rate of 27,533 from 2015 for 5years 8 months. The assessment of universal metering at 85% of households is explained further below.

Examining the number of meter installations so far this AMP and taking account of the effects of events on the housing market, allows ESW to forecast numbers of installations for AMP5 assuming we continue with the mixture of selective and optant metering currently in place:-

Year	Optant	Selective	Total Meters	% measured
2010/11	5,000	11,500	16,500	48
2011/12	5,000	11,000	16,000	51
2012/13	5,000	10,750	15,750	54
2013/14	5,000	10,500	15,500	57
2014/15	5,000	10,000	15,000	60
AMP5 Totals	**25,000**	**53,750**	**78,750**	

This level of metering proposed for AMP5 is consistent with the level in AMP4 and has proved to be manageable. It is also an increase on the likely outturn numbers of AMP4 and is substantially above the PR04 Business Plan total of 59,900 allowed for in funding.

Cost

Using our meter location split, outlined in option 2, the costs for this programme are:-

Internal (Intelligent meter) 5,000 x £145.83 = £729,150

External existing BB 23,625 x £52.20 = £1,233,225

External without BB 50,125 x £333.43 = £16,713,178

Total CAPEX = £18,675,553

Water savings: it is assumed that Optants save 5% of unmeasured pcc and selectives save 8% of unmeasured pcc.

Optants – 25,000 x 1.63 x (169.32 x 0.05) = 0.34Ml/d

Selectives 53,750 x 3.03 x (169.32 x 0.08) = 2.21Ml/d

Total water savings = 2.55Ml/d

Cost per Ml/d £7.33m

Option 2

This would involve achieving universal metering during the five years of the AMP5 period (2010-2015). The number of meters required would be the 78,750 for AMP5 and the 156,000 for AMP6 (from option 1) i.e. 234,750. The stated policies of Defra, Ofwat and CCWater would not allow this option to proceed as it is not possible to demonstrate that the costs and benefits of a compulsory metering programme are in any way comparable to other demand management or resource development options. In addition the Environment Agency have never offered a scientific or reasoned explanation as to why universal metering by 2015 has become their chosen option and why customers should be expected to pay for the significant increase to bills to pay for it. However, the option is included for comparison against the other options in the Plan and to cater for circumstances where the regulatory and political framework, although unlikely, may alter. Changes to Regulations have now given companies the ability to achieve Water Scarcity Status (WSS) within the Water Resource Management Planning process, rather than the previous application for WSS that was a stand-alone process, outside of the quinquennial water resource planning associated with the periodic reviews. The process within the draft WRMP is an improvement over the previous method as it allows various options, within the twin track approach to developing a supply demand balance, to be compared simultaneously and to the same base. The various options are also consulted upon with stakeholders as part of the public consultation exercise required for the draft WRMP. Following a consultation exercise by Defra into the proposal for WSS that resulted in its approval, Defra issued the following press release on 16th August 2007.

Water metering to become an option in long term plans.

Water companies in areas of serious water stress will be able to seek compulsory water metering as part of their 25 year forward plans, Environment Minister Phil Woolas announced today.

The proposal, developed by the Water Saving Group, adds metering to the existing raft of options for companies – alongside developing new resources – for ensuring long term security of supply. Today's move follows consultation with companies, regulators, charities and members of the public. The Environment Agency is publishing its response to a parallel consultation on defining areas of water stress today.

Phil Woolas said:

"The terrible flooding we have seen recently came after more than two years of severe drought in some parts of the country. As the impacts of climate change on our weather and rainfall patterns increase, we have to face up to the fact that what we might now consider to be extremes could become more

commonplace. We need a flexible range of tools at our disposal if we are to manage supplies sustainably in the future.

"Metering saves water – around 10% per household – and it seems right to me that in seriously water-stressed areas the costs and benefits of compulsory metering are given consideration alongside other options.

"This is not a green light for universal metering, and it in no way absolves companies from their responsibility to deliver on leakage targets. Water companies will have to make a strong case in their 25 year forward plans for compulsory metering in their region to get approval to go ahead, demonstrating that metering offers the best value for water customers' money compared with the other options available, such as building new reservoirs. They will have to take into account the impacts on individual customers and particularly on vulnerable households. Their draft plans will be open to public consultation, so everyone in an affected area will have the chance to make their views known".
Inclusion of metering in long term management plans will come into effect after the price review 2009.

The calculation below gives the estimated costs and effects on customer bills resulting from achieving universal metering in AMP5. For a compulsory programme it is assumed, for practical reasons and staff safety, that all installations are external.

Costs

There is potentially some saving in external installation costs by a compulsory programme compared to the current optant/selective programme and we have assumed 20% due to being able to install at neighbouring properties. This may be an over estimation due to the way our current workforce is located and work planned to minimise travel between jobs already. Any advantage in cost savings is likely to be overstated as the number of boundary boxes available is likely to be less than 30% (average installation cost assumes 30% of unmeasured properties have an already installed but empty meter box) in the London Boroughs, where our meter penetration is lower.

For our current metering the following installation locations and costs are assumed:-

Optants

Internal with AMR	20% of meters @ £145.34p per meter
External without BB	50% of meters @ £333.43p per meter
External existing BB	30% of meters @ £52.20p per meter

Selectives

External without BB 70% of meters @ £333.43p per meter
External existing BB 30% of meters @ £52.20p per meter

Compulsory

External existing BB 30% of meters @ £52.20p per meter

External without BB 70% of meters @ (£333.43 - £52.20) x 0.8 + £52.20
= £277.18 per meter
(the cost of the meter, £52.20p, is constant whatever the programme therefore this cost is not reduced by 20% for a compulsory programme).

To achieve universal metering by 2015 would require the company to install 234,750 meters in the AMP5 period.

Using the location splits and costs above gives:
External existing BB 70,425 meters @ £52.20 = £3,676,185

External without BB 164,325 meters @ £277.18= £45,547,603

Total CAPEX = £49,223,788

There is also a significant increased operating cost per customer associated with twice annual meter reading, data input, billing and billing inquiries.
Assuming a 15 year asset life the capex/opex effect on an average bill is an increase of 6.8% equivalent to **£8.50 pa.**

Water saving

Unmeasured occupancy 3.03

234,750 x 3.03 = 711,295 customers

Dry year unmeasured PCC for 2015 = 169.32 l/h/d

at 8% saving = 711,295 x 13.54 l/h/d
= 9.63 Ml/d

but current option 1 has 78,750 meters being installed, therefore the additional potential saving is:- **6.4Ml/d**

Additional Capital cost per Ml/d

For 8% saving £30.54m ÷ 6.4Ml = **£4.77m/Ml/d**
(for comparison, the latest estimate for the Abberton Scheme is **£2.36m/Ml/d**)

Conclusion

Both Ofwat and Defra have said that they will support compulsory metering by companies only where it can be shown to be cost beneficial. Ofwat has slightly softened their stance by adding that where it cannot be shown to be fully cost beneficial on economic grounds, other, non economic benefits may be considered.
In the case of Essex a cost benefit case cannot be made, mainly because of the high cost of metering and relatively low water savings, meaning the current supply demand deficit cannot be closed by metering and therefore Abberton timing cannot be deferred or delayed. This then means customers would be subjected to the additional expense of metering with no removal of other expenditure, leading to unwarranted increase to water bills. Whilst the CBA is not nearly close enough for other, non economic benefits of universal metering to be considered, not understanding the EA's reasoning for wanting universal metering by 2015 in the first place, would make this "benefit" difficult to justify.

Option 3

ESW has reviewed whether there is scope to 'merge' the two options. This would mean going for a compulsory programme from 2010 to achieve universal metering by the end of 2020 and would equate to:-

234,750 meters ÷ 10.75 years = 21,837 meters pa.

Therefore for AMP5 ESW would need to install:-

21,837 x 5 = 109,185 meters

Under option 1 ESW already intend to install 78,750 meters, therefore the additional meters = 30,435 or 6,087 pa.

The benefit during AMP5 by moving from the Company's current optant/selective policy to this option would be fairly weak. ESW could not make a credible case for this option as the increased number of properties metered is not sufficiently significant in terms of numbers or demand savings over that already planned in option 1.

AMP 5 Strategy

The company has found the only feasible option, from the perspective of balancing the requirements of all of its stakeholders is Option 1. This shows that ESW has committed to have universal metering across the Essex resource zone by the end of 2020, and will have 60% of properties metered by 2015.
It should be remembered that metering customers per se is not the prize, the overall objective must be how best to encourage ESW's customers to use less water. The Company has had significant success over the last 10 years with its approaches to water efficiency, evidenced by the flat profile of unmeasured PCC by comparison with Industry trends. This has been achieved by working with our customers, who are the ones that must change their water use to save water, and we must ensure that this customer goodwill is maintained as we move to completion of metering across Essex. The changes to Part G of the Building Regulations and the introduction of Ofwat's water efficiency targets, as well as increasing metering, will all contribute to lower pcc going forward.

Intelligent Metering

In addition to installing meters to all properties, the company is also interested in whether or not intelligent meters would be more able to influence customer behaviour either by giving greater detail of their water use or by having more sophisticated water tariffs. ESW will be investing significant sums (unfunded by Ofwat) over the next two years to investigate a range of options with several trials planned. From this the Company will have good evidence as to the best way to encourage better use of water by our customers. In our draft Business Plan to Ofwat we proposed to install intelligent meters to new homes, optant and selective meters and to our significant AMP5 meter replacement programme. Because so little is known in the UK about how greater water use information or sophisticated tariffs lead to customers using less water, the additional cost of the intelligent, as opposed to the current dumb, meter could not be shown to be cost beneficial. Our proposal was therefore more a "leap of faith". However Ofwat would not accept the proposal as a cost benefit cannot be shown. On reflection their attitude is probably correct as the current trials we are beginning, and trials by other companies should inform the decision as to whether to change meter types from AMP6 onwards or not. Given other upward pressures on water bills at this difficult economic time, the cost of moving to intelligent metering before any benefits are known cannot be justified to our customers.
Properties currently unable to be metered

The other area where we are focussing is the (currently assessed) 15% of properties that are 'not meterable'. These are those properties on a 'schedule', flats or those with complex supply pipes. In the latter case, ESW is significantly accelerating our programme in Dagenham where there are some 30,000 properties with common supply pipes. This is a major investment for the Company, designed largely to reduce leakage in this specific area. The other advantage is that we will then be able to meter these properties. This work alone should make significant inroads into the unmeterable property figure; potentially enabling us to get universal metering closer to 90%.

ESW is also doing work on assessing the 'carbon' impact of all our demand management and resource development options. Whilst this is not complete, it is worth noting that when taking into account the installation and ongoing maintenance and reading costs of meters, it is not clear that this offsets carbon used in the marginal quantities of water saved.

Conclusion

ESW's proposed metering strategy is option 1.

In developing this approach, ESW has listened to and read the various views on metering from all of the major stakeholders. The Company has also taken account of what is physically manageable in terms of the annual number of meter installations required and the overall impact of the costs and timing of costs on our customers' bills, along with the possible water savings. Having due regard to all of the different pressures and drivers associated with metering ESW believes that option 1 is the most likely to be deliverable and acceptable to the majority of stakeholders and will thereby have the best chance of being allowed and implemented.

2015 and beyond

ESW's intention is to include compulsory metering in its draft WRMP2014 and to compulsorily meter all available properties in Essex by the end of 2020. At this stage we have made no decisions on the areas that would be chosen first to begin the compulsory programme but it is likely to be based on fully metering 3 areas of the Essex supply at any one time. By doing geographically disparate areas of the company simultaneously allows us to maximise the geographic spread of our workforce.
The number of annual meter installations and percentage meter penetration would be:

	2015/16	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**
Meters %measured	27,000 64	26,500 68	26,000 73	25,750 77	25,500 81	25,250 85

Beyond 2021

Having reached universal metering by the end of 2020 the company still anticipates continuing to meter the unmeasured properties through to at least 2035. Properties that are assumed to be “unmeterable” for the purpose of achieving universal metering, are able to be metered but at a much greater cost per meter than allowed per property to get to universal metering. Following the achievement of universal metering we consider that it will be acceptable to meter a much lower number of properties each year at a higher average cost. The properties chosen to meter may be ones that are involved in other types of work on the system in a similar way to the Dagenham supply pipe replacement work that has been mentioned. It is also possible that over this timescale some of the Local Authority properties currently on a schedule will revert back to become direct customers of the company. In addition to these opportunities there will undoubtedly be advances in meter technology that will allow currently unmeterable properties to be metered more easily and cheaply.

The forecast numbers of meters per annum beyond 2020 and the meter penetration is tabled below:-

Years	Meter Numbers pa	% penetration
2021/22 – 2024/25	5,000	89
2025/26 – 2029/30	2,000	91
2030/31 – 2034/35	2,000	93

Universal Metering

Universal Metering is the term adopted by the water industry to denote the level of metering possible without incurring unreasonable costs per meter installation or metering those properties that are on a “schedule”. The schedule is a mechanism that a number of Local Authorities, and a few private landlords with multiple properties, enter into with the company for the payment of the water rates on rented properties.

The company bills the Local Authority for the water supplied to their properties based on the rateable value. The Local Authority then charges its tenants a rent that includes an element within the rent for the provision of water. So far as the tenant is concerned they simply pay a rent to the property owner, but do not pay a water rate. These tenants are therefore not customers of the company, do not appear on our billing database and we do not have direct access to them. The local authorities do not want these properties metered for two reasons. Firstly, metering would give a variable charge, paid in arrears, as an element of the housing rent and would be more complex and more expensive to administer. Secondly, although a current tenant may opt for a meter because of single occupancy of that property, the system of allocation for public housing favours larger families. Therefore when the single, metered, tenant moves out they are likely to be replaced by a larger family for whom a water meter would be financially disadvantageous. Under the current law tenants have the right to a free meter, and a small number have been fitted to Local Authority houses, but as the tenants do not pay a direct water bill, opting for a meter is uncommon. In Essex there are approximately 52,000 properties on the schedule equating to almost 9% of the properties served in Essex.

In the past there were far more Local Authorities that were on the schedule but changed to a system that saw their tenants being directly billed by the water company. However, we have no evidence that the remaining ones have any intention of changing.

Whilst the properties excluded from universal metering are easy to enumerate from the schedule, the number that are excluded because of the disproportionate cost of installation of a meter are more difficult to define. To estimate this number we have to rely on the experience gained from our current selective metering programme. This suggests that a further 5 – 10% of properties are unmeterable, at currently allowable costs, due to the complexity or inadequacy of their supply pipes. Blocks of flats, although not as numerous in the Essex area as some areas of England, are often difficult to individually meter as the main supply of water goes into a tank in the roof area. The individual supplies from the roof tank are then inaccessible for a meter installation. A number of properties built between the wars and immediately following the 2nd World War also have complex common supply arrangements that make meter installation at reasonable cost unachievable.
Taking these two areas together we estimate that between 80 – 85% of the current housing stock is capable of being metered. Currently we are assuming that Universal metering is 85%.

Reports quoting 90%, or more, properties can be metered in a company's area are being overly simplistic. Different areas of the Country are bound to have different levels depending on a number of circumstances. Essex for instance saw a very rapid house building after the war to house Londoners bombed out during the Blitz. The houses were built quickly with common supply pipes. This level of building was not seen in the South and North of England, but was confined to the Counties surrounding London. Equally no company has got anywhere near universal metering, and most have never had a selective, let alone compulsory, metering programmes therefore the level of universal metering can only be a desktop estimate and may change considerably whem implemented.

Given our experience from 4 years of selective metering we are comfortable assuming 85% universal metering. Should a higher, or lower, level be found to be possible the number of installations will be altered during the compulsory programme.

5.3. Suffolk Metering

AMP4

The current AMP4 metering strategy has been a continuation of the optant metering programme. Progress to date is as stated below.

Optant meters:

	2005/06	**2006/07**
PR04	1500	1500
Actual	1359	1739
PR04 Cumulative	1500	3000
Actual Cumulative	1359	3,098

At the end of 2006/07 52.36% of properties in Suffolk were measured. This is higher than Essex and has come about purely from all new homes being metered since 1989 and through the optant metering programme, effectively started in 1997. The majority of the measured customers have come from the optant programme. The optant programme in Suffolk, because of the more favourable water resource situation, has not been stimulated to increase uptake as it has in Essex. Part of the reason for more people opting for a meter in our Suffolk area, compared to our Essex area, may be down to there being more second homes in Suffolk than Essex. In the case of a second, or weekend-only, home it is often economically more advantageous to opt for a metered supply but this is unlikely to account for the majority of the optant meters. This relatively high level of meter penetration is seen in the neighbouring water companies in East Anglia and seems to reflect a regional preference for paying a measured bill.

However, while the level of optants has been high it is likely to settle at lower levels going forward, continuing the decline in numbers from the past, as less than 50% of the homes remain unmeasured. Whilst there remain unmeasured properties there is always likely to be a number of optants as the current occupier's circumstances change in terms of occupant numbers. With only an optant policy in force in Suffolk at the moment, property buying will also generate additional optants. For the remainder of this AMP4 period we have slightly reduced the number of optants previously forecast because of the slow down in the housing market.

	2007/08	**2008/09**	**2009/10**
PR04	1500	1500	1500
Forecast	1618 (outturn)	1250	1250

This gives a forecast AMP4 outturn of 7,216 meters compared to the PR04 expected 7,500. The meter penetration for the end of AMP4 is now 57%.

AMP5

Essex & Suffolk Water is classified under the Environment Agency's methodology as "Seriously Water Stressed Area". As such Defra requires us to consider applying for Water Scarcity Status. The Suffolk area would not have been classified under the Environment Agency's methodology had it been a stand alone company. For this reason, combined with the fact that compulsory metering cannot be justified for Essex in AMP5 on cost benefit grounds, we do not consider it reasonable to propose compulsorily metering Suffolk.

However, we did propose moving to selective metering, on change of occupier, for AMP5 onwards in our draft WRMP to counteract the reducing number of Optants coming forward as meter penetration increases. We have been informed by Ofwat, in their Baseline report to the company, that they will not make an allowance in prices for selective metering as without a deficit in any of the 3 WRZs it cannot be shown to be cost beneficial. As such we have had to revert to optant only metering for Suffolk.
In AMP6 we would hope that it does become cost beneficial as some of the Sustainability Changes we have recently been informed of will make future resource development necessary.

The proposed meter numbers for AMP5 are:

	2010/11	2011/12	2012/13	2013/14	2014/15
Optants	1100	1100	1100	1100	1100
Selectives	0	0	0	0	0
Total	1100	1100	1100	1100	1100

This gives a total installation number of household meters over the AMP5 period of 5,500 and raises the measured rate from 57% to 64%.

AMP6 and beyond

The AMP6 strategy will be optant metering and selective metering and would be continued through to the end of the planning horizon (2035). With the forecast number of meters to be installed in each AMP as detailed in the table below:-

	AMP6	AMP7	AMP8	AMP9
Optant	3,750	2,500	500	500
Selective	6,000	4,750	2,500	1,250
Total	9,750	7,250	3,000	1,750
% measured	74	81	84	86

Universal Metering

Universal metering is the term adopted by the water industry to denote the level of metering possible without incurring unreasonable cost per meter installation or metering those properties that are on a “schedule”. The level of meter penetration in Suffolk, to reach universal metering, is likely to be higher than Essex as no properties in Suffolk are on a schedule. Universal metering will, therefore, be dictated by the number of properties with complex, therefore expensive to meter, supply pipe layouts. We currently estimate that it will be possible to reach 95% meter penetration in Suffolk, although experience gained when we begin selective metering will allow a more informed estimate.

Beyond AMP9 it may be necessary to introduce a relatively small compulsory programme into Suffolk to achieve universal metering.

5.3.1. Essex and Suffolk Meter Location

In AMP3 and AMP4 the optant metering programme was required to maximise the number of meters installed internally to minimise the overall capex costs. The selective programme was all externally metered. In AMP3 about 40% of installed meters were internal but during AMP4, because of the dominance of selective meters from the Essex area, only 20% of the total meters will be internally installed. Internal meters, although cheaper to install than an external meter that requires a new meter chamber, have a whole life cost that is very close to the whole life cost of a new external installation. This is because of the difficulty of gaining first time access to read the meter if no outreader is fitted, the short-life of an outreader and the poor reliability of outreaders. Additionally when it comes to replacing an internal meter it is more expensive than replacing an external meter. From a demand management perspective external meters are more effective at detecting supply pipe leaks than internal meters as any leakage is picked up by the meter and alerts the customer. ESW assume supply pipe leakage per externally metered property is a half that of an internally metered property.

For PR09 we are seeking an allowance in price limits to maximise the number of external meters being installed. Although a number of properties only lend themselves to the installation of an internal meter, the intention is to increase the external meter installations to 90% of meters installed in AMP5. The internal meters that still need to be fitted will now be intelligent meters, capable of transmitting the meter reading to a person walking past the property with a receiver. These “intelligent” meters being fitted will be capable of being simply adapted should more sophisticated intelligent meters be chosen by the company in AMP6.

5.4. Leakage Forecast

5.4.1. Background

LIMES models

In 1997/98, a strategic leakage economics models was developed for Essex and Suffolk Water, using the "LIMES" software package, which is based on the Bursts and Background Estimates (BABE) principles. These concepts were combined with those described in the 1996/97 series of UKWIR reports and those in the Managing Leakage Reports, to produce a model of a system in "steady state".

The model was based on 22 zones for the company, and represented the key elements of the company's supply network and leakage control infrastructure. It also simulated the operational process of leakage control. It then generated an assessment of the associated costs liable to be incurred in maintaining the steady state condition. The model did not include the cost of clearing out the backlog of unrepaired leaks and bursts, as this work was already complete by then.

Previous submissions and current positions

Since the original economic level of leakage (ELL) submission made in 1997/98, major reviews of the input data have been carried out at intervals of approximately two years. However, in that period no modifications have been made to the model itself. The most recent submissions were made as part of the Strategic Business Plans for PR04 and the interim ELL review in June 2007. Following on from the PR04 submission, the following glide path for leakage targets through the AMP4 period was agreed with Ofwat.

Annual Reporting Period	Leakage Target for NWL South (Ml/d)
2004/5	69.8
2005/6	69.1
2006/7	68.5
2007/8	67.9
2008/9	67.3
2009/10	66.6

The reported leakage level for 2006/07 in the Southern area was 68.0 Ml/d.

The Economic Level of Leakage

The 'economic level of leakage' is defined as the point at which the marginal cost of active leakage control equals the marginal cost of water lost through leakage.
This is equivalent to the statement made by Ofwat:

"It is generally accepted that expenditure on leakage control should be increased to the point where the incremental costs involved are in balance with the incremental costs of alternatives for balancing supply and demand, for example resource development or demand management (such as metering)".
The level of leakage control activity should be increased or reduced to the point where the marginal cost of finding an additional unit of water equals the marginal benefit derived from the water saved.

Although often presented as applying solely to leakage, the marginal benefit of water saved from leakage control is a function of the marginal cost of water provided by all of the other options, such as new water resources schemes or additional metering. This emphasises the integrated nature of the assessment and the importance of optimising across the full range of water supply and demand options.

5.4.2. The New ELL Model

Reasons for the new model

In 2007 NWL introduced a new ELL model to replace the LIMES model. The main reasons for this were as follows:

The LIMES models could not easily be adapted to the current network arrangement of system zones

The LIMES model is a traditional BABE model, and is therefore heavily reliant on the assumed burst flow rates, which are inevitably very uncertain. For this reason it is now considered that a model based on natural rates of rise (NRR) of leakage at district meter area (DMA) level will be more accurate.

NWL wished to have a model which could be used as an operational tool as well as a strategic model.

The new model is therefore an NRR-based model, with the economics of active leakage control being optimised at DMA level. The ELLs at DMA level are then simply summed to give the overall ELL at company level. As with LIMES, the new model is also applicable to a system in steady state.

Principles of the new model

A water undertaker has a choice of two operational options in response to increasing levels of leakage:
Increase the volume of water put into supply
Increase the level of effort on active leakage control (ALC).
Figure 5.4.1 illustrates the trade-off between the two options. Increasing the volume of water put into supply results in increased production costs (i.e. cost of water), which follows a linear relationship. The cost of increasing effort on active leakage control (ALC) is non-linear and shows diminishing returns. The total cost curve in Figure 5.4.1 is the sum of the marginal supply cost curve (the cost of water lost) and the manpower cost curve (the manpower costs incurred in undertaking ALC). It is at a minimum when the gradients of the two component curves are equal and opposite.

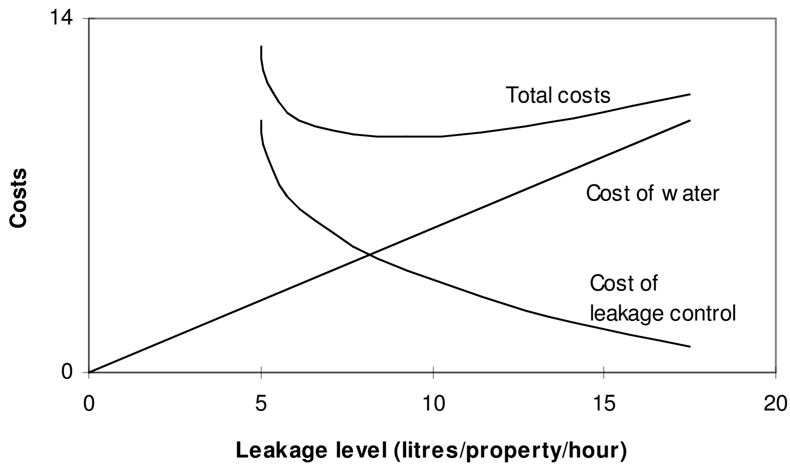


Figure 5.4.1 Leakage cost curves

Figure 5.4.2 represents the hypothetical behaviour of leakage in a DMA

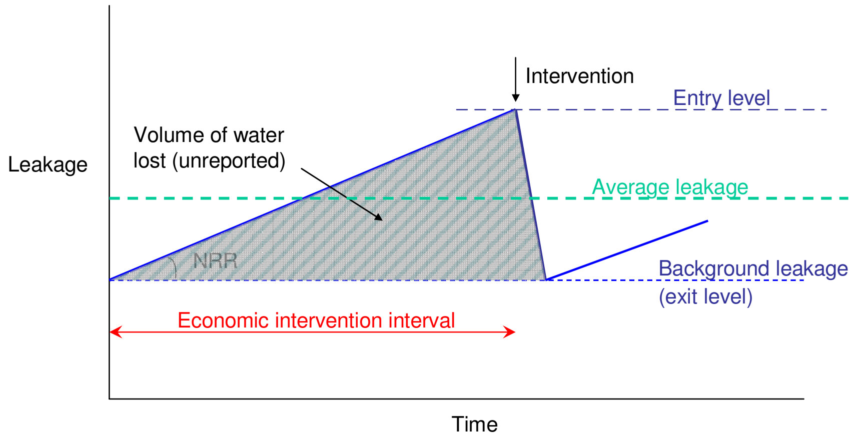


Figure 5.4.2 Hypothetical profile of leakage in a DMA

At time zero on Fig 5.4.2, an intensive leak detection and repair campaign has just been completed, and leakage has been reduced to the background level. Thereafter leakage rises at a gradient equal to the natural rate of rise. Eventually another leakage reduction campaign is undertaken, and leakage is again brought down to the background level. The shaded triangle represents the volume of water lost above the background level between interventions, i.e. water lost due to unreported burst leakage. It can be shown that the total cost to the company is a minimum when the value of the water lost between interventions is equal to the cost of the intervention. The intervention frequency will then be the economically optimum intervention frequency. The average leakage level in the medium or long term is at half the height of the triangle as shown, and this is the economic level of leakage for the DMA. The ELL for the company is then calculated by summing the ELLs for the DMAs.

Operational use of the model

Besides its use as a strategic ELL model, the new model will also be used as a tool for optimising the operation of each DMA. Initially the analysis described above will be used to calculate the economic intervention frequency for each DMA. However, the model is being built into a new "Leakage Campaign Planner" module of Netbase. Each week this model will allow NWL to assess retrospectively the value of the actual volume of water lost to date in a DMA, and will then project forward using the assessed NRR to forecast the probable intervention date for that DMA. Eventually an intervention will be triggered when the actual value of water lost is equal to the cost of the intervention. Intervention costs will be DMA-specific

Data sources

Background leakage levels and ICFs

Background leakage levels were identified for each DMA by analysing historical night flow data over an extended period, typically 6 years. The minimum leakage level sustained for a significant period, when the data passes all validity tests, is assumed to be the background leakage level. This derived level is then expressed as a proportion of the reference background leakage levels calculated from the relationships defined in "Managing Leakage". This ratio is termed the "Infrastructure Condition Factor" (ICF). Maximum and minimum limits are placed on this factor to reduce the likelihood of spurious results and to identify cases where further reductions in leakage should be possible.

Natural rates of rise of leakage

For ELL modelling, the Natural Rate of Rise (NRR) for a DMA is defined as the rate at which leakage will rise due to unreported bursts if no active leakage control takes place. A separate study was commissioned to derive NRR values for all DMAs in the Southern area. The method used followed exactly the recommendations of the UKWIR report on calculation of NRR, published in 2005.
The method involves analysis of time-sequences of minimum night flow data, and calculation of regression relationships for periods between consecutive unreported leak repairs. Short periods below a minimum duration are discarded, and the final NRR calculation is the average of the results from each regression period, weighted by the duration of each.

Burst frequencies

The average annual numbers of reported bursts on distribution mains, service pipes and supply pipes in each DMA were calculated from Netbase, using data from 2002 to 2006. Netbase automatically imports this data weekly from "Engarde", the company's work management system.

Unit costs of leak detection staff

These marginal costs include the direct costs of all leak detection technicians, both direct labour and contractors. The rates also include costs of supervision and support of these staff, as well as the equipment and vehicles required to carry out the work. However no on-costs are added.

DMA leakage survey costs

The model requires a predicted cost for a full leak detection survey in each DMA. These were calculated using "detection cost modelling analysis." Historical costs were compiled for recent surveys using several different survey procedures. Regression analyses were then performed to relate the number of man-hours required to the numbers of properties and length of mains within each DMA. The analysis was carried out for two different survey processes:

Noise logging in areas of non-plastic mains, followed by sounding of areas of interest identified, together with intensive sounding in plastic areas.

Intensive sounding of the whole DMA

Cost modelling for the first process used data from NWL's Southern area, and modelling of the second process used data from the Northern area. Both analyses made an allowance for a proportion of the DMAs requiring second and third pass surveys in order to reduce leakage to the exit level.

Reported leakage

The reported leakage component of the ELL is calculated from reported burst frequencies, reported burst flow rates and awareness, location and repair times.

Burst flow rates were derived as part of the calibration process for the natural rate of rise study. The numbers of each type of reported burst with appropriate burst flow rates are calibrated against the overall natural rate of rise (i.e. for reported and unreported bursts).

Awareness and location times are based on the company's processes for management of reported bursts, and are unchanged from the previous ELL model. The repair times for reported bursts were calculated by analysis of data from Engarde, the company's works management system, for repairs carried out in 2006/07.

Marginal costs of water

The short run marginal cost of water for each DMA comprises the marginal operating costs for electricity, treatment chemicals and sludge disposal, including all boosting and pumping costs within the network. Electricity costs are based on average flows for the past three years, together with the 2008/09 agreed electricity tariffs, and include both raw water and treated water pumping costs. Marginal treatment costs used for ELL analysis relate to the most expensive source within each zone.

However as there are currently headroom constraints in the South, the ELL relates to the long-run marginal cost of water, which also includes a capital deferment element derived from the least-cost resource planning model. This element of the marginal cost has not been reassessed for the draft or final Water Resource Management Plan, and the values derived from the PR04 modelling have been used.

The environmental, social and carbon costs of water have not yet been included in the ELL analysis. OFWAT has recently published a first draft of its proposed methodology for assessment of these costs, and NWL is one of two companies who are currently trialling this methodology on behalf of OFWAT. However the final version of this methodology will not be published until the autumn of 2008.

Property counts

Property numbers have been derived for each DMA from Netbase. Netbase uses a composite analysis of customer information imported from the corporate ICIS customer database, and geographic information on customer locations and DMA boundaries from the APIC GIS database. All of this data is updated in Netbase using an automated import routine on a monthly schedule.

Mains lengths

Mains lengths are derived for each DMA from Netbase. Netbase holds the APIC GIS database information and analyses the lengths of each material type and diameter within each of the DMA polygons.

Average zonal night pressure

Average zonal night pressures in each DMA are calculated within Netbase utilising the pressure data collected by telemetry. Each DMA has a designated pressure monitor, and the ground levels within the DMA are derived from the APIC GIS information.

Hour-day factors

The hour-day factor is a conversion factor applied to the night leakage value to derive a daily average leakage value. The conversion factor is derived using recorded diurnal pressure profiles from each DMA, together with an appropriate leakage-pressure relationship. Analyses are carried out for several different times of year. Hour-day factors for NWL South vary from 17 hours to 23.9 hours, with an average of 22.2 hours.

Results of ALC modelling

The resulting leakage-cost curve for active leakage control in the Southern area is shown in Figure 5.4.3.

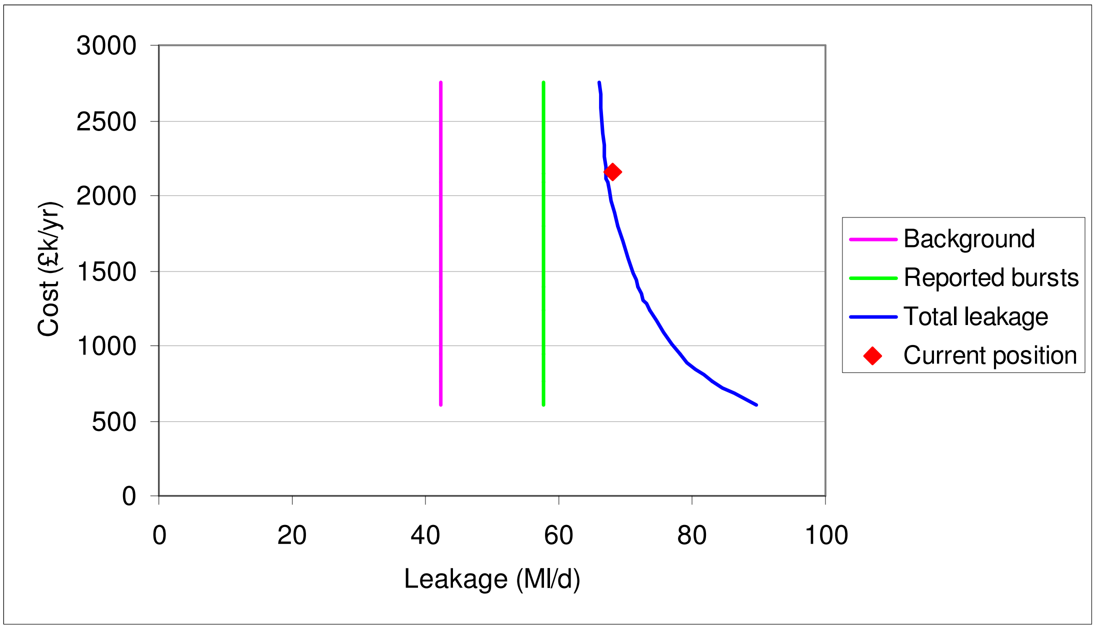


Fig 5.4.3 ALC cost curve for the Southern area

The model complies with all of the best practice principles set out in the 2003 Tripartite Report. In particular, Figure 5.4.3 shows that the point representing the current position, i.e. the current leakage level and the current annual expenditure, lies on the ALC curve for both areas. For this purpose, the calculation of current expenditure is consistent with the unit rates used for the derivation of the ALC cost curve itself, i.e. it includes all marginal costs relating to the active leakage control process.

5.4.3. Overall Economic Levels of Leakage

Consistency with bottom-up leakage calculation

MLE adjustments

The bottom-up leakage calculation of actual leakage is based on analysis of the company's records of minimum night flows in DMAs. However, in the MLE process, the final values of actual leakage as reported for 2006/07 were adjusted upwards. For NWL South, the average value of this adjustment over the past 8 years has been 1.7 Ml/d. It is implied by this process that the final post-MLE reported values are the best estimates of "true leakage", and that the bottom-up process underestimates true leakage by these amounts.

The key parameters in the ELL model are the background leakage levels and the natural rates of rise. Both of these are derived from analysis of the same records of minimum night flows in DMAs, as the ELL model is basically a bottom-up process. Therefore it should be assumed that these parameters have been underestimated by the same amounts as the MLE adjustments. Thus, in order to ensure that the ELL calculation is consistent with the bottom-up calculation of actual leakage, as required by the Tripartite Report, the same adjustment is added to the ELL value from the ALC model.

Trunk main leakage

As all trunk mains are contained either in DMAs or in dummy DMAs, it is assumed that trunk main leakage is already included in the bottom-up calculation of actual leakage. The same assumption is made in the ELL assessment, so no separate allowance has been added to the ELL for trunk main leakage.

Service reservoir leakage

As service reservoirs are outside of the DMAs and dummy DMAs, leakage from this source was considered separately in the bottom-up analysis. However, for NWL South, field data has consistently shown that this source of leakage is negligible, so no allowance has been added to the modelled ELL.

5.4.4. Final economic levels of leakage

The results of the processes described in 5.4.4, and the final value of the economic level of leakage for NWL's Southern area, is shown in the following table.

	Essex	Suffolk	Total
ELL from ALC modelling (Ml/d)	60.8	6.0	66.8
MLE adjustment (Ml/d)	1.7	0.0	1.7
Service reservoir leakage (Ml/d)	0.0	0.0	0.0
Final Economic Level of Leakage (Ml/d)	62.5	6.0	68.5

5.4.5. Future Leakage Targets

Comparison of the table above with the table in Section 5.4.1 shows that from 2007/08 onwards the leakage target will be below the ELL of 68.5. However, from 2008/09 onwards the Company is promoting a programme of leakage-driven mains renewals, and also a programme of renewals of common service pipes in the Dagenham area. It is expected that this will result in a fall in the ELL of 0.3 Ml/d per year. This means that the ELL will fall to the 2009/10 target by 2015/16, so it is proposed that the target should remain at this level (66.6 Ml/d) until at least that date. It follows that to achieve a target of 66.6 Ml/d prior to 2015, the Company will have to operate "uneconomically".

Proposed targets for years beyond 2015/16 will be reassessed in PR14. At that stage, better information will be available on the infrastructure renewal programmes which have been funded in AMP5, and the benefits gained from these. Also, by that date the Abberton enlargement will be complete, and the long run marginal cost of water will change significantly. Therefore at this stage it is assumed that targets beyond 2015/16 will remain at 66.6 Ml/d.

The resulting profiles of ELLs and proposed leakage targets are detailed in the following table:

AMP	Annual Reporting Period	Predicted ELL (Ml/d)	Proposed leakage target (Ml/d)
AMP4	2007/8	68.5	67.9*
	2008/9	68.5	67.3*
	2009/10	68.2	66.6*
AMP5	2010/11	67.9	66.6
	2011/12	67.6	66.6
	2012/13	67.3	66.6
	2013/14	67.0	66.6
	2014/15	66.7	66.6
AMP6	2015/16	66.6	66.6
	2016/17	66.6	66.6
	2017/18	66.6	66.6
	2018/19	66.6	66.6
	2019/20 and beyond	66.6	66.6

* targets agreed at PR04

6. CLIMATE CHANGE

6.1. Introduction

This chapter outlines how climate change has been considered within ESW's WRMP.

The effects of climate change on both baseline supply and baseline demand have been considered using guidance indicated in the Water Resources Planning Guideline (Environment Agency, 2008a), associated supplementary guidance released in November 2007, and Ofwat's Water Supply and Demand Policy (Ofwat, 2008).

The fundamental basis for assessing climate change has been the scenario and subsequent derivative forecasts produced from the UK Climate Impacts Programme (UKCIP) in 2002. These forecasts have been used in deriving guidance for water resource planning purposes by UKWIR and the Agency. Due to the required timing for production of WRMPs, it will not be possible to take account of the latest UKCIP08 scenarios since they are not due for publication until spring 2009. However, in order to evaluate whether climate change is driving investment in AMP5, additional scenarios have been developed with climate change removed from the assessment.

6.2. Effect of Climate Change on Supply

The impact of climate change on supply has been considered in terms of:

(1) the explicit effect on deployable output. This has been defined for three scenarios namely; wet, Mid and dry. The Mid scenario has been chosen as the central scenario to be included within deployable output in the supply-demand balance (as per Agency WRPG).

(2) the uncertainty on the effect on deployable output as described in target headroom (using triangular distributions defined by minimum, best estimate and maximum scenarios)

The above assessment has effectively resulted in a defined envelope of climate change that can be defined for deployable output, and ultimately for WAFU.

The above information has been used to illustrate the effect of climate change on supply in each resource zone both in tabular and graphical format. The following sections give a brief synopsis as to how climate change has been considered followed by summary information of the results.

6.2.1. Assessment of Groundwater (Essex & Suffolk Supply Areas)

Supplementary guidance to Chapter 8 of the WRPG (Environment Agency, 2007a) suggests using a groundwater model for assessing the impact of climate change on groundwater sources. Where a model is not available, as is the case with ESW, the guidance suggests examining the vulnerability of individual source yields in drought conditions.

Although the WRPG provides a means of determining changes in groundwater recharge due to climate change impacts, this is of no benefit unless recharge can be directly related to water levels at individual groundwater sources.

In the assessment of climate change on groundwater source yields ESW have evolved the semi-quantitative approach used during the last periodic review. This approach uses historic information relating to available drawdown in drought periods based on data assessed as part of the determination of deployable outputs of the Company's groundwater sources (ESW, 2003 & Mott MacDonald, 1997). Information was obtained on the lowest drought non-pumping water level, the lowest depth of drought curve and the total depth of each groundwater source. The deepest advisable pumping water level (DAPWL) was also confirmed or where appropriate was re-calculated as indicated in the 1995 UKWIR methodology (UKWIR, 1995a).

Available drawdown for each source was then determined (in metres) by subtracting the base of the drought curve from the DAPWL. This was then expressed as a percentage of the total depth of the well or borehole, which effectively represents the percentage change in head of water required before the DAPWL is reached. Sources with a low percentage are clearly at greater risk to the impacts of climate change than sources with a high percentage.

The groundwater sources were then ranked into medium-high and low vulnerability to climate change dependent on the relative quantum of the calculated percentages of change in head. The medium-high and low vulnerability sources were then assigned categories based on an assumed reduction in percentage of the source's deployable output, as defined in the following table:

Change in head of water required to reach DAPWL	Level of Vulnerability	Reduction in DO (%) in 2025
<10% >10%	Medium-High Low	25 1

The result of the assessments for all ESW groundwater sources was the Juby Farm, Rickinghall, Roding and Linford sources fell into the medium-high vulnerability category while all other sources (the vast majority) fell into the low category.

The reduced deployable outputs were considered to be equivalent to the 2025 'dry' climate change scenario in the case of Essex and the 2025 'mid' climate change scenario in the case of Suffolk, with the scenario names being analogous to those defined for surface water sources under the WRPG (Environment Agency, 2007a).

The envelope of scenarios in 2025 was then defined as follows:

- For the Essex wells the remaining mid and wet scenarios were determined by proportioning to the same ratio of the deployable output values determined for the climate change scenarios for Essex System.

- For the Suffolk groundwater sources the remaining dry and wet scenarios were determined by proportioning to the same ratio of the Q90 flows determined for the climate change scenarios for the River Waveney at Needham.

Scaling factors included in the WRPG supplementary guidance (Environment Agency, 2007a) were then used to obtain a profile of climate change throughout every year of the planning horizon by extrapolating forward and backward from 2025.

The above information was then used to define uncertainty in the effect of climate change as required within target headroom component S8. This was manifested as a triangular distribution for every year within the planning horizon utilising the envelope of the dry and wet scenario values relative to the mid scenario value.

The results of the climate change assessment for groundwater sources will be presented in a separate headroom report to be produced post draft WRMP submission.

6.2.2. Surface Water - Essex Resource Zone

The bulk of the Essex resource zone supply is provided by the Essex System which is represented in the Aquator water resources system model. Of the other components to Essex supply:

- Thames Water Utilities have indicated that they have assumed no effect of climate change on the Chigwell bulk supply, hence no assessment has been required.

- The smaller proportion from groundwater has also been assessed for the effects of climate change as previously indicated.

In terms of the Essex System the work to define climate change scenarios, as previously described in Chapter 3 on deployable output is summarised in the following sections.

Supplementary guidance relating to the assessment of the effects of climate change on baseline deployable output has been provided in the Environment Agency's WRPG (Arnell & Reynard, 2007).
The recommended methodology requires a number of scenarios to be assessed to derive a baseline deployable output value for the Essex System and the associated climate change effects. The scenarios assessed are indicated as follows:

Deployable Output Flow Scenario	Description
Baseline	No climate change
Baseline Climate Change Mid	Respective Mid, Wet and Dry climate change monthly flow factors for 2025 applied to naturalised flow record in Aquator
Baseline Climate Change Wet	
Baseline Climate Change Dry	

The Environment Agency's methodology does not recommend scenario 1 to be carried out, however, ESW felt it was appropriate to present this scenario in order to provide clarity on the effect the climate change factors have on the baseline deployable output. The results of the scenarios assessed are presented in the table below.

Scenario	Year	Deployable Output (Ml/d)
Baseline	2007 – 2035	298
Baseline Climate Change Mid	2025	290
Baseline Climate Change Wet	2025	321
Baseline Climate Change Dry	2025	259

The deployable output values for the climate change scenarios are the anticipated values for 2025. In order to incorporate this information into the whole planning horizon it was necessary to interpolate between 2007 and 2040 for the scenarios where climate change factors were applied. This was carried out in accordance with the Environment Agency's guidance (Arnell & Reynard, 2007).

6.2.3. Surface Water – Northern/Central Zone

In the Suffolk supply area, surface water is only a component of supply in the Northern/Central zone; in the form of the River Waveney, River Bure, Ormesby Broad and the Lound/Hopton Ponds and Fritton Lake System.

The Environment Agency guidance on the assessment of climate change on supply (Environment Agency, November 2008) builds on UKWIR CL04 surface and groundwater reports (UKWIR, 2007b & 2007c) and uses the UKWIR06 scenarios and integrated spreadsheet v2.4.

In the case of the Suffolk river water abstractions from the River Waveney and the River Bure, no rainfall-runoff model is available and the respective river catchments under consideration were not used in the UKWIR CL04 study. Method 1b was therefore applied to derive the relevant flow factors to be used in the climate change assessment. This method requires an estimation of the catchment Base Flow Index (BFI). Information on the BFI for each catchment was obtained from the Hydrometric Register and Statistics 1996-2000 (CEH, 2003). The BFI were then inserted into the integrated spreadsheet v2.4, and the resulting flow factors used to carry out an assessment of the effects of climate change on each of the catchments under consideration. The details of the analysis carried out for each river are provided in the following sections.

River Waveney

The flow factors derived from the integrated spreadsheet v2.4 were imported into the *Aquator* model of the River Waveney abstraction and applied to the naturalised flow data for the River Waveney in this model.

The recommended methodology requires a number of scenarios to be assessed to derive a baseline deployable output value for the Waveney abstraction and the associated climate change effects. The scenarios assessed were as follows:

Deployable Output Flow Scenario	Description
Baseline	No climate change
Baseline Climate Change Mid	Respective Mid, Wet and Dry climate change monthly flow factors for 2025 applied to naturalised flow record in Aquator
Baseline Climate Change Wet	
Baseline Climate Change Dry	

Deployable output calculations were carried out in the *Aquator* model of the River Waveney to determine the effects of the flow factors on the yield of the abstraction at the Shipmeadow intake. The results of the scenarios assessed are presented in the table below.

Scenario	Year	Deployable Output (Ml/d)
Baseline	2007 – 2035	13.5
Baseline Climate Change Mid	2025	9.0
Baseline Climate Change Wet	2025	13.5
Baseline Climate Change Dry	2025	9.0

The *Mid* and *Dry* climate change scenarios both produced a deployable output value of 9Ml/d. The reason there is no apparent difference in yield between these scenarios is due to the operation of the WAGS boreholes.

Under the dry climate change scenario, increased volumes of water are made available from the WAGS boreholes to mitigate against the lower flows experienced under this climate change scenario, compared to the *Mid* climate change scenario. Similarly, less river support is required from WAGS under the *Wet* climate change scenario than is required under either the *Mid* or the *Baseline* scenarios.

The deployable output values for the climate change scenarios are the anticipated values for 2025. In order to incorporate this information into the whole planning horizon it was necessary to interpolate between 2007/08 and 2034/35 for the scenarios where climate change factors were applied. This was carried out in accordance with the Environment Agency's guidance (Environment Agency, November 2008). The results of the application of this scaling factor are presented in the table below in terms of the beginning and end of the planning horizon:

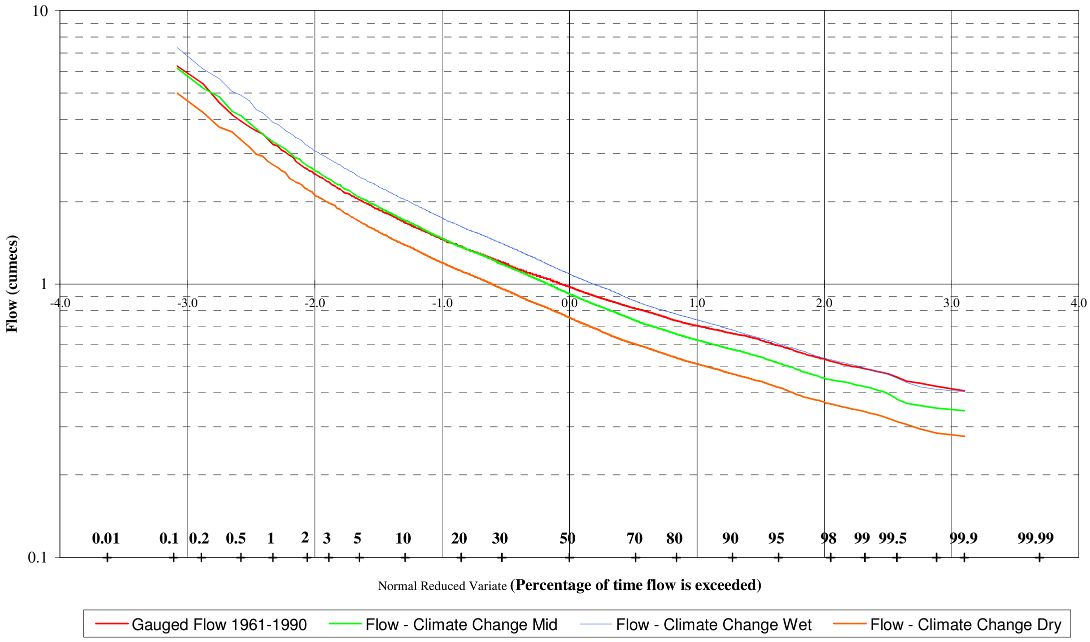
Climate Change Scenario	**2007/08 (Ml/d)**	**2025 (Ml/d)**	**2034/35 (Ml/d)**
No climate change	13.5	13.5	13.5
Mid	13.5	9.0	8.19
Wet	13.5	13.5	13.5
Dry	13.5	9.0	8.19

The Environment Agency climate change guidance recommends that the Mid climate change scenario be taken as the baseline deployable output. The Wet and the Dry scenarios are therefore used to define the uncertainty associated with climate change for the purposes of the headroom assessment. The distribution used in headroom for the Waveney abstraction is a minimum of 0Ml/d, to represent the effect of the wet scenario, a maximum of +4.5 Ml/d to represent the effect of the dry scenario and a most likely of 0Ml/d to represent the Mid scenario. Again, this distribution is for 2025 and is therefore applied across the planning horizon using scaling factors as per the Environment Agency's guidance (Environment Agency, November 2008).

River Bure

The flow factors derived from the integrated spreadsheet v2.4 were applied to the gauged flow record at Ingworth from 1961 to 1990. The flow record at Ingworth was adjusted using the flow factors to produce a revised record reflecting the possible effects of the Mid, Wet and Dry climate change predictions. Flow duration curves (FDC) were produced representing each of the flow records to illustrate the predicted change in flow frequency as a result of climate change. A flow duration curve for the whole of the gauged record assessed can be seen at figure 3.

Figure 3: Flow Duration Curve for River Bure @ Ingworth



Under the conditions of ESW's River Bure abstraction licence the total combined volume of water authorised for abstraction from the intakes on the Bure is 27.1Ml/d. The total annual abstraction volume is an aggregate quantity of 100,000Ml combined with the surface water abstractions at Ormesby Broad and the groundwater abstractions at Juby Farm and Grange Farm. The deployable output of each of these sources is determined by distributing the annual aggregate between each of the sources to generate a daily abstraction value for each source. Based on this methodology, the abstraction from the Bure has a deployable output of 17.8Ml/d.

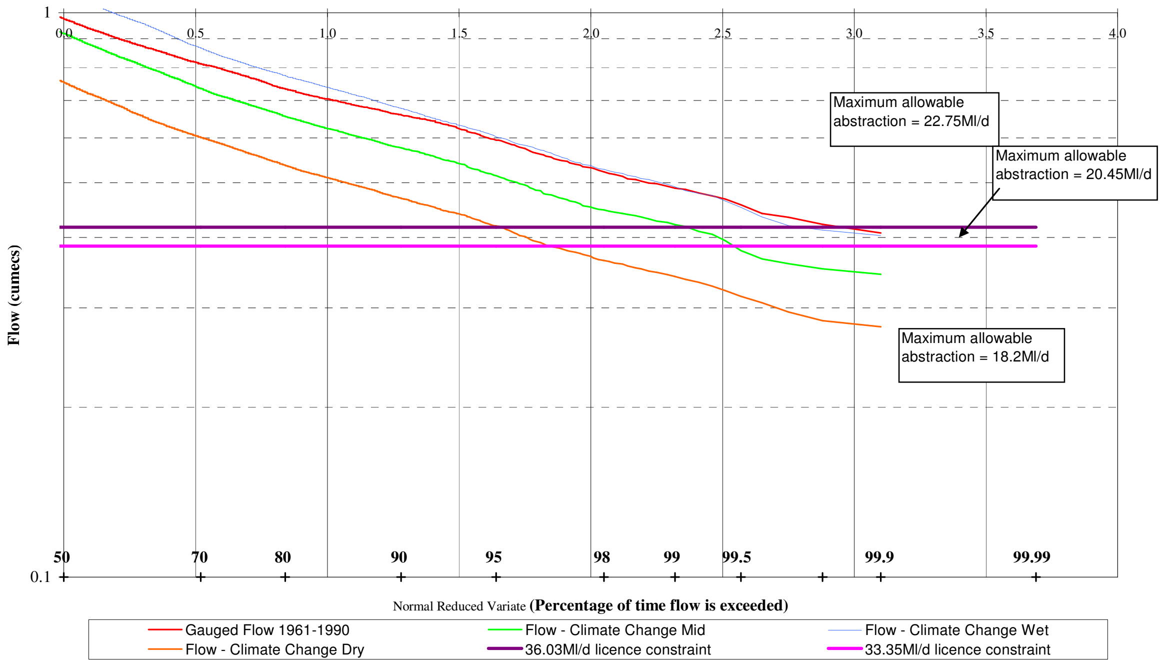
Under the East Anglian (Bure Valley) Water Order 1964, the quantity of water abstracted from the Bure is limited by the flow conditions in the river at Ingworth. The Table below summarises the maximum allowable abstraction volumes associated with reduced flows at Ingworth gauging station.

River Bure at Ingworth (Ml/d)	Maximum allowable abstraction (Ml/d)
>36.03	22.75
36.03 to 33.35	20.45
<33.35	18.2

The maximum allowable abstraction associated with the minimum threshold is greater than the deployable output of the intakes on the Bure. Any change in flows on the River Bure associated with climate change are therefore not likely to affect the volumes of water that can be abstracted under the terms of the existing licence.

The gauged flow record at Ingworth was assessed to provide an understanding of the likely effects of climate change on flow in the Bure. A FDC was produced for the gauged flow record and each of the climate change adjusted records. The upper end of the flow duration curve in the context of the licence restrictions is presented in figure 4. This illustrates where the licence restricting flow appears in the context of the flow duration curves, and that the flow frequencies under consideration are all in excess of 95% (percentage of time flow exceeded).

Figure 4: Flow Duration Curve for River Bure @ Ingworth



Based on the above assessment and the deployable output value for this source in the context of the daily licence volume and the restrictions based on flow availability, ESW has determined that there is little risk to this source from the effects of climate change. The deployable output of this source throughout the planning horizon has therefore been set at 17.8 Ml/d, with no allowance made in the headroom uncertainty calculation.

Ormesby Broad

Work undertaken as part of the ESW's contribution to the Agency's Review of Consents under the National Environment Programme has confirmed that the Trinity Broads (of which Ormesby Broad is a part), are largely groundwater fed. This being the case the climate change effects on Ormesby Broad were considered in a similar manner to the majority of the Suffolk groundwater sources that were identified as having a low vulnerability to change in water level. Accordingly a 1% reduction in source deployable output was assumed for the 'mid' scenario. The remaining dry and wet scenarios were determined by proportioning to the same ratio of the Q90 flows determined for the climate change scenarios for the River Bure at Ingworth.

Loud/Hopton Ponds and Fritton Lake System

Similarly to Ormesby Broad the Loud/Hopton Ponds and Fritton Lake system appears to be largely groundwater fed and hence an identical approach was adopted. The lower vulnerability class for both sources is reflected by their resilience in drought periods.

6.3. Climate Change Effects on Supply - Results

The defined envelope of climate change for each resource zone is illustrated in the following sections in the form of summary tables and graphs.

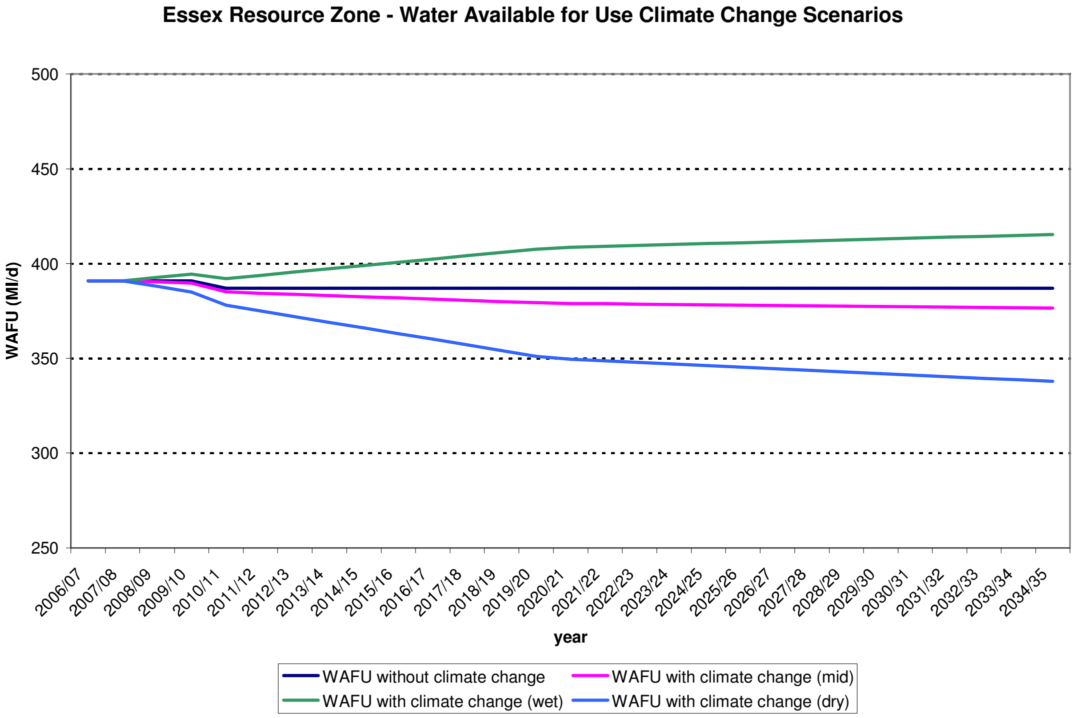
Essex Resource Zone

The envelope, as defined by the wet (upper) and dry (lower) climate change scenarios widens to 77 Ml/d by the end of the planning horizon (2034/35).

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
None	391.02	391.02	387.02	387.02	387.02	387.02	387.02
Mid	391.02	389.76	382.61	379.45	378.37	377.48	376.60
Wet	391.02	394.46	399.06	407.66	410.62	413.03	415.43
Dry	391.02	385.06	366.15	351.24	346.11	341.94	337.76

Effect of Climate Change on Essex WAFU forecasts (Ml/d)

The Mid climate change scenario, which has been selected for planning purposes in accordance with the WRPG, lies immediately below the no climate change scenario with the difference between the two scenarios widening to 10.4 Ml/d by the end of the planning horizon.



Suffolk Resource Zones

For all the Suffolk resource zones it should be recognised that the wet forecasts should be interpreted with some caution as existing licence and related infrastructure constraints have not been applied. This is because under a continuously wet scenario it is assumed that current abstraction licence limits might be increased to reflect additional water availability.

Additionally it should be noted that the baseline (no climate change forecast) for all the Suffolk resource zones shows a slight increasing trend over the planning horizon due to the assumed potential to reduce process losses from many of the Suffolk WTW's from AMP6 onwards.

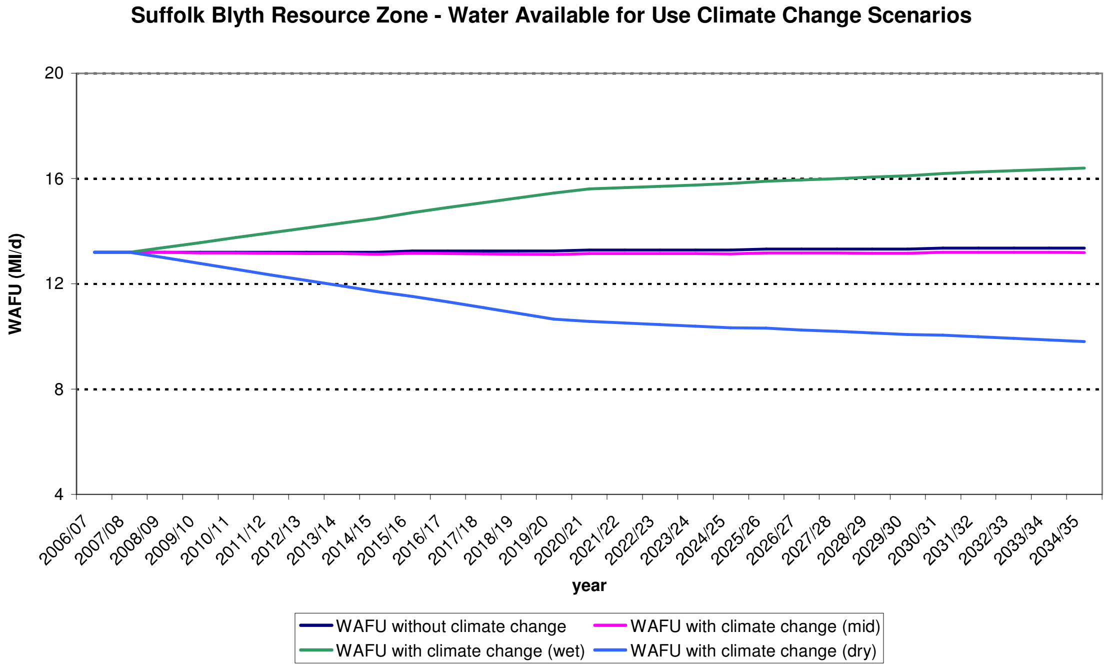
Suffolk Blyth Resource Zone

The envelope, as defined by the wet (upper) and dry (lower) climate change scenarios widens to 6.6 Ml/d by the end of the planning horizon (2034/35).

The Mid climate change scenario, which has been selected for planning purposes in accordance with the WRPG, lies very close to and just below the no climate change scenario with the difference between the two scenarios widening to only 0.18 Ml/d by the end of the planning horizon.

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
None	13.21	13.21	13.21	13.25	13.29	13.33	13.37
Mid	13.21	13.19	13.14	13.13	13.15	13.17	13.19
Wet	13.21	13.58	14.50	15.46	15.81	16.11	16.41
Dry	13.21	12.78	11.70	10.67	10.34	10.08	9.81

Effect of Climate Change on Blyth WAFU forecasts (Ml/d)



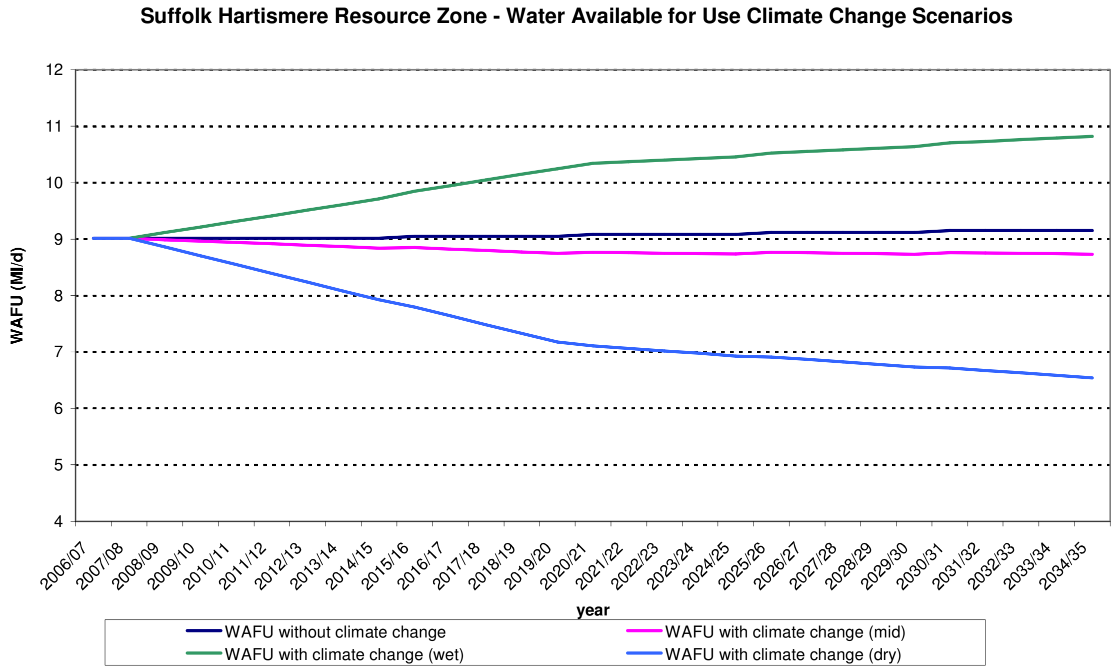
Suffolk Hartismere Resource Zone

The envelope, as defined by the wet (upper) and dry (lower) climate change scenarios widens to 4.28 Ml/d by the end of the planning horizon (2034/35).

The Mid climate change scenario, which has been selected for planning purposes in accordance with the WRPG, lies immediately below the no climate change scenario with the difference between the two scenarios widening to 0.42 Ml/d by the end of the planning horizon.

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
None	9.01	9.01	9.01	9.05	9.08	9.12	9.15
Mid	9.01	8.96	8.84	8.75	8.74	8.73	8.73
Wet	9.01	9.21	9.71	10.25	10.46	10.64	10.82
Dry	9.01	8.70	7.92	7.17	6.93	6.74	6.54

Effect of Climate Change on Hartismere WAFU forecasts (Ml/d)



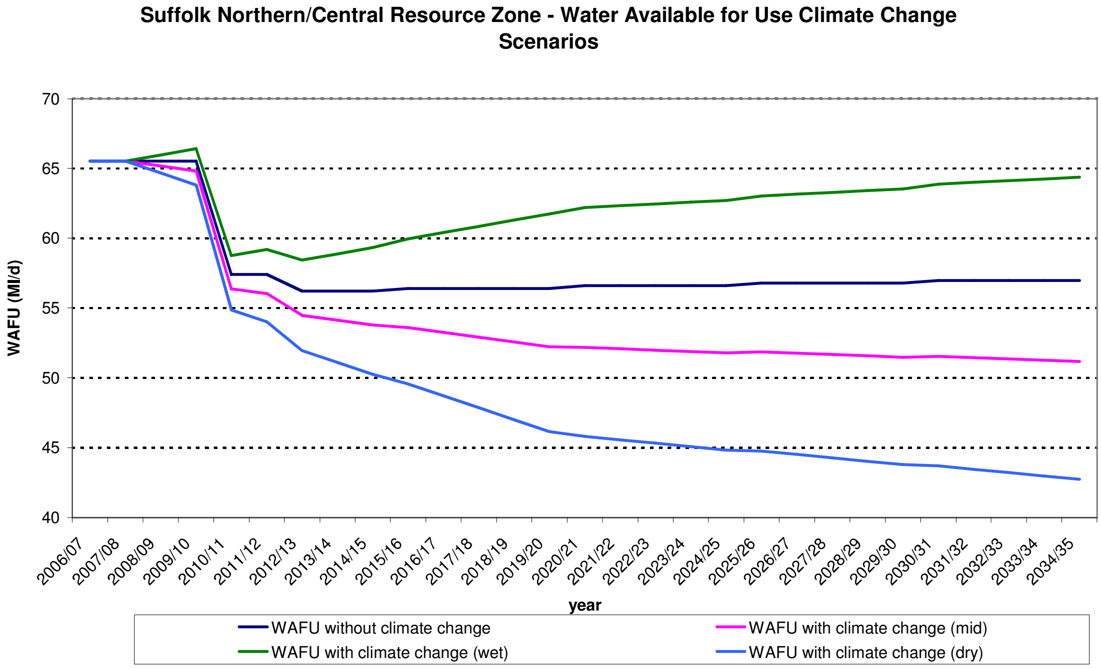
Suffolk Northern/Central Resource Zone

The envelope, as defined by the wet (upper) and dry (lower) climate change scenarios widens to 21.6 Ml/d by the end of the planning horizon (2034/35).

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
None	65.52	65.52	56.22	56.41	56.60	56.79	56.98
Mid	65.52	64.83	53.78	52.22	51.79	51.48	51.16
Wet	65.52	66.41	59.32	61.74	62.71	63.54	64.37
Dry	65.52	63.82	50.25	46.15	44.84	43.79	42.74

Effect of Climate Change on Northern/Central WAFU forecasts (Ml/d)

The Mid climate change scenario, which has been selected for planning purposes in accordance with the WRPG, lies approximately below the no climate change scenario, with the difference between the two scenarios widening to 5.8 Ml/d by the end of the planning horizon.



There are two notable dips in WAFU for all scenarios in 2010 and 2012. The dip in 2010 is due to the Geldeston Meadows sustainability reduction being applied, and the dip in 2012 is due to the potential loss of the Southwold sourceworks due to the impact of the Blyth Strategy, as detailed in section 3.2.4.

6.4. Effect of Climate Change on Demand

The impact of climate change on demand has been considered in terms of:

(1) the explicit effect on distribution input. This has been defined for two scenarios as outlined in the applicable guidance, CCDeW (Defra, 2003); namely low and medium/high. The low scenario has been chosen as the central scenario to be included within deployable output in the supply demand balance (as per WRPG (Environment Agency, 2007a)).

(2) the uncertainty on the effect on distribution input as described in target headroom (using triangular distributions defined by zero, best estimate and maximum scenarios)

The above assessment can also enable definition of an envelope of climate change. Such an envelope can be defined for each weather scenario considered in demand forecasts (principally dry, but also normal and wet).

The above information has been used to illustrate the effect of climate change on demand in each resource zone both in tabular and graphical format. The following sections give a brief synopsis as to how climate change has been considered followed by this summary information of the results.

6.4.1. Methodology

As stated previously, the effects of climate change on domestic demand have been based upon regional estimates as reported in CCDeW (Defra, 2003), which itself is based upon UK Climate Impacts Programme's climate scenarios and the Environment Agency water demand scenarios (EA, 2001). The Anglian Region BETA reference (World markets) scenariosfrom the CCDeW report were used, as it was deemed that these reflected best the economic situation in the area.

The CCDew report provides regional estimates of the climate change impacts on domestic demand, which for the Anglian Region are represented by the following factors:

Alpha and Beta Reference Scenarios		
Low 2020s	**M-High 2020s**	**M-High 2050s**
1.45	1.84	3.04

The impacts are also represented by the following contribution of microcomponents:

Three Valleys	Beta 2020s	Beta 2050s
Garden	33.3%	21.7%
Car	3.7%	5.2%
Misc.	0.5%	0.5%
Bath	62.4%	72.6%
Total	1.7%	3.1%

The CCDeW 'Low' scenario has been applied to the demand forecasts to produce the Most Likely distribution input. The CCDeW 'Med-High' scenario has been used to produce the Maximum effect on distribution input. The

Minimum effect on distribution input assumes that there will be no climate change.

The 2020s scenarios have been interpolated between the 2007/8 and 2025, whilst the 2050s scenario has been interpolated between 2026 and 2055.

Within the microcomponent model each of the above microcomponents has been adjusted according to the percentages above. The household demand components not forecast through the microcomponent model (selectives and optants) have had their total PCCs adjusted by the overall percentage.

It has been assumed that household demand is the only component of demand affected by climate change.

6.5. Climate Change Effects on Demand - Results

Envelopes of climate change for the respective weather forecasts (i.e. dry, normal and wet year) of baseline distribution input have been defined for each resource zone and are described in the following sections. The envelopes are notably much narrower than those defined for equivalent WAFU scenarios.

In all cases it is notable that the low and medium-high scenarios (for all weather scenarios) appear very close together.

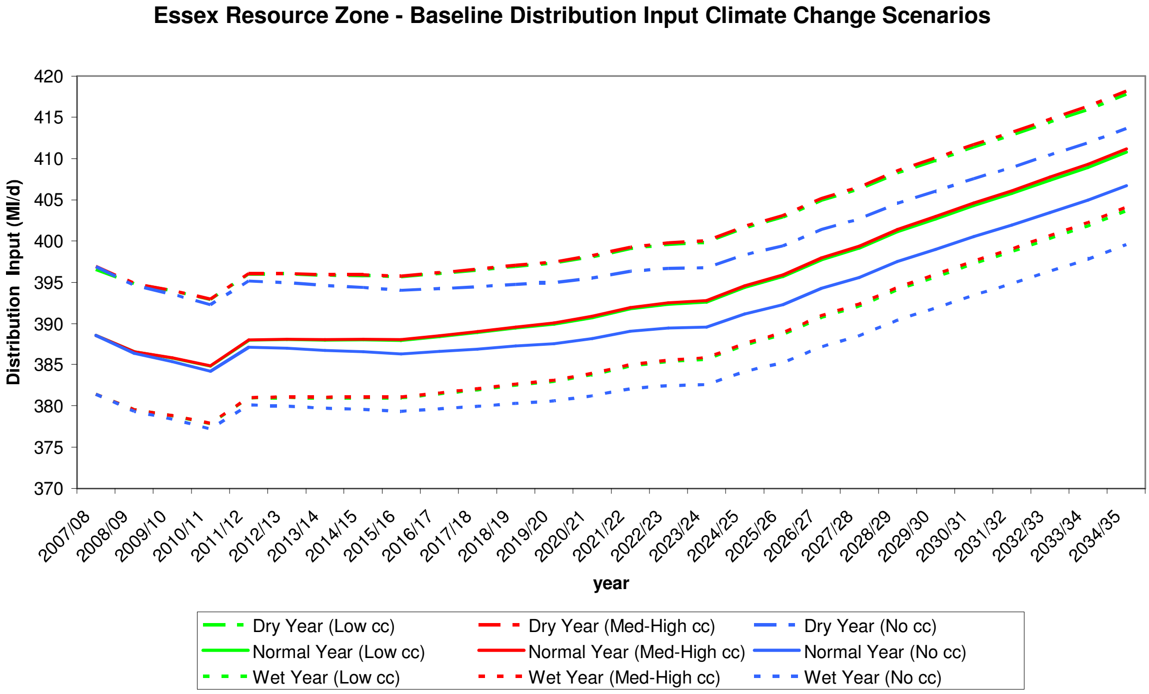
Essex Resource Zone

The envelopes of climate change for each weather scenario, as defined by the Med-High and no climate change scenarios widen to approximately 4.5 Ml/d by the end of the planning horizon (2034/35) in all cases.

The range of all the weather scenarios considered, as defined by the extremes of wet year with no climate change, and dry year with med-high climate change equates to 18.6 Ml/d by 2034/35.

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year Forecast							
Med-High	396.91	394.00	395.91	397.48	401.81	410.06	418.17
None	396.91	393.55	394.38	394.96	398.33	406.02	413.64
Normal Year Forecast							
Med-High	388.55	385.83	388.08	390.04	394.57	402.95	411.16
None	388.55	385.38	386.57	387.55	391.14	398.97	406.69
Wet Year Forecast							
Med-High	381.40	378.82	381.10	383.11	387.60	395.94	404.10
None	381.40	378.37	379.57	380.59	384.12	391.90	399.56

Effect of Climate Change on Essex DI forecasts (Ml/d)



Suffolk Blyth Resource Zone

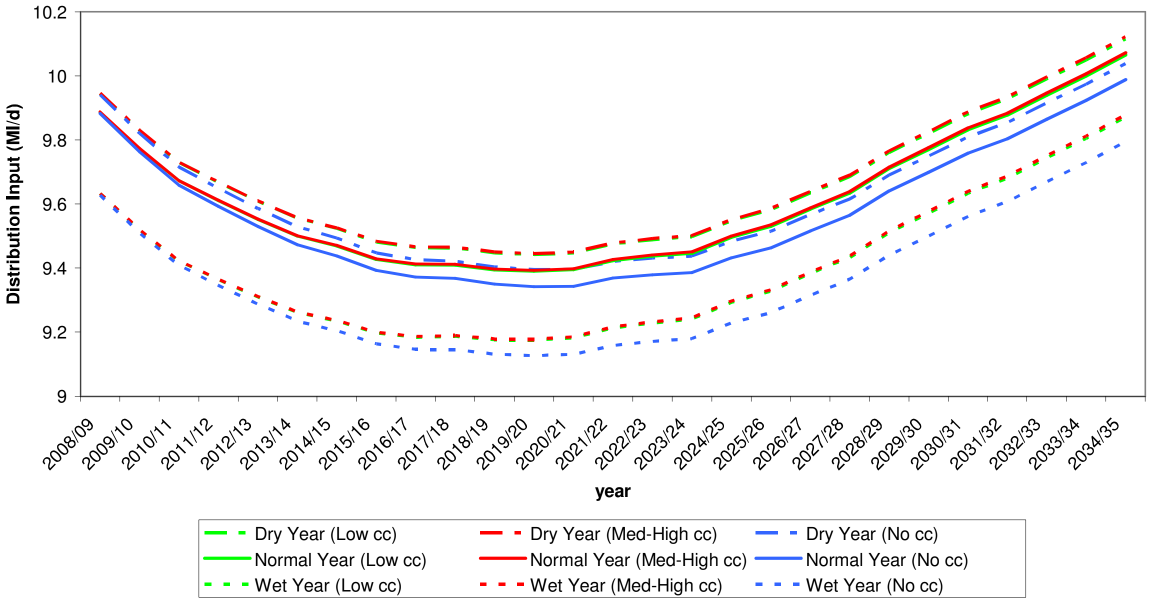
The envelopes of climate change for each weather scenario, as defined by the Med-High and no climate change scenarios widen to approximately 0.1 Ml/d by the end of the planning horizon (2034/35) in all cases.

The range of all the weather scenarios considered, as defined by the extremes of wet year with no climate change, and dry year with med-high climate change equates to 0.32 Ml/d by 2034/35.

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year Forecast							
Med-High	9.86	9.83	9.53	9.45	9.55	9.83	10.12
None	9.86	9.82	9.49	9.39	9.48	9.75	10.04
Normal Year Forecast							
Med-High	9.80	9.77	9.47	9.39	9.50	9.78	10.07
None	9.80	9.76	9.44	9.34	9.43	9.70	9.99
Wet Year Forecast							
Med-High	9.54	9.52	9.24	9.18	9.30	9.58	9.88
None	9.54	9.51	9.20	9.13	9.23	9.50	9.80

Effect of Climate Change on Suffolk Blyth DI forecasts (Ml/d)

Suffolk Blyth Resource Zone -
Baseline Distribution Input Climate Change Scenarios



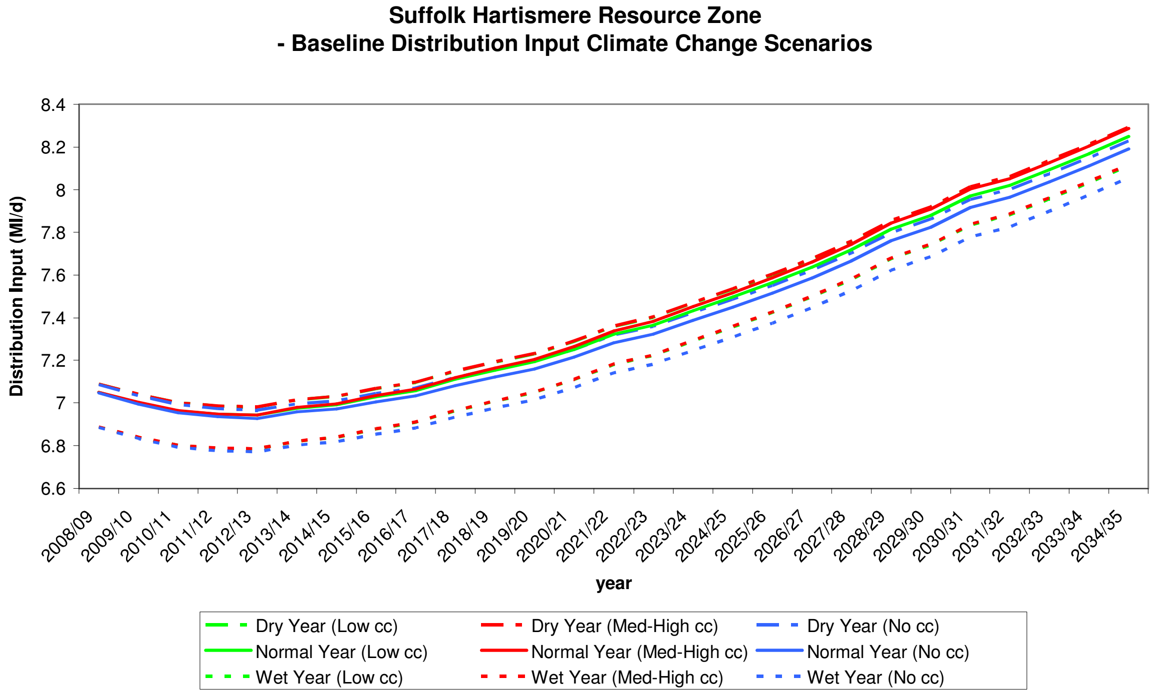
Suffolk Hartismere Resource Zone

The envelopes of climate change for each weather scenario, as defined by the Med-High and no climate change scenarios widen to approximately 0.1 Ml/d by the end of the planning horizon (2034/35) in all cases.

The range of all the weather scenarios considered, as defined by the extremes of wet year with no climate change, and dry year with med-high climate change equates to 0.24 Ml/d by 2034/35.

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year Forecast							
Med-High	6.90	7.04	7.03	7.23	7.54	7.92	8.29
None	6.90	7.03	7.01	7.20	7.49	7.86	8.23
Normal Year Forecast							
Med-High	6.86	7.00	7.00	7.21	7.52	7.91	8.29
None	6.86	7.00	6.97	7.16	7.45	7.82	8.19
Wet Year Forecast							
Med-High	6.69	6.84	6.84	7.05	7.36	7.75	8.12
None	6.69	6.83	6.82	7.02	7.31	7.69	8.05

Effect of Climate Change on Suffolk Hartismere DI forecasts (Ml/d)



Suffolk Northern/Central Resource Zone

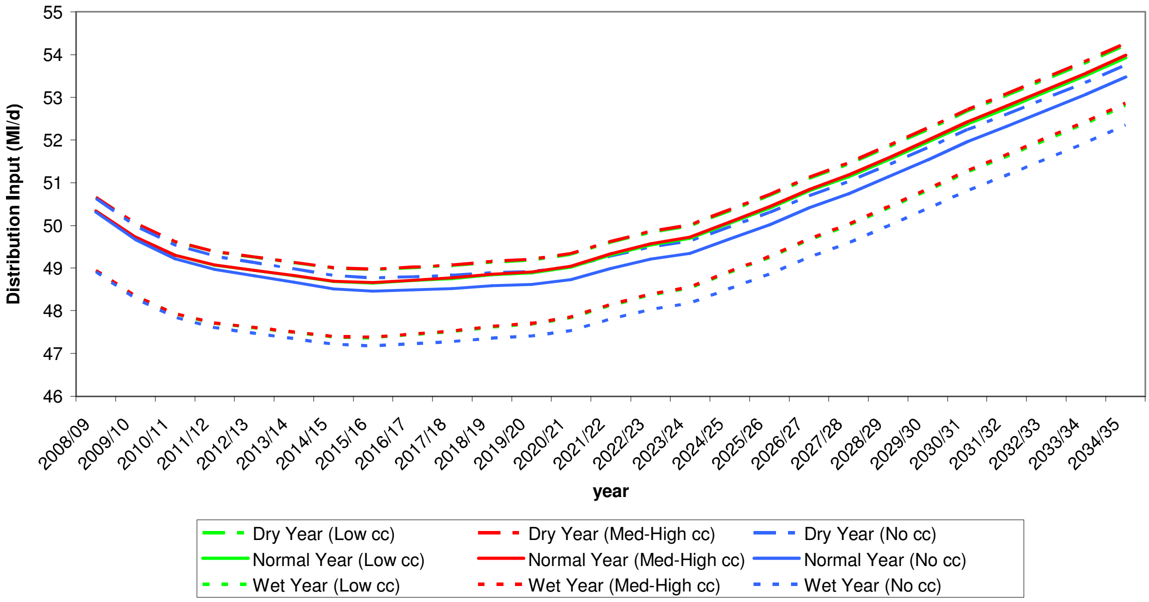
The envelopes of climate change for each weather scenario, as defined by the Med-High and no climate change scenarios widen to 0.51 Ml/d by the end of the planning horizon (2034/35) in all cases.

The range of all the weather scenarios considered, as defined by the extremes of wet year with no climate change, and dry year with med-high climate change equates to 1.92 Ml/d by 2034/35.

Climate Change Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2006/07	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year Forecast							
Med-High	50.09	50.05	49.01	49.21	50.37	52.28	54.27
None	50.09	49.99	48.83	48.91	49.97	51.82	53.76
Normal Year Forecast							
Med-High	49.75	49.73	48.70	48.91	50.08	51.99	53.98
None	49.75	49.67	48.51	48.62	49.68	51.53	53.47
Wet Year Forecast							
Med-High	48.37	48.34	47.40	47.70	48.92	50.86	52.86
None	48.37	48.28	47.21	47.41	48.52	50.40	52.35

Effect of Climate Change on Suffolk Northern/Central DI forecasts (Ml/d)

Suffolk Northern/Central Resource Zone - Baseline Distribution Input Climate Change Scenarios



6.6 Impact on Supply Demand Balance

The impact of climate change on the overall supply demand balance and the sensitivity to climate change scenarios can only be evaluated at the appropriate point in the water resources planning process, after the initial supply demand balance has been constructed. Accordingly the impacts of climate change on the supply demand balance have been described at the end of Chapter 8 on Baseline Supply Demand Balance.

7. TARGET HEADROOM

7.1. Background

Actual headroom is the difference between the supply and demand forecasts of the Supply Demand Balance (i.e. the difference between Water Available for Use or WAFU, and the constrained dry weather demand forecast). A water company would ideally like WAFU to be greater than the demand forecast to allow for uncertainty and ensure it can meet demand.

The 'ideal' amount of actual headroom that a prudent water company should retain is called target headroom. Target headroom can be thought of as a security margin, or more accurately a means of assessing uncertainty in the Supply Demand Balance.

In the Agency's Water Resources Planning Guideline (Environment Agency, 2008a) target headroom is defined as:

"the threshold of minimum acceptable headroom, which would trigger the need for total water management options to increase WAFU or decrease demand".

An alternative definition provided by UKWIR and the Agency in 1998 (UKWIR, 1998a) for target headroom is:

"the minimum buffer that a prudent water company should allow between supply (including raw water imports and excluding raw water exports) and demand to cater for specified uncertainties (except those due to outage) in the overall supply-demand balance. Introducing this buffer into the overall supply-demand balance will help to ensure that the company's chosen level of service can be achieved".

A probabilistic approach to determining target headroom in all four of ESW's resource zones was adopted at the last periodic review (ESW, 2004), utilising the latest industry standard methodology produced in 2002 (UKWIR, 2002). This probabilistic approach has been used again for the current periodic review in all four of ESW's resource zones.

A description of the methodology, the results produced and their interpretation has been outlined in an internally produced report. The assessment has already been completed and is summarised below.

7.2. Methodology

The 2002 headroom methodology (UKWIR, 2002) introduces the concept of 'headroom uncertainty', which is defined as:

"a probability distribution that represents a likely range of values for headroom for selected years within the planning period".

Inherent in the definition is the need to make choices from the probability distribution on the level of risk (or degree of uncertainty), that a water company is prepared to accept in relation to headroom. This is necessary in order to define a value for target headroom for each resource zone for each year across the planning horizon, suitable for incorporation in the supply demand balance. The calculation of headroom uncertainty is required over the planning horizon from 2006/2007 to 2034/2035. However, as headroom uncertainty is forward-looking, the calculation of headroom uncertainty has commenced in 2008/2009.

The basis of the 2002 methodology (UKWIR, 2002) is to apportion target headroom into two main areas; supply side and demand side. For all four resource zones these areas can then be subdivided into respective supply or demand side components indicated as follows:

Supply Side Headroom Components

- S4 Bulk imports
- S5 Gradual pollution of sources causing a reduction in abstraction
- S6 Accuracy of supply side data
- S8 Uncertainty of impact of climate change on deployable output
- S9 Uncertainty of new sources

Demand Side Headroom Components

- D1 Accuracy of sub-component demand data
- D2 Demand forecast variation
- D3 Uncertainty of impact of climate change on demand
- D4 Uncertainty of demand management measures

Three additional supply side components known as S1 (vulnerable surface water licences), S2 (vulnerable groundwater licences) and S3 (uncertainty of renewal of time-limited licences) have been removed at the request of the Agency, and as indicated in the revised Water Resources Planning Guidance (Environment Agency, 2008a). This is because the Agency has stated that no allowance for the risk of sustainability reductions should be made in Headroom. In addition, the Agency has been instructed by Ministers to ensure that there is not a risk of security of supply due to time-limited licences.

All components are associated with sources within ESW's four resource zones, with the exception of the supply side component S4, which considers the bulk supply from Thames Water Utilities to ESW's Chigwell Water Treatment Works.

Supply side components generally require the identification of individual groundwater or surface water sources, which are likely to be impacted. The only exception is the accuracy of supply side data (S6), which groups sources according to the factor constraining deployable output of the source. Demand side components are considered on a holistic basis for each resource zone.

To formally document all the sources identified under each supply side component and all demand side components, the methodology makes use of 'Headroom Issues Proforma' spreadsheets, which contain details of each identified headroom component for a particular resource zone. The proformas allow each component to be uniquely identified and relationships between components to be defined.

Where a component is not independent, the UKWIR methodology (UKWIR, 2002) and Crystal Ball→ allows for overlapping, correlated and dependent relationships to be included in the Headroom calculation. These relationships are determined as follows:

- Overlapping or mutually exclusive relationships ensure that it is only possible for the deployable output of a source to be lost once. Each component is assessed independently before taking the largest value selected from two or more overlapping components.

- Correlating data allows a variety of relationships to be defined between two or more components. For example groundwater sources at different locations may abstract from the same aquifer and therefore face similar sustainability issues or risks from pollution. A correlation coefficient is applied to describe the relationship between the different sources.

- A dependent relationship occurs when a source's headroom uncertainty is dependent on the uncertainty at another source. No dependent relationships occur between any headroom components associated with ESW and consequently dependent relationships were not used in any of the headroom uncertainty calculations.

A summary of the assumptions used to assess the uncertainty for each supply side and demand side headroom component is provided below.

Supply Side Components

S4 The Chigwell bulk import was split into two sub-components. This was to enable the inclusion of two key points within the agreement between Thames Water Utilities and ESW:

- Should Thames Water Utilities enforce a hosepipe ban but ESW does not, the quantity supplied to ESW is reduced by 25%;
- Should both water companies have a hosepipe ban in place and Thames Water Utilities enforces a non-essential use ban, a fair apportionment of supply would take place.

The levels of service for both water companies were used to determine the risk of loss of deployable output from the Chigwell bulk import, across the whole planning horizon.

S5 All ESW groundwater sources were included as being at risk from pollution, with the headroom uncertainty for each source separated into point and diffuse pollution. Catchment risk assessment work undertaken by ESW was used determine the uncertainty of point and diffuse pollution at all of ESW's groundwater sources. The calculation of the uncertainty of point pollution additionally made use of the number of petrol and diesel storage sites currently within the total groundwater protection zone of each groundwater source.

S6 All ESW groundwater and surface water sources and the Chigwell bulk supply were grouped according to the factor constraining deployable output. The accuracy of supply side data was determined for each of the following:

- aquifer constrained sources, using the combined accuracy of abstraction meters and water level transducers;
- licence constrained sources, using the accuracy of abstraction meters;
- infrastructure constrained sources, subdivided into pump capacity and Water Treatment Works accuracy, using accuracy of pumps and Water Treatment Works output meters, respectively.

S8 All ESW groundwater and surface water sources were included in the uncertainty of impact of climate change on deployable output. The uncertainty was defined around the climate change mid scenario. Further information on climate change can be found in chapter 6 of this report.

S9 All potential new groundwater and surface water sources were included, to ensure sufficient resources within each resource zone over the planning horizon.

Demand Side Components

D1 The accuracy of distribution meters was used to determine the accuracy of sub-component demand data for each ESW resource zone, on a holistic basis.

D2 Distribution Input was subjected to a statistical technique known as the Maximum Likelihood Estimation, which took into account the difference between recorded DI and the sum of all its components, with the aim to make these figures reconcile as closely as possible. The uncertainty surrounding the dry year distribution input for each of the four resource zones was used to determine the demand forecast variation.

D3 Climate change demand forecast figures from the CCDew report (Defra, 2003) were used to scale the uncertainty of impact of climate change on demand for each of the four resource zones. Further information on climate change can be found in chapter 6 of this report.

D4 The uncertainty of demand management measures for each ESW water resource zone was determined for each of the following:

- delivering the meter strategy, using the number of meters forecast to be installed;
- leakage, using historical data to determine the expectancy of meeting the leakage targets;
- water efficiency, using the likelihood of meeting Ofwat's current water efficiency targets.

Further Elements of Methodology

The timing of important events such as the implementation of new sources has been taken into account in the year the uncertainty is predicted to occur. Uncertainties have been assessed for every year within the planning horizon.

Once information on the sources of uncertainty for each headroom component had been collated, a probability distribution was defined for each of the components uniquely identified in the Issues Proforma spreadsheets. To define the probability distribution, information was sought from relevant reports, data and expert knowledge within ESW as to the most appropriate type to best fit the data and situation.

Probability distribution profiles can be continuous or non-continuous. In many circumstances continuous distributions will be more appropriate for assessing headroom uncertainty. These allow any value between the stipulated values to be applied to the probability, whereas a non-continuous distribution only allows probability to be determined for the particular values stipulated.

An ‘Input Proforma’ spreadsheet was completed for each individual headroom component identified within the Issues Proforma spreadsheets, in order to allow the data, probability distributions and specific parameters to be documented and the decisions for these choices to be transparent and auditable. The sheets include specific sections to document meetings and discussions used to progress the particular component, relevant reports and data applied.

The individual headroom components were grouped on a resource zone basis and inserted into a purpose-built spreadsheet produced by Mott MacDonald as part of the UKWIR project (UKWIR, 2002). The probability distributions, parameters and relationships between components form the basis of the Monte Carlo simulation, which determines the overall Headroom Uncertainty by adding the individual Headroom components together. The software package Crystal Ball→7.3.1 was used within the spreadsheet environment to allow the Monte Carlo simulations to be run. When run, Monte Carlo randomly selects numbers from the probability distribution assigned to each component, effectively simulating a ‘what if’ scenario. The Monte Carlo simulation derives Headroom Uncertainty for each year within the planning horizon. The simulation was run through 10,000 iterations for each of the four ESW resource zones, in order to gain a suitable level of consistency in the results.

At the request of Ofwat the Monte Carlo simulation was re-run excluding the climate change components S8 (uncertainty of impact of climate change on deployable output) and D3 (uncertainty of impact of climate change on demand) for each of the four ESW resource zones. The Headroom Uncertainty figures with and without climate change were compared for every year within the planning horizon to analyse the significance of climate change.

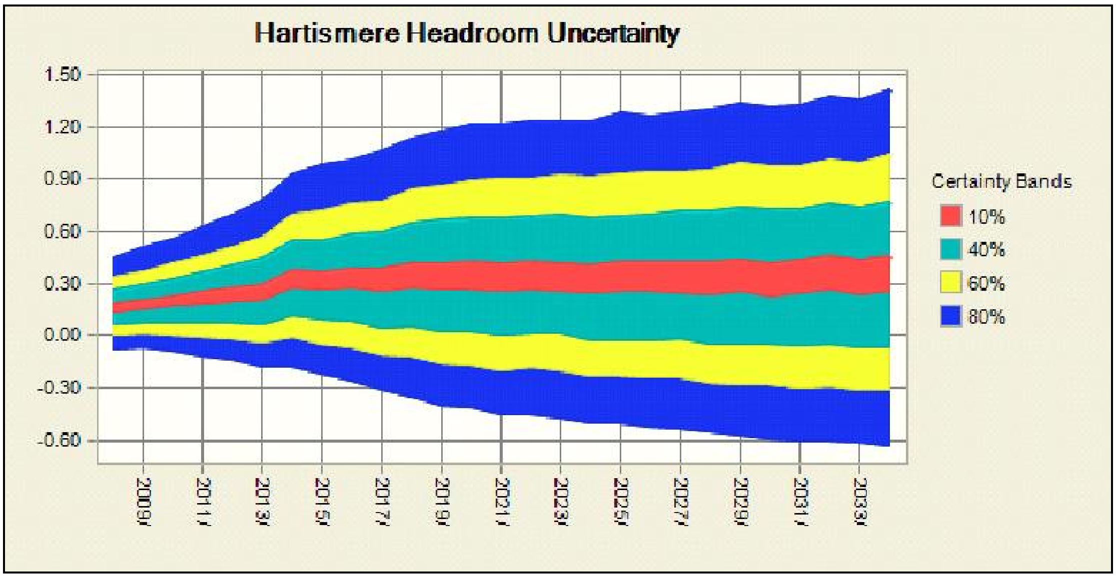
The data and assumptions made for each of the elements of headroom are discussed further in the Company’s updated headroom report, and should be referred to for additional information. Due to its importance, climate change, which is covered by headroom components S8 for supply side and D3 for demand side, is worthy of specific mention and is discussed in chapter 6.

7.3. Form of Output – Trend Charts and Sensitivity Analysis

The results from the Monte Carlo simulation are expressed in terms of percentiles for every year within the planning horizon, for each of the four resource zones.

7.3.1. Trend Charts

The percentile envelopes of headroom uncertainty can be plotted in Crystal Ball→ as a ‘headroom uncertainty trend chart’, which indicates how the uncertainty in headroom varies throughout the planning horizon, under the analysis for each resource zone. The headroom uncertainty trend chart for the Hartismere resource zone is provided below by way of an example.



When interpreting such Crystal Ball→ trend charts it should be recognised that as in the above example:

- Headroom uncertainty has been defined for all years within the planning horizon;
- The various certainty bands indicated are represented by <u>all</u> the range of values between and including the indicated upper and lower bounds;
- The certainty bands above are not the same as percentiles but are related as follows:
    - The 10% certainty band in red equates to the difference between the 45th and 55th percentile (i.e. 5% either side of the median value);
    - Similarly the junction between the yellow and blue shaded areas is the 80th percentile at the top of the chart and the 20th percentile and the bottom of the chart;
- Upper percentiles have been considered as choices for target headroom.

When determining which of the upper percentiles of headroom uncertainty should be used for target headroom, ESW has recognised that this choice is important given that it reflects the level of risk the company is willing to accept. It should be recognised that this choice may directly affect investment decisions and the driving supply demand balance scenario. The upper percentiles reflect return periods as indicated in the following table:

Percentile	Return Period
50	1 in 2
75	1 in 4
80	1 in 5
90	1 in 10
95	1 in 20
96	1 in 25
98	1 in 50

The return periods can be viewed as the probability for each year of headroom uncertainty not falling within a respective defined envelope. The following percentiles have been chosen as the basis for defining 'target headroom' for all ESW's resource zones:

- 90th 2008/09 – 2019/20
- 80th 2020/21 – 2029/30
- 70th 2030/31 – 2034/35

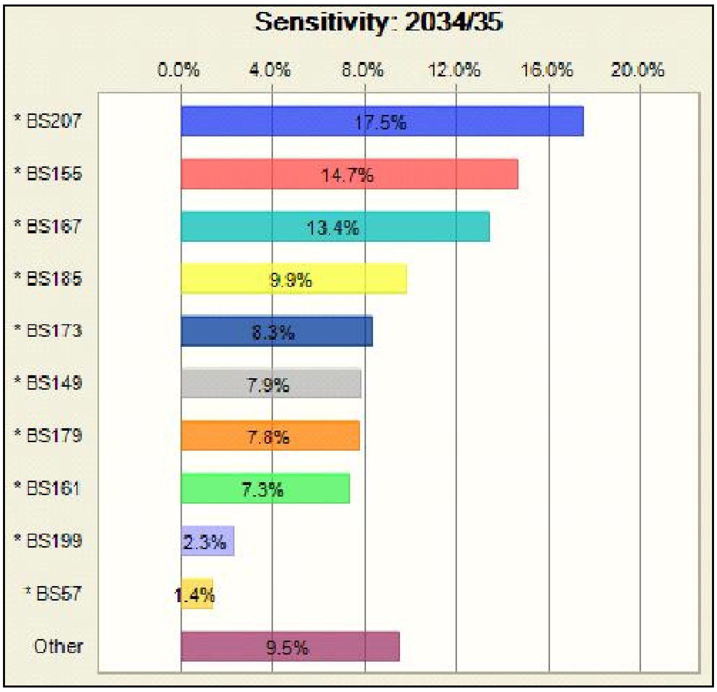
ESW has chosen to adopt a decreasing percentile throughout the planning horizon and therefore accepts an increasing risk over the time period that required headroom falls outside the range of values indicated in the headroom uncertainty trend chart. This is in accordance with the Agency's Water Resource Planning Guideline (Environment Agency, 2008a) and is compliant with the Draft WRMP consultation comments received from the Agency and Ofwat. The use of a decreasing percentile takes into account that the uncertainties of target headroom will decrease over time.

7.3.2. Sensitivity Analysis

The UKWIR methodology includes an inherent assumption that all components identified are of an equal weighting unless related through overlapping, correlations or dependency. The creation of sensitivity charts from the Monte Carlo simulation allows sensitivity analysis to be performed for each component through the use of correlation coefficients. An individual sensitivity chart has been created for every year over the planning horizon, for each resource zone. The sensitivity chart for Hartismere in 2034/35 is presented overleaf by way of an example.

The components (e.g. BS207) identified in the sensitivity charts in Crystal Ball refer to the specific cell reference number in the Monte Carlo spreadsheet used for the particular resource zone being considered.

The UKWIR 2002 methodology (UKWIR, 2002) suggests the checking of headroom components contributing to over 25% of overall uncertainty, to ensure they are realistic. Where sensitivity analysis has highlighted such components, stringent checking has occurred and it has been determined that the parameters input to the probability distributions are realistic. Where a headroom component contributes over 50% to overall headroom uncertainty, the methodology suggests that further investigations to confirm or refine estimates may be justified. This does not apply to any of the four ESW resource zones investigated as the sensitivity charts do not highlight any contributions over 32.7%.



The sensitivity charts created for the last year of each AMP (i.e. end of each five year period) throughout the planning horizon have been analysed for each resource zone. The ten most significant components in each sensitivity chart have been identified, and their variation in contribution across the planning horizon assessed. These results are displayed as tables within this section.

7.4. Headroom Uncertainty Results

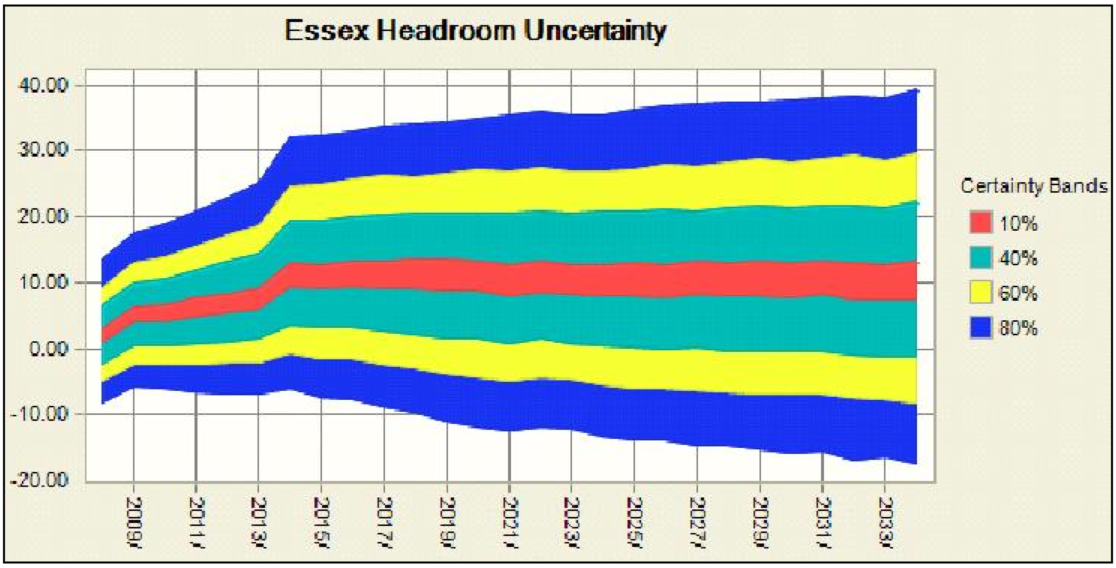
The results of the headroom assessment for each resource zone are indicated on the following pages, along with explanatory text. In understanding this assessment the following should be taken into account:

(i) The assessment of headroom uncertainty has been a major undertaking for ESW and represents a significant body of work.

(ii) To some extent the headroom assessment anticipates the likely water resource management options to be employed in the final planning scenario. This is unavoidable since element S9 of the headroom assessment specifically relates to quantifying uncertainty of new sources. This has previously been identified by ESW as a potential weakness of the current UKWIR headroom uncertainty methodology.

(iii) The following pages give a general overview, and the Company's final headroom report should be consulted in order to obtain the complete picture.

7.4.1. Headroom Uncertainty Results – Essex Resource Zone



Explanatory Text

By reference to the upper 80%, 60% and 40% certainty bands:

- The gradual rise from 2008/09 to 2013/14 is largely due to demand forecast variation, and also due to uncertainty of aquifer constrained sources and distribution input rising from meter inaccuracy;
- The larger increase from 2013/14 to 2014/15 is mainly due to the impact of increasing uncertainty of the demand forecast variation;
- The small increasing trend over the remainder of the planning horizon is due to impact of the supply side and demand side climate change components.

Target Headroom Range

Using the chosen percentiles the target headroom accepted ranges from 13.69 Ml/d in 2008/09 to 22.34 Ml/d in 2034/35. This represents 3.51% and 5.93% of WAFU in 2008/09 and 2034/35, respectively.

Sensitivity Analysis – Essex Resource Zone

Essex: Percentage Significance of Components

Component Reference	Component/Year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
D2/1	Demand Forecast Variation	32.1	32.6	20.2	15.3	13.3	12.7
S6/2	Accuracy of supply side data - Uncertainty of aquifer constrained sources	26.4	7.2	4.6	3.4	3.2	2.5
D1/1	Uncertainty of distribution input arising from meter inaccuracy	11.7	12.0	7.7	5.7	5.2	4.3
S4/1	Chigwell Bulk Supply - hosepipe ban	10.4	4.8				
S8/7	Uncertainty of impact of climate change on Essex System	3.1	13.5	24.4	25.9	28.4	28.5
D3/1	Uncertainty of impact of climate change on demand	1.9	7.0	11.3	13.3	14.0	14.5
D4/1(ii)	Uncertainty of impact of demand management - Leakage	-1.3					
D4/1(iii)	Uncertainty of impact of demand management - Water Efficiency	-1.1					
D4/1(i)	Uncertainty of impact of demand management - Metering	-1.1					
S8/5	Uncertainty of impact of climate change on Dagenham	0.9	2.9	4.5	5.1	5.5	6.1
S8/6	Uncertainty of impact of climate change on Ball Lane		3.0	4.2	5.3	5.4	5.8
S8/1	Uncertainty of impact of climate change on Roding		2.9	4.3	5.3	5.6	5.9
S8/3	Uncertainty of impact of climate change on Stifford		2.8	4.3	5.4	5.5	5.8
S8/2	Uncertainty of impact of climate change on Linford			4.1	5.2	5.2	5.8

N.B. Only the ten most significant components in each year were analysed.

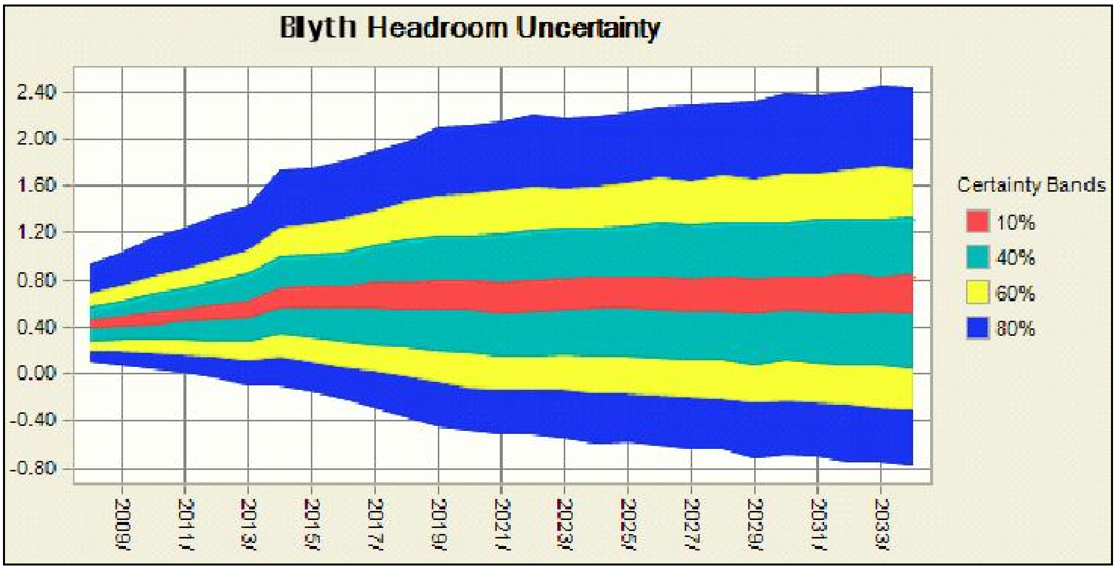
Key

<=5%	
>5 - 15%	
>15 - 25%	
>25%	

Explanatory Text

- At the beginning of the planning horizon demand forecast variation contributes the greatest proportion of overall uncertainty, at 32.1%. The significance of this component gradually decreases over the planning horizon, to 12.7% in 2034/35;
- The uncertainty of the accuracy of aquifer constrained sources contributes to 26.4% of overall uncertainty in 2009/10 but the uncertainty declines as the significance of the climate change components increases;
- The significance of the uncertainty of the impact of climate change on the Essex System increases over the planning horizon, from 3.1% in 2009/10 to 28.5% in 2034/35. It is considered realistic that the impact of climate change is a significant factor of uncertainty in the Essex resource zone.

7.4.2. Headroom Uncertainty Results – Suffolk Blyth Resource Zone



Explanatory Text

By reference to the upper 80%, 60% and 40% certainty bands:

- Generally there is a gradual increase over the planning horizon, which is largely due to the uncertainty of the impact of climate change on demand and supply.

Target Headroom Range

Using the chosen percentiles the target headroom accepted ranges from 0.94 Ml/d in 2008/09 to 1.33 Ml/d in 2034/35. This represents 7.12% and 10.05% of WAFU in 2008/09 and 2034/35, respectively.

Sensitivity Analysis – Suffolk Blyth Resource Zone

Suffolk Blyth: Percentage Significance of Components

Component Reference	Component/Year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
D3/2b	Uncertainty of impact of climate change on demand	9.2	14.2	16.0	16.5	17.0	17.0
D2/2b	Demand forecast variation	9.1	5.2	2.1			
S5/15b	Risk of loss of DO due to diffuse pollution at Benhall	7.6	2.9	1.9	1.8		
S5/20b	Risk of loss of DO due to diffuse pollution at Little Glemham	7.6			1.8		1.6
S8/16	Uncertainty of impact of climate change on Walpole	6.8	10.1	11.0	11.0	11.4	11.9
S8/21	Uncertainty of impact of climate change on Little Glemham	6.8	10.0	11.2	11.1	11.8	11.6
S8/20	Uncertainty of impact of climate change on Leiston	5.7	8.2	9.6	9.8	9.6	9.9
S8/15	Uncertainty of impact of climate change on Little Glemham	5.4	9.5	10.5	10.7	10.8	10.5
S8/19	Uncertainty of impact of climate change on Coldfair Green	5.1	8.4	9.5	9.7	9.6	9.5
S8/17	Uncertainty of impact of climate change on Saxmundham	3.9	6.1	6.8	6.9	7.0	7.3
S8/18	Uncertainty of impact of climate change on Parham		5.5	6.1	6.7	6.5	6.4
S5/15a	Risk of loss of DO due to point pollution at Benhall					1.5	1.6
S5/14a	Risk of loss of DO due to point pollution at Walpole					1.5	

N.B. Only the ten most significant components in each year were analysed.

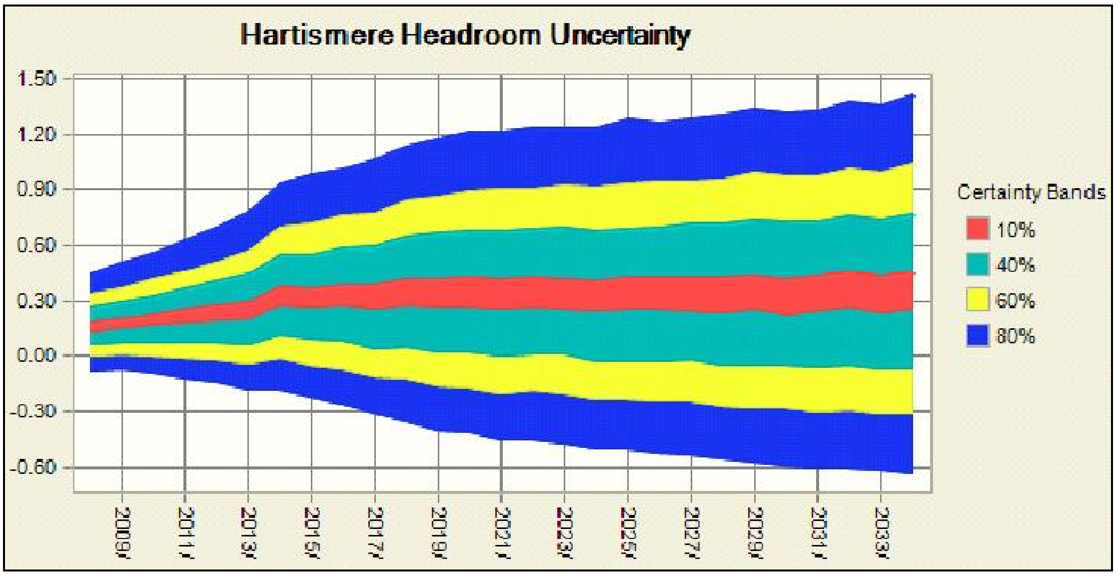
Key

<=5%	(yellow)
>5 - 15%	(cyan)
>15 - 25%	(green)
>25%	(lilac)

Explanatory Text

- The uncertainty of the impact of climate change on demand contributes the largest proportion of overall uncertainty throughout the planning period, and increases from 9.2% in 2009/10 to 17% in 2034/35;
- The uncertainty of impact of climate change on groundwater sources remains a fairly significant contribution to the overall uncertainty throughout the planning horizon.

7.4.3. Headroom Uncertainty Results – Suffolk Hartismere Resource Zone



Explanatory Text

By reference to the upper 80%, 60% and 40% certainty bands:

- Generally there is a gradual increase over the planning horizon, which is largely due to the uncertainty of the impact of climate change on demand and supply.

Target Headroom Range

Using the chosen percentiles the target headroom accepted ranges from 0.45 Ml/d in 2008/09 to 0.78 Ml/d in 2034/35. This represents 4.99% and 8.89% of WAFU in 2008/09 and 2034/35, respectively.

Sensitivity Analysis – Suffolk Hartismere Resource Zone

Suffolk Hartismere: Percentage Significance of Components

Component Reference	Component/Year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
D2/2a	Demand forecast variation	13.8	7.7	3.1	2.4	2.3	2.3
D3/2a	Uncertainty of impact of climate change on demand	8.8	14.4	16.6	17.1	17.0	17.5
S6/7a	Accuracy of supply side data - Uncertainty of aquifer constrained sources	7.8					
S8/11	Uncertainty of impact of climate change on Syleham	7.6	11.4	13.6	13.2	13.4	13.4
S8/9	Uncertainty of impact of climate change on Wortham	7.5	12.0	14.0	14.2	14.7	14.7
D1/2a	Uncertainty of distribution input arising from meter inaccuracy	5.3	3.0				
S8/14	Uncertainty of impact of climate change on Bleach Green	5.3	9.0	9.9	10.1	10.2	9.9
S8/8	Uncertainty of impact of climate change on Eye	4.1	6.4	7.5	7.8	7.3	7.9
S8/13	Uncertainty of impact of climate change on Bedingfield	4.0	6.0	7.3	7.7	7.8	7.8
S6/6a	Uncertainty of licence constrained groundwater sources	3.8					
S8/12	Uncertainty of impact of climate change on Rickinghall		7.0	7.7	8.1	8.2	8.3
S8/10	Uncertainty of impact of climate change on Mendlesham		6.4	7.2	7.0	7.0	7.3
S5/8a	Risk of loss of DO due to point pollution at Wortham			1.9		1.4	1.4
S5/10a	Risk of loss of DO due to point pollution at Syleham				1.4		

N.B. Only the ten most significant components in each year were analysed.

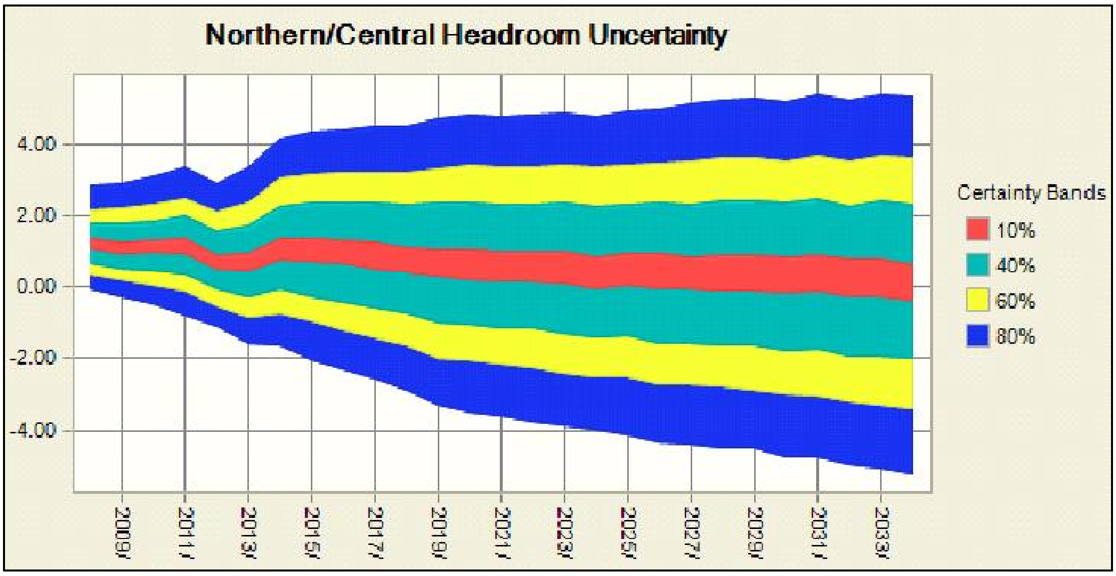
Key

<=5%	(yellow)
>5 - 15%	(blue)
>15 - 25%	(green)
>25%	(purple)

Explanatory Text

- Demand forecast variation is the largest contribution to overall uncertainty at the beginning of the planning horizon, at 13.8%;
- The contribution of uncertainty of impact of climate change on demand gradually increases over the planning horizon, from 8.8% in 2009/10 to 17.5% in 2034/35;
- The uncertainty of impact of climate change on groundwater sources remains a fairly significant contribution to the overall uncertainty throughout the planning horizon.

7.4.4. Headroom Uncertainty Results – Suffolk Northern/Central Resource Zone



Explanatory Text

By reference to the upper 80%, 60% and 40% certainty bands:

- Generally there is a slight increase from 2008/09 to 2011/12 mainly due to the significance of demand forecast variation and also due to the uncertainty of the impact of climate change on supply and demand;
- The decrease between 2011/12 and 2012/13 is likely to be due to the removal of all components relating to Alder Carr.

Target Headroom Range

Using the chosen percentiles the target headroom accepted ranges from 2.87 Ml/d in 2008/09 to 2.33 Ml/d in 2034/35. This represents 4.40% and 4.56% of WAFU in 2008/09 and 2034/35, respectively.

Sensitivity Analysis – Suffolk Northern/Central Resource Zone

Suffolk Northern/Central: Percentage Significance of Components

Component Reference	Component/Year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
D2/2c	Demand forecast variation	15.1	10.2				
D1/2c	Uncertainty of distribution input arising from meter inaccuracy	6.1					
D3/2c	Uncertainty of impact of climate change on demand	5.9	10.0	11.7	12.3	12.2	12.3
S8/36	Uncertainty of impact of climate change on River Waveney	4.3	7.5	8.7	8.6	8.8	9.0
S8/27	Uncertainty of impact of climate change on Barsham	4.1	6.2	6.8	7.1	6.8	6.9
S8/33	Uncertainty of impact of climate change on Ormesby	3.5	5.7	6.6	6.7	6.9	6.5
S8/29	Uncertainty of impact of climate change on Barsham Hall	3.2	5.1	5.8	5.8	5.8	5.7
S5/26b	Risk of loss of DO due to diffuse pollution at Barsham	3.2					
S8/35	Uncertainty of impact of climate change on Lound	3.1	5.6	6.3	6.7	6.5	6.7
S8/32	Uncertainty of impact of climate change on Shipmeadow (Nunnery Farm)	2.9	4.6	5.1	5.2	5.1	5.5
S8/28	Uncertainty of impact of climate change on Puddingmoor		4.8	4.9	5.2	5.3	5.3
S8/30	Uncertainty of impact of climate change on Broome		4.4		5.4	5.0	5.3
S8/26	Uncertainty of impact of climate change on Halesworth			4.8	4.9	4.9	4.9
S8/25	Uncertainty of impact of climate change on Alder Carr			4.7			

N.B. Only the ten most significant components in each year were analysed.

Key

<=5%	
>5 - 15%	
>15 - 25%	
>25%	

Explanatory Text

- Demand forecast variation is the largest contribution to overall uncertainty at the beginning of the planning horizon, at 15.2%;
- The contribution of uncertainty of impact of climate change on demand generally increases over the planning horizon, from 5.9% in 2009/10 to 12.3% in 2034/35;
- The uncertainty of impact of climate change on groundwater sources remains a fairly significant contribution to the overall uncertainty throughout the planning horizon.

7.5. Sensitivity Analysis of Climate Change

The difference between the Headroom figures with and without the climate change components in all four resource zones was found to be much lower than the contribution of climate change determined during the sensitivity analysis for Headroom with climate change. This is because it is not possible to make deterministic interpretations with target headroom results due to the probabilistic approach of Monte Carlo analysis. Therefore if a component is removed from the calculation, it does not mean that target headroom will reduce by a similar amount. If there are fewer components, the random selection of values in the simulation increases the likelihood that more extreme values will be selected, and ultimately a completely different distribution will result.

The impact of climate change on the supply demand balance is explained in more detail in Chapter 8.

7.6. Comparison with 2004 Periodic Review

The following table provides comparison between the above results (for PR09) and those determined in for the 2004 Periodic Review (PR04):

Zone	Target Headroom (Ml/d)			
	PR04 base year	PR09 base year	PR04 end of planning horizon	PR09 end of planning horizon
Essex	8.19	13.69	35.06	22.34
Blyth	0.77	0.94	0.99	1.33
Hartismere	1.00	0.45	1.45	0.78
Northern/Central	2.98	2.87	7.97	2.33

The target headroom in the base year for each resource zone is higher for PR09 than PR04 for Essex and Blyth but lower for Hartismere and Northern/Central. The target headroom determined at the end of the planning horizon is generally lower for PR09 than PR04, with the exception of Blyth.

The target headroom has changed between PR04 and PR09 due to completing a new calculation for each resource zone, which included new sources of uncertainty and new assumptions. In addition there have been improvements in representing the uncertainty.

8. BASELINE SUPPLY-DEMAND BALANCE

All the baseline supply and demand related information determined in the previous chapters has been put together to produce an initial supply demand balance for each of the four water resources zones. All the known changes to water available for use and the known baseline demand management policies have been included in these calculations. The baseline supply-demand balances identify which zones are predicted to have deficits in their target headroom requirement over the planning horizon.

This chapter is equivalent to Stage 2 of the EBSD framework (UKWIR/ Environment Agency, 2002).

The following pages in this section contain graphs of the baseline supply demand balance for each resource zone, based on the baseline dry weather demand scenario and the baseline WAFU profiles. The purpose of the graphs is to flag up where planning problems are likely to exist in terms of potential deficits in target headroom.

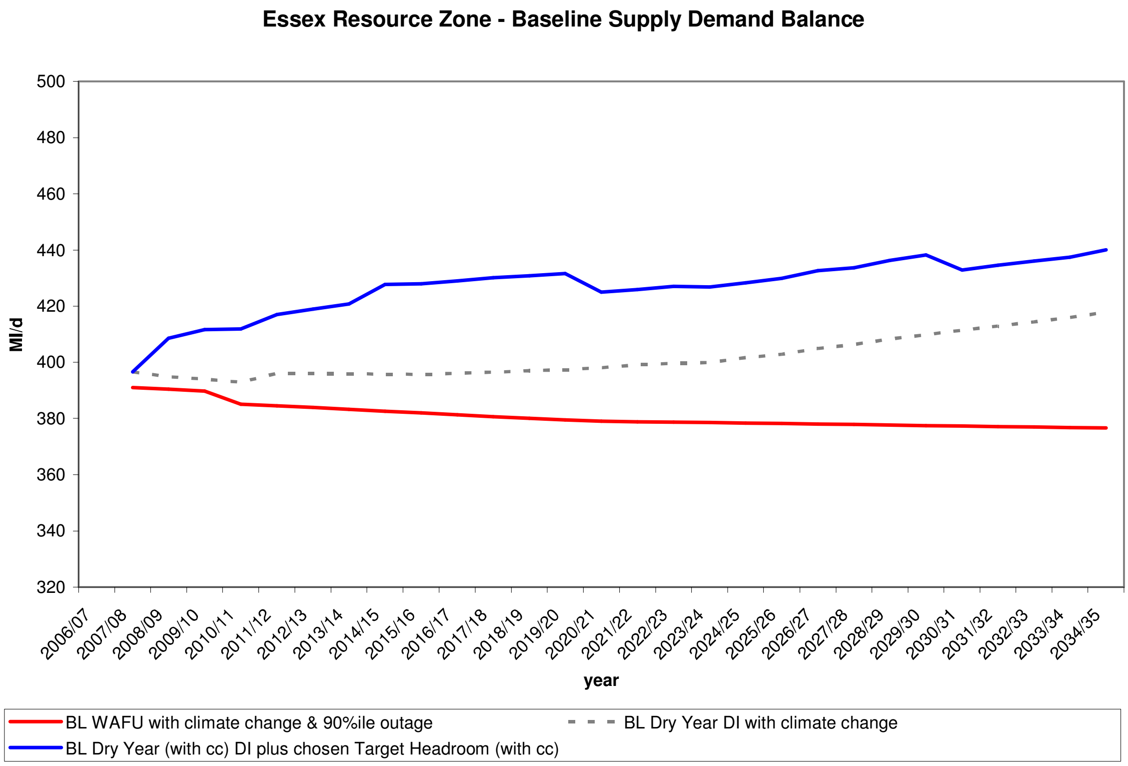
Notable features to consider on the graphs are:

- the 'target headroom' profile which has been added to the constrained dry weather demand forecast.
- sustainability reductions and other reductions on DO have been assumed as highlighted in Chapter 3.2.
- the demand forecasts include the assumptions on water efficiency savings from the Company's baseline demand management.
- climate change has been built into the supply, demand and target headroom forecasts as outlined earlier in this document.

The initial supply demand balance (SDB) graphs for each resource zone are presented in the following sections along with commentary on the key features of interest.

In the following sections SDB graphs are generally only presented for the dry weather scenario, but where appropriate commentary is made to indicate any patterns in the normal weather scenario.

8.1. Essex Resource Zone



For both dry year (above) and normal year planning scenarios:

- Supply is currently insufficient to meet demand (both including and excluding any allowance for target headroom). The only exception to this is with the normal year scenario for the base year only where a nominal surplus exists.

- With no action the forecast deficit is set to worsen over the planning horizon, due to declining baseline WAFU and increasing distribution input.

- Baseline WAFU declines over time due to the effects of climate change.

- Distribution input initially declines from the base year to 2010 and then rises immediately afterwards. This is largely due to the predicted increase in housebuilding post 2010 when the effects of the economic downturn are predicted to have ended.

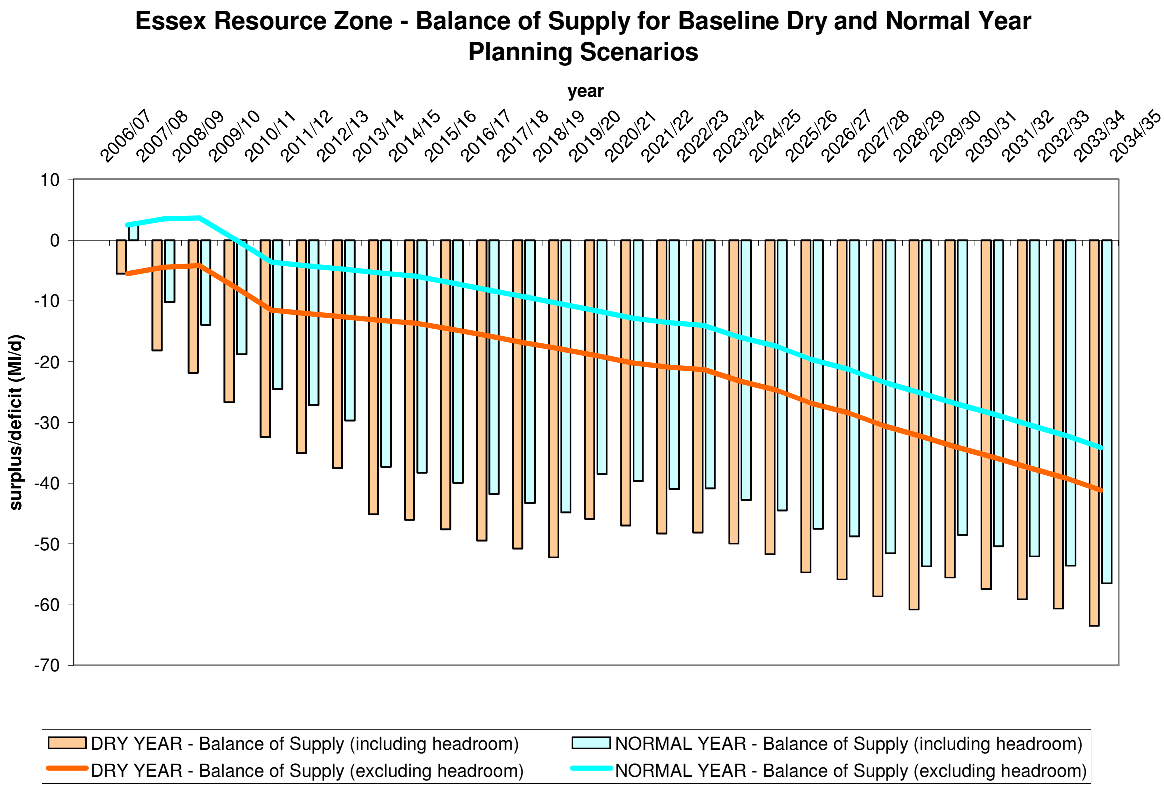
- Target headroom determined under the current EBSD rises steadily to 34.3 Ml/d by 2019/20. In the following year (due to the switch to a lower percentile) target headroom reduces to 26.9 Ml/d and thereafter remains reasobaly static until the next drop in percentile in 2030.

- A 4 Ml/d sustainability reduction for the Blackwater Estuary has been applied from 2010 onwards for all the Essex baseline scenarios.

The balance of supply for both dry year and normal year planning scenarios in Ml/d can be summarised as follows:

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year							
No headroom	-5.51	-4.21	-13.21	-17.88	-23.23	-32.28	-41.17
headroom	-5.51	-21.82	-45.14	-52.23	-50.02	-60.83	-63.51
Normal Year							
No headroom	+2.48	+3.66	-5.39	-10.45	-16.00	-25.17	-34.16
headroom	+2.48	-13.94	-37.31	-44.80	-42.78	-53.73	-56.50

Balance of Supply for Essex Resource Zone in Ml/d with no Interventions

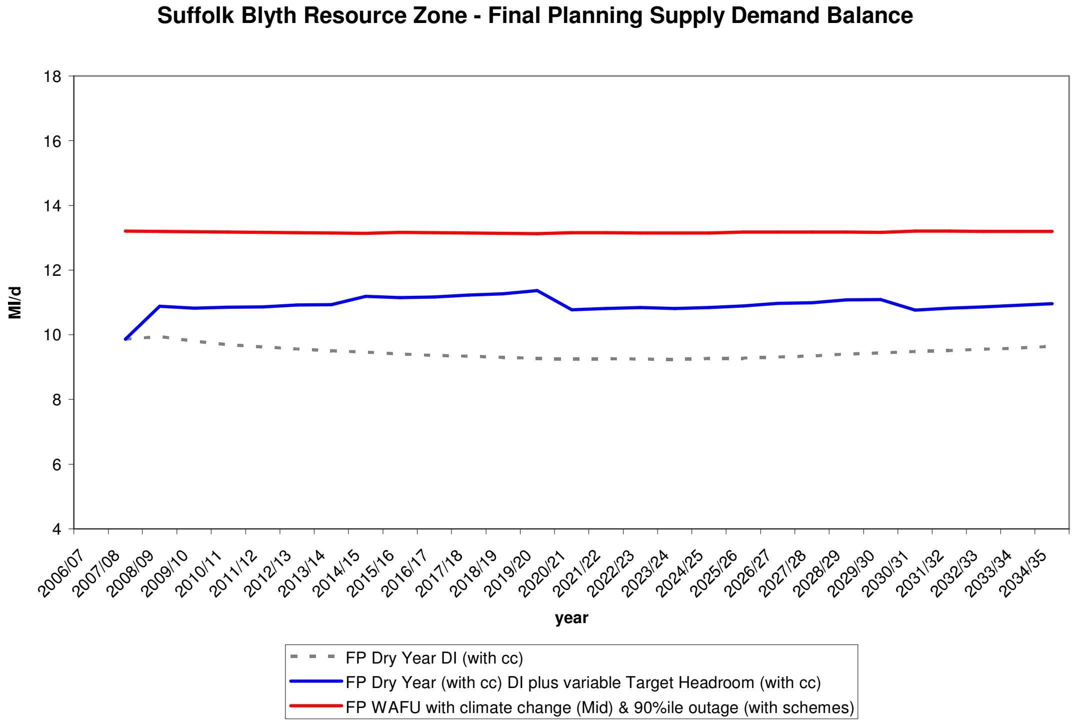


With no interventions existing supply deficits under the dry year planning scenario would increase throughout the planning horizon reaching 41.2 Ml/d in 2034/35 assuming no headroom requirement, and 63.5 Ml/d assuming the current EBSD determined headroom requirement. Under the normal year planning scenario these deficits would be 34.2 Ml/d and 56.5 Ml/d respectively.

If no action is taken, then under a period of sustained dry weather, elements of the Company's Drought Plan (ESW, 2007a) would need to be implemented which may include the need for restrictions. Eventually drought measures would not be enough and supply failures would result.

The timing of the problem is such that water resource management options are required now to address the deficit in actual headroom and absence of target headroom in Essex.

8.2. Suffolk Blyth Resource Zone



For both dry year (above) and normal year planning scenarios:

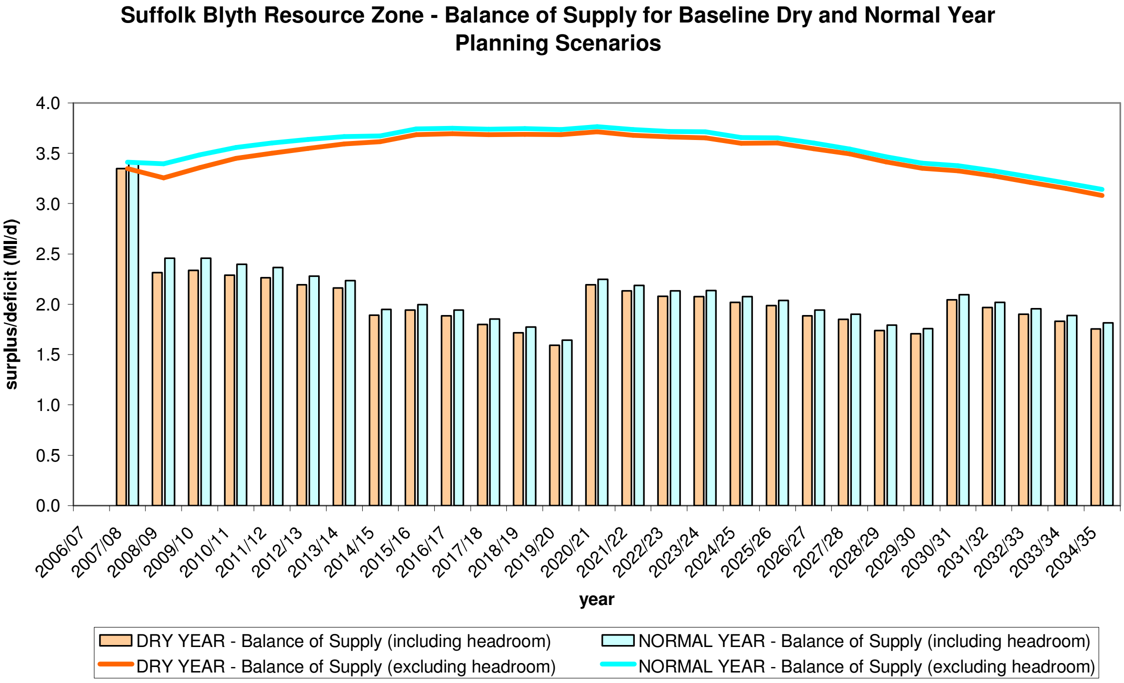
- Supply is sufficient to meet demand (both including and excluding any allowance for target headroom) throughout the whole planning horizon.
- No action is therefore required to maintain supplies.
- Baseline WAFU declines slightly over time due to the effects of climate change.
- Distribution input experiences a gentle and slight decline until 2020 after which a similar gentle increase is experienced until the end of the planning horizon. The initial decline is largely due to the effect of savings from baseline water efficiency.

- Target headroom determined under the current EBSD ranges from 0.93 Ml/d in 2008/09 to 1.32 Ml/d by 2034/35. The two small visible ramps in the profile are due to the switch in percentile in 2020 and 2030.

The balance of supply for both dry year and normal year planning scenarios in Ml/d can be summarised as follows:

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year							
No headroom	+3.35	+3.36	+3.61	+3.68	+3.60	+3.35	+3.08
Headroom	+3.35	+2.34	+1.89	+1.59	+2.02	+1.71	+1.75
Normal Year							
No headroom	+3.41	+3.48	+3.67	+3.74	+3.66	+3.40	+3.14
Headroom	+3.41	+2.46	+1.95	+1.65	+2.08	+1.76	+1.82

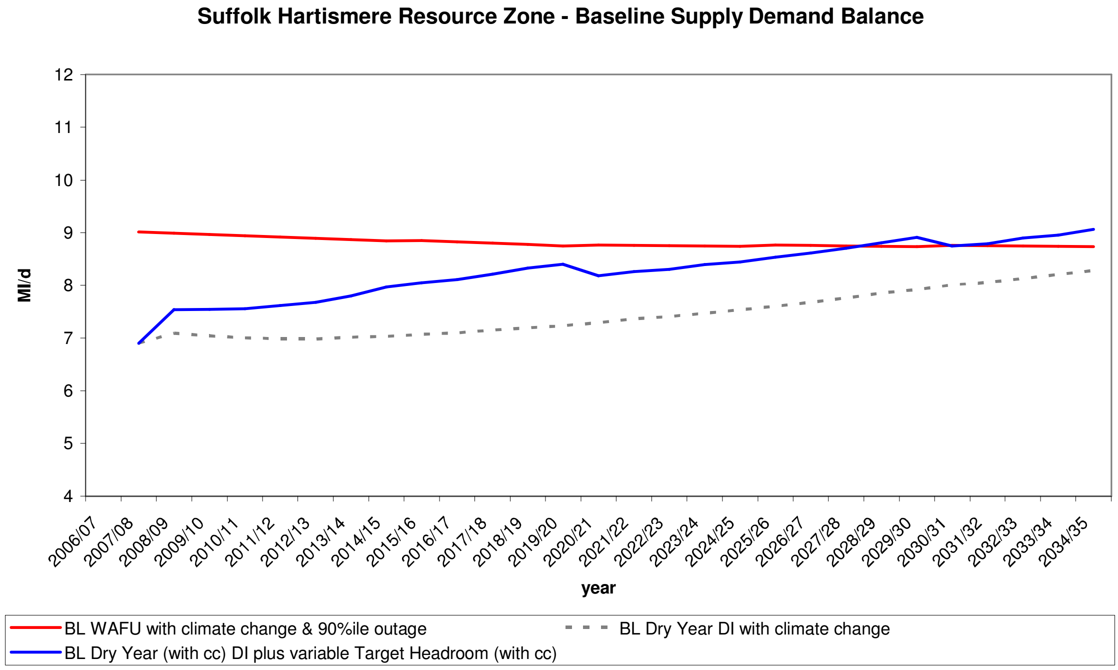
Balance of Supply for Suffolk Blyth Resource Zone in Ml/d – Baseline



Under the baseline dry year scenario supply surpluses under the dry year planning scenario would decrease throughout the planning horizon from around 3.35 Ml/d in 2007/08 to 3.08 Ml/d in 2034/35 assuming no headroom requirement, and 1.75 Ml/d assuming the current EBSD determined headroom requirement. Under the normal year planning scenario these surpluses for 2034/35 would be 3.14 Ml/d and 1.82 Ml/d respectively.

If no action is taken then under a period of sustained dry weather demand would continue to be met in all years of the planning horizon.

8.3. Suffolk Hartismere Resource Zone



- For both the dry and normal year planning scenarios:
  - Supply is sufficient to meet demand (excluding the target headroom requirement) throughout the planning horizon.
  - Supply is sufficient to meet demand (including the target headroom requirement) until 2028 after which a small deficit in supply exists.
  - No action is required during AMP5 to maintain supplies, but action may be required immediately prior to 2028 to prevent the need for restrictions or supply failures.

- Baseline WAFU declines slightly over time due to the effects of climate change.

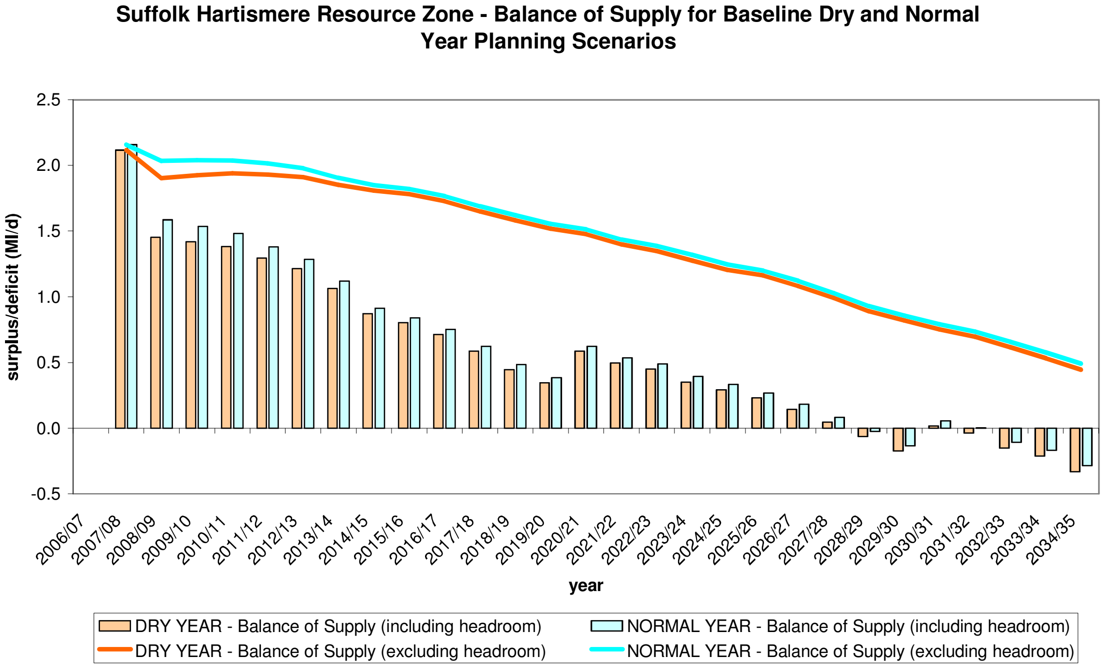
- Distribution input experiences a gentle and slight decline until 2013 after which a notable increase is experienced until the end of the planning horizon. The initial decline is largely due to the effect of savings from baseline water efficiency.

- Target headroom determined under the current EBSD ranges from 0.45 Ml/d in 2008/09 to 0.78 Ml/d by 2034/35. The two small visible ramps in the profile are due to the switch in percentile in 2020 and 2030.

The balance of supply for both dry year and normal year planning scenarios in Ml/d can be summarised as follows:

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year							
No headroom	+2.12	+1.93	+1.81	+1.52	+1.20	+0.82	+0.45
Headroom	+2.12	+1.42	+0.88	+0.35	+0.29	-0.17	-0.33
Normal Year							
No headroom	+2.16	+2.03	+1.85	+1.55	+1.25	+0.86	+0.49
Headroom	+2.16	+1.53	+0.91	+0.38	+0.33	-0.13	-0.29

Balance of Supply for Suffolk Hartismere Resource Zone in Ml/d – Baseline

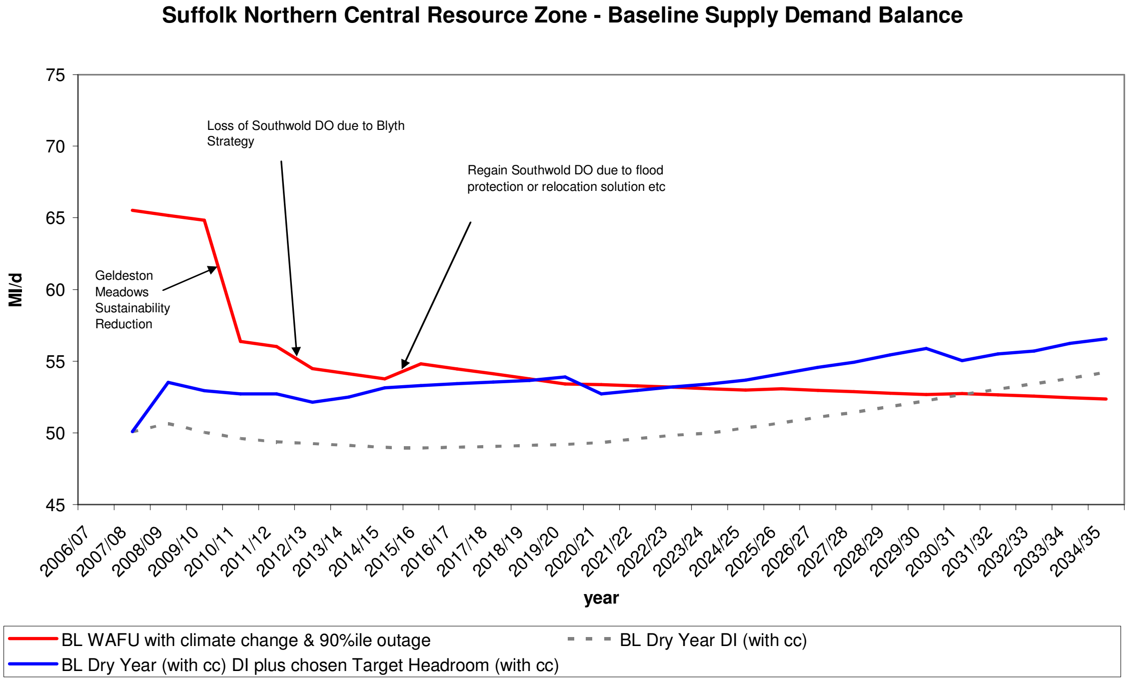


Under the baseline dry year scenario surpluses in supply under the dry year planning scenario would decrease throughout the planning horizon from around 2.12 Ml/d in 2007/08 to 0.45 Ml/d in 2034/35 assuming no headroom requirement. Under the normal year planning scenario the surplus would decrease from 2.16 Ml/d to 0.49 Ml/d respectively.

Assuming the current EBSD determined headroom requirement then the balance of supply would go into deficit in 2028, reaching a maximum shortfall of 0.33 Ml/d and 0.29 Ml/d by 2034/35 under the dry and normal year planning scenarios respectively.

If no action is taken then under a period of sustained dry weather demand may not be met from 2028 onwards. However given the relatively small deficit it is possible that measures from ESW's Drought Plan (ESW, 2007a), or measures included in ESW's final planning DI forecast, may temporarily restore the balance of supply.

8.4. Suffolk Northern/Central Resource Zone



- Supply is sufficient to meet demand (excluding the target headroom requirement) until 2031 under both the dry and normal year planning scenarios.
- Under both the dry and normal planning scenarios, supply is sufficient to meet demand (including the target headroom requirement) until 2019 after which a deficit in supply exists.
- Action is required to maintain supplies in advance of 2019 in order to prevent the need for restrictions or supply failures after this date.
- Baseline WAFU declines slightly over time due to the effects of climate change. A first notable loss of 8.1 Ml/d in 2010 is attributable to the sustainability reduction for Geldeston Meadows being applied under the Environment Agency's review of consents. A second smaller loss in 2012 is due to impact of the Agency's Blyth Strategy (Environment Agency, 2007e) and potential loss of the Southwold sourceworks due to flooding. A corresponding increase in supply in 2015 reflects the intention to implement a solution to the impact of the Blyth strategy (e.g. relocating the sourceworks or constructing a localised flood defence structure).

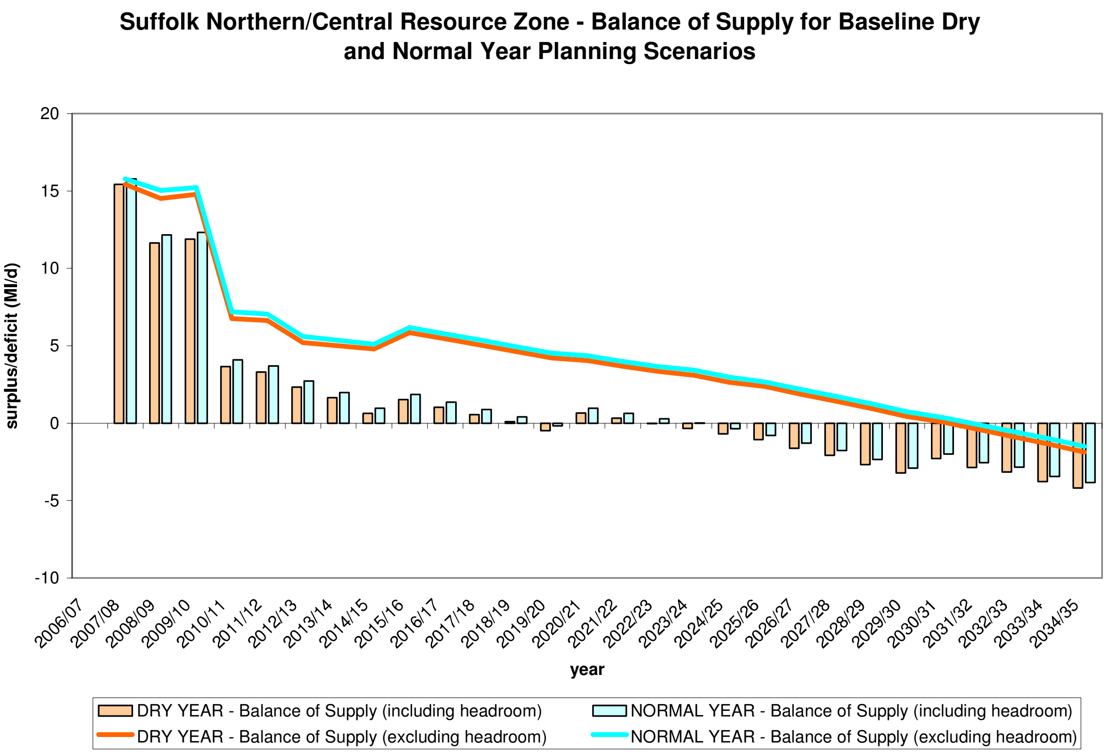
- Distribution input experiences a gentle and slight decline until 2020 after which a notable increase is experienced until the end of the planning horizon. The initial decline is largely due to the effect of savings from baseline water efficiency.

- Target headroom determined under the current EBSD ranges from 2.87 Ml/d in 2008/09 to 2.33 Ml/d in 2034/35. The two small visible ramps in the profile are due to the switch in percentile in 2020 and 2030.

The balance of supply for both dry year and normal year planning scenarios in Ml/d can be summarised as follows:

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
Dry Year							
No headroom	+15.44	+14.79	+4.79	+4.23	+2.65	+0.43	-1.86
Headroom	+15.44	+11.88	+0.64	-0.48	-0.69	-3.21	-4.20
Normal Year							
No headroom	+15.77	+15.23	+5.11	+4.53	+2.98	+0.73	-1.50
Headroom	+15.77	+12.33	+0.96	-0.18	-0.36	-2.90	-3.83

Balance of Supply for Suffolk Northern/Central Resource Zone in Ml/d – Baseline



Under the baseline dry year scenario, surplus in supply under the dry year planning scenario would decrease throughout the planning horizon from around 15.4 Ml/d in 2007/08 to zero in 2031/32, assuming no headroom. From 2031 onwards the zone experiences an increasing deficit to 1.86 Ml/d in 2034/35. Under the normal year planning scenario the surplus would decrease from 15.8 Ml/d in 2008/09 to zero in 2031/32, with a then increasing deficit rising to 1.5 Ml/d in 2034/35.

Assuming the current EBSD determined headroom requirement then the balance of supply would go into deficit in 2023, reaching a maximum shortfall of 4.2 Ml/d and 3.8 Ml/d by 2034/35 under the dry and normal year planning scenarios respectively.

If no action is taken then under a period of sustained dry weather demand may not be met from 2023 onwards. In the years immediately after this date it is possible that measures from ESW's Drought Plan (ESW, 2007a) may temporarily restore the balance of supply; but this is unlikely to be a sustainable solution for the future water supply of the zone.

8.5. Impact of Climate Change on the Overall Supply Demand Balance

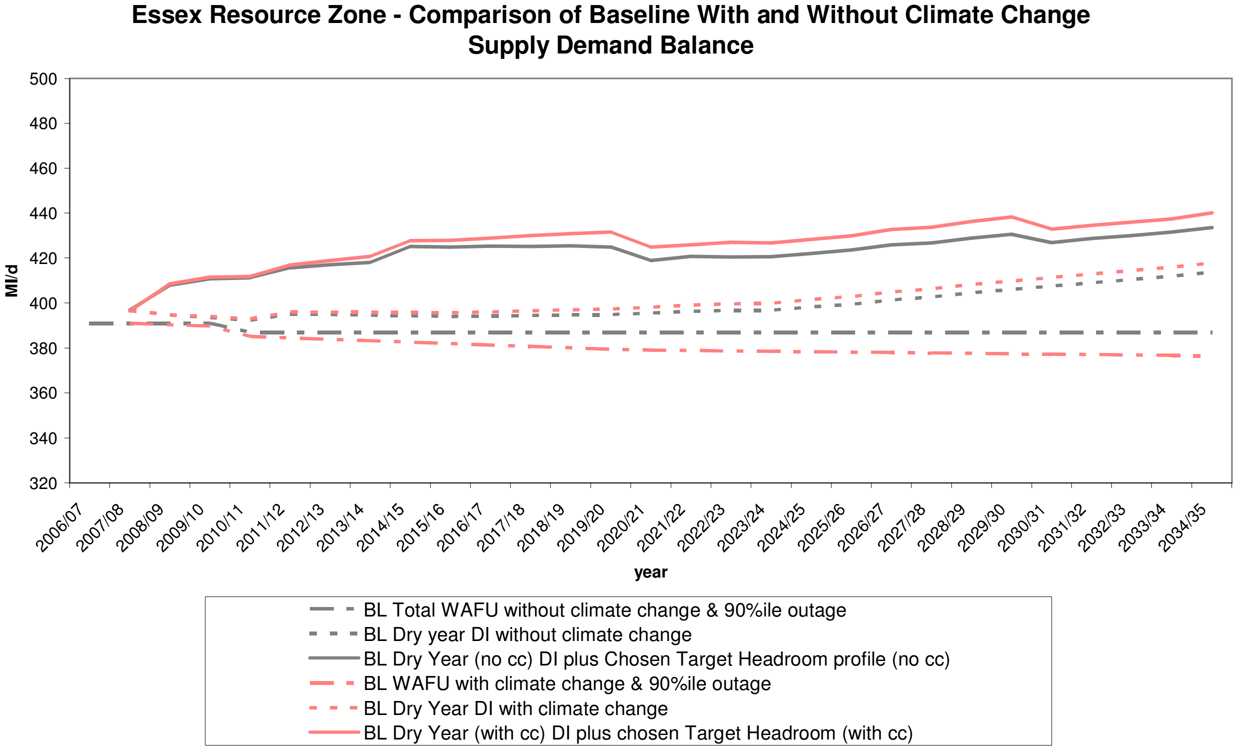
The effect of climate change on both supply and demand forecasts has been described in Chapter 6. Subsequent to the calculation of target headroom and the development of initial supply demand balances for each of the ESW water resource zones, the impact of climate change on the balance is summarised in this section. This has been primarily undertaken to address concerns raised by Ofwat (with the whole water industry) that climate change should not be driving investment needs, particularly in AMP5 which is the subject of the current periodic review.

A comparison has been made between the supply demand balance with and without climate change. This has been enabled by re-running the target headroom calculations through Monte Carlo simulation but with the relevant climate change components (on both supply and demand) having been removed. This is desribed further in Section 7.5.

The results of the assessment for each water resource zone are illustrated in the following sections. In each section a graph is presented which compares the supply demand balance in a particular zone for both with and without climate change scenarios. The "with climate change" scenarios are illustrated in red and the "without climate change" scenarios are illustrated in grey:

8.5.1. Essex Resource Zone

The with and without climate change baseline dry year supply demand graph is indicated as follows:



The difference in the Essex resource zone balance of supply (including target headroom) according to the two scenarios can be summarised as follows:

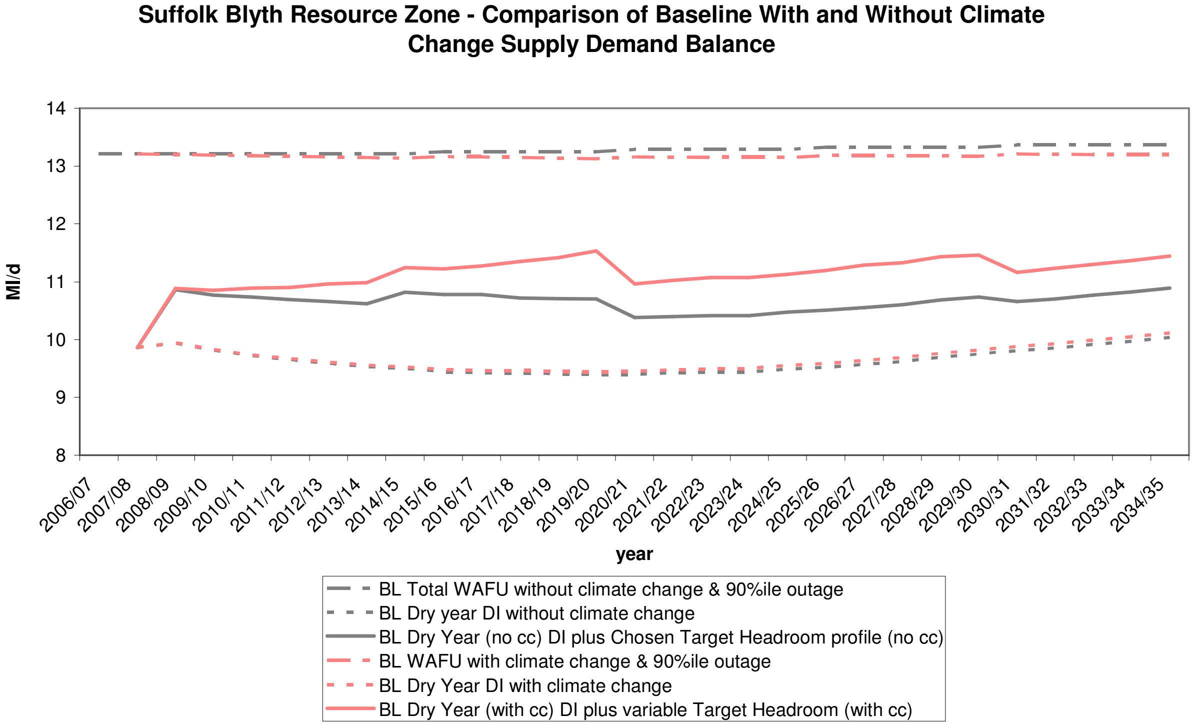
year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
with climate change BoS (Ml/d)	-21.82	-45.14	-52.23	-50.02	-60.83	-63.51
without climate change BoS (Ml/d)	-19.88	-38.23	-37.82	-35.03	-43.59	-46.50

Note : negative numbers indicate a deficit

The differences in the balance of supply clearly indicate that the inclusion of climate change is not driving the need for the investment in this zone.

8.5.2. Suffolk Blyth Resource Zone

The with and without climate change baseline dry year supply demand graph is indicated as follows:



The difference in the Suffolk Blyth resource zone balance of supply (including target headroom) according to the two scenarios can be summarised as follows:

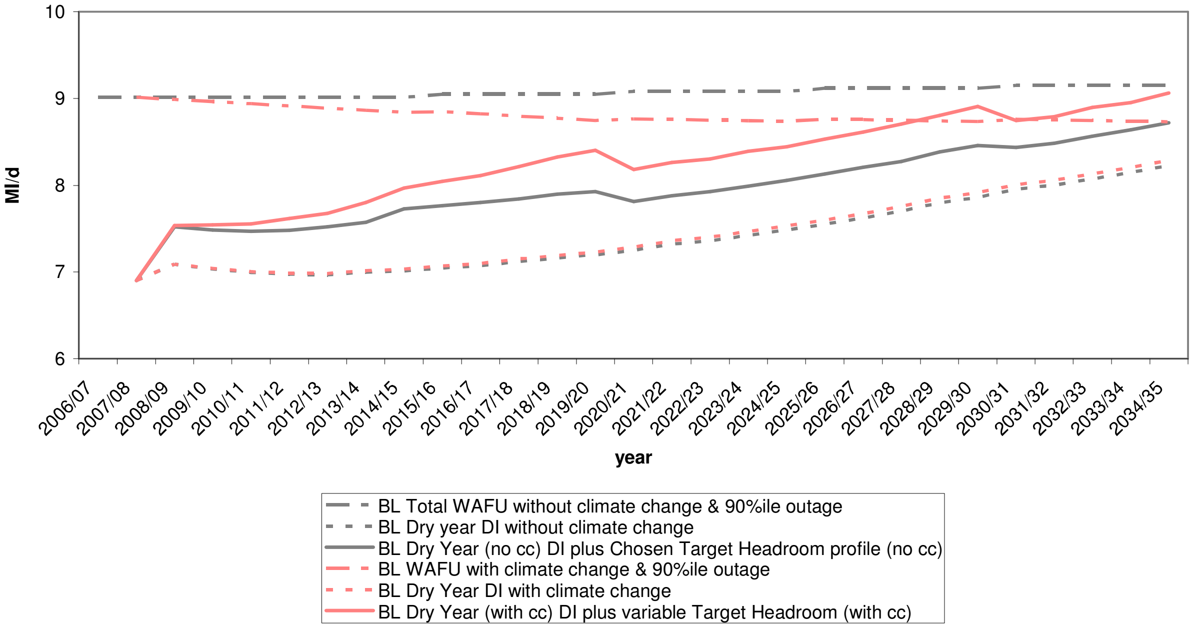
year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
with climate change BoS (Ml/d)	2.34	1.89	1.59	2.02	1.71	1.75
without climate change BoS (Ml/d)	2.44	2.39	2.54	2.81	2.59	2.47

Both the with and without climate change scenarios indicate that no investment is required in this zone, in order to meet the predicted profile of demand throughout the planning horizon.

8.5.3. Suffolk Hartismere Resource Zone

The with and without climate change baseline dry year supply demand graph is indicated as follows:

Suffolk Hartismere Resource Zone - Comparison of Baseline With and Without Climate Change Supply Demand Balance



The difference in the balance of supply (including target headroom) according to the two scenarios can be summarised as follows:

year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
with climate change BoS (Ml/d)	1.42	0.87	0.35	0.29	-0.17	-0.33
without climate change BoS (Ml/d)	1.53	1.29	1.12	1.03	0.66	0.43

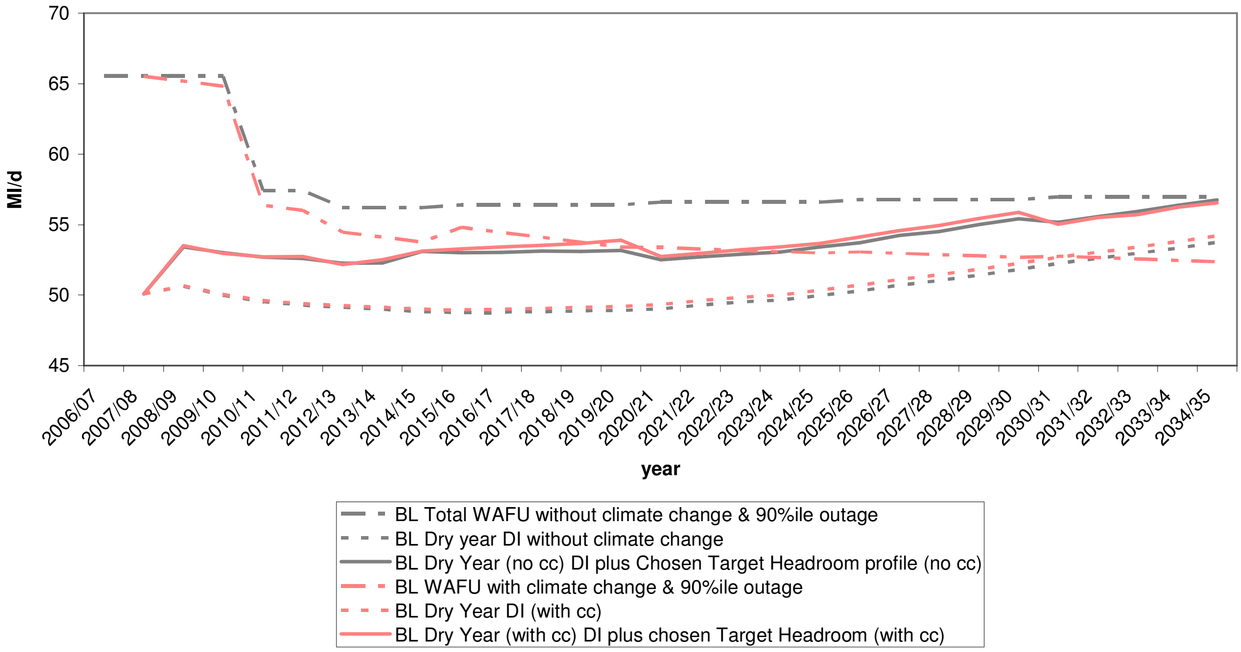
Note : negative numbers indicate a deficit

The differences in the balance of supply indicate that the inclusion of climate change could potentially be driving the need for the investment from 2028 onwards. It should be appreciated however that the final planning demand forecasts will be lower due to the inclusion of metering and distribution management strategies.

8.5.4. Suffolk Northern/Central Resource Zone

The with and without climate change baseline dry year supply demand graph is indicated as follows:

Suffolk Northern/Central Resource Zone - Comparison of Baseline With and Without Climate Change Supply Demand Balance



The difference in the balance of supply (including target headroom) according to the two scenarios can be summarised as follows:

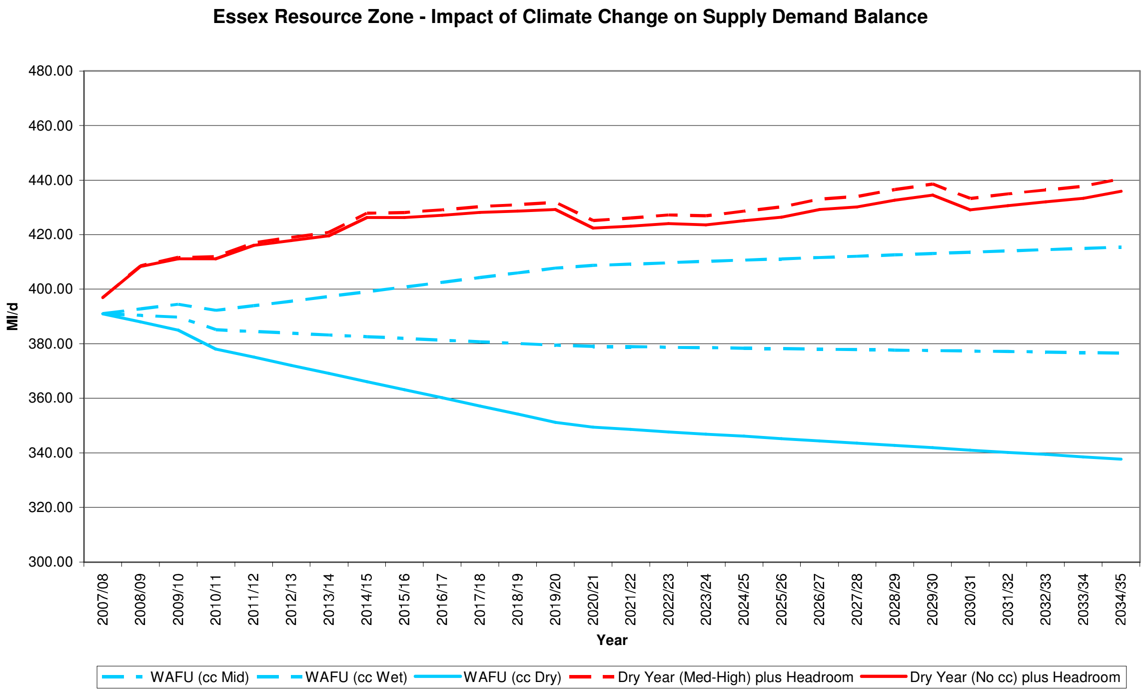
year	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
with climate change BoS (Ml/d)	11.88	0.64	-0.48	-0.69	-3.21	-4.19
without climate change BoS (Ml/d)	12.54	3.10	3.23	3.16	1.38	0.22

Note : negative numbers indicate a deficit

The differences in the balance of supply indicate that the inclusion of climate change could potentially be driving the need for the investment from 2019 onwards. It should be appreciated however that the final planning demand forecasts will be lower due to the inclusion of metering and distribution management strategies; and hence this date may in reality be much later.

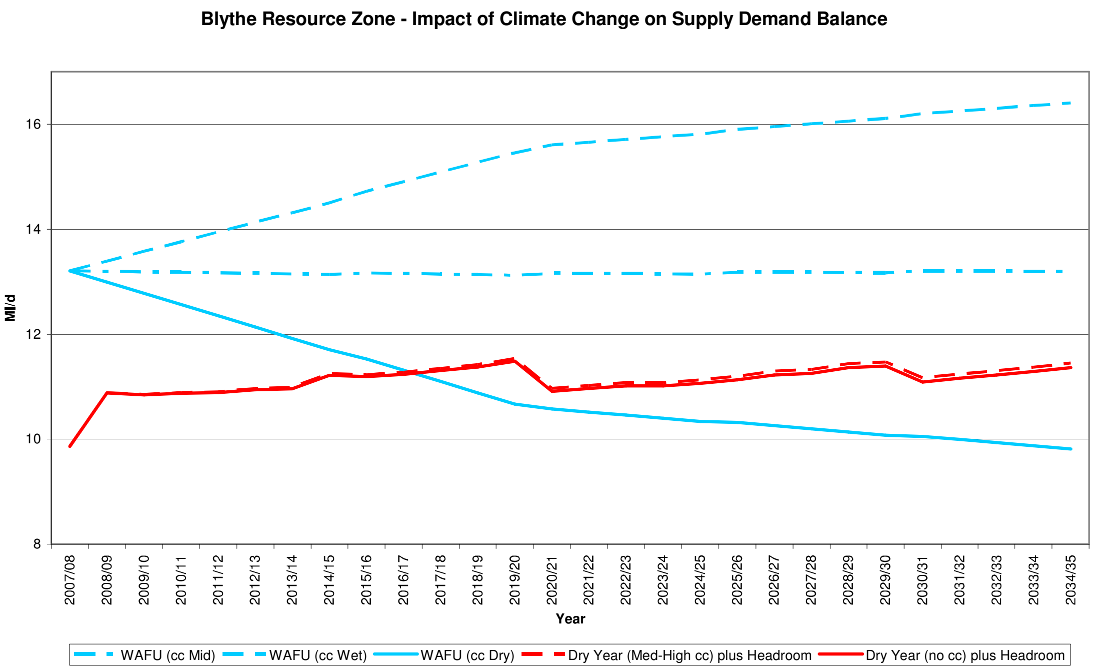
8.6. Sensitivity to Climate Change on the Baseline Supply Demand Balance

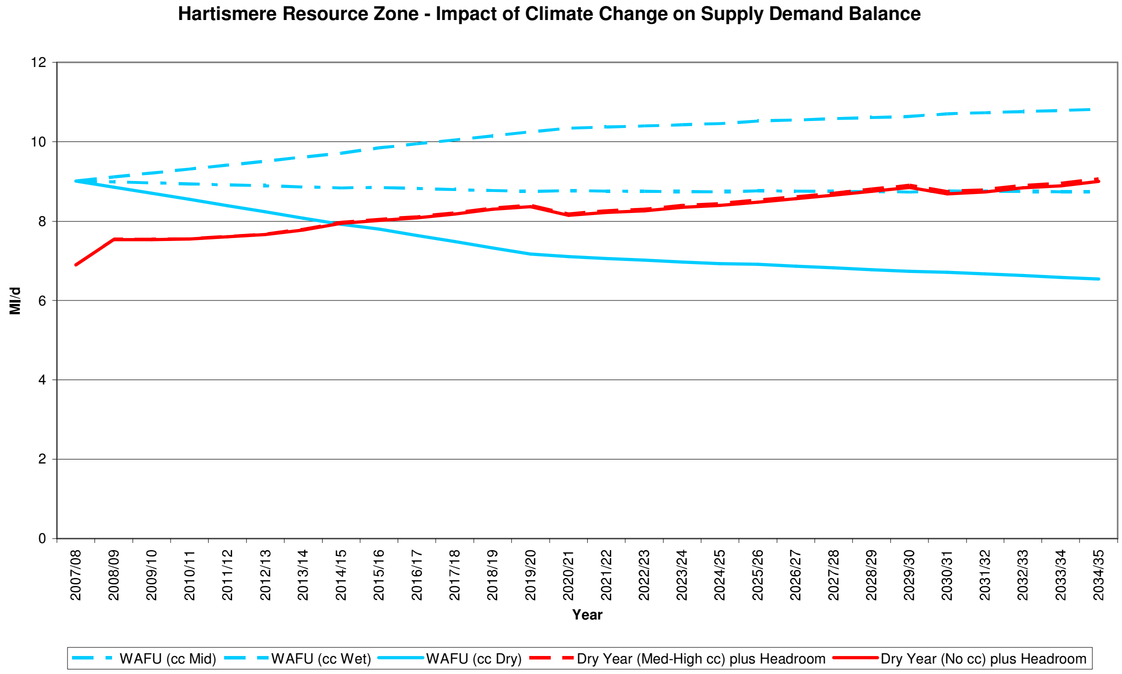
8.6.1. Essex Resource Zone



The graph shows that the Essex Resource Zone will remain in deficit in all the climate change scenarios assessed because demand plus headroom will be in excess of WAFU in all cases.

8.6.2. Suffolk Blyth & Hartismere Resource Zones

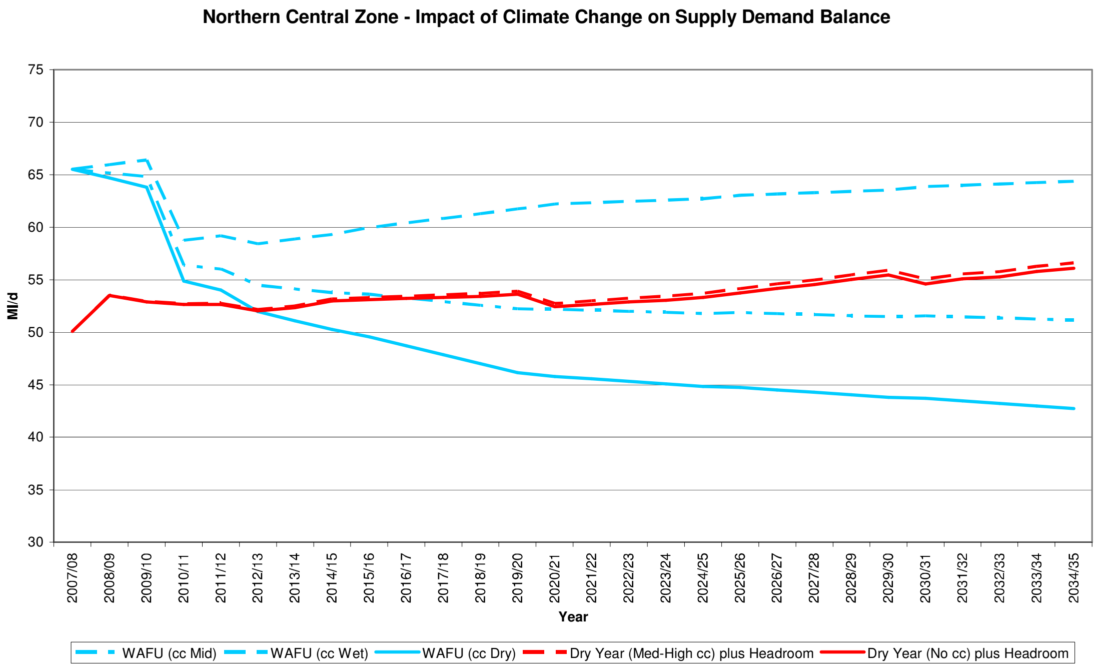




The upper graph shows that in the Suffolk Blyth Resource Zone a dry climate change scenario would result in a new resource scheme being required by 2017/18 as this is when the WAFU line crosses below the demand plus headroom line. Under all other climate change scenarios no additional water resource schemes are required before the end of the planning horizon.

The lower graph shows that in the Suffolk Hartismere Resource Zone, a dry climate change scenario results in the need for a water resource scheme to be brought forward by 15 years from 2029/30 under the mid climate change scenario, to 2014/15 under the dry climate change scenario.

8.6.3. Suffolk Northern/Central Resource Zone



The graph shows that in the Suffolk Northern/Central Resource Zone, a dry climate change scenario results in the need for a water resource scheme to be brought forward by 4 years from 2017/18 under a mid climate change scenario to 2013/14 under the dry climate change scenario.

8.7. Sensitivity to Indicative Sustainability Reductions

As indicated in the Agency's WRPG definite sustainability changes (reductions) have been applied to the respective resource zones and included in the baseline supply demand balances. The guidelines also indicate that sensitivity to indicative sustainability changes should also be evaluated. In the case of ESW there are currently only three indicative sustainability changes, indicated as follows:

Designated Site	ESW Zone Potentially Affected	Indicative Sustainability Change
Lower River Stour at Cattawade	Essex	5 Ml/d
Alde-Ore Estuary	Suffolk Blyth	0.76 Ml/d
Trinity Broads SSSI (including Bure Broads & Marshes SSSI, Crostwick Marshes, Hall Farm Fen, and Burgh Common & Muckfleet Marshes)	Suffolk Northern/ Central	2.73 Ml/d

Cognisance of these indicative sustainability changes with the analysis given earlier in this chapter (in terms of the Balance of Supply) indicates that if the changes were included as reductions then:

- In the Essex zone the deficit identified from 2010 onwards would be increased by 5 Ml/d. This would mean that the case for implementation of water resource management options to address the total deficit would be even stronger.

- In the Suffolk Blyth zone, an additional 0.76 Ml/d sustainability reduction would have no material difference in the balance of supply, with demand continuing to be met under all scenarios.

- In the Suffolk Northern/Central zone, application of an additional 2.73 Ml/d sustainability reduction from 2010 would result in the deficit in this zone being substantially brought forward to 2012, resulting in the need for a water resource management option to be implemented much earlier.

8.8. Implications for Options Appraisal & Economic Analysis

Given that the short and medium term deficits in the balance of supply only occur in the Essex resource zone and the Suffolk Northern/Central resource zone, only these zones have been taken forward for option appraisal and economic analysis.

Since the deficit in the Suffolk Hartsimere resource zone is late in the planning horizon no investment would be required for some time, and it is likely that an increase in distribution input under the dry year scenario may address the deficit all together. Hence the need for advanced options appraisal may not be required.

The surplus in the Suffolk Blyth resource zone means that no options appraisal has been required for this zone.

9. OPTION APPRAISAL

9.1. Approach to Option Appraisal

In view of the supply-demand deficits in the Essex and Northern/Central resource zones within the planning period, ESW has adopted an approach to option appraisal consistent with that indicated in the Water Resources Planning Guideline (Environment Agency, 2007a). The approach can be summarised as follows;

(1) production of a comprehensive generic **unconstrained options** list including all the options that could be used to address the planning problem.

(2) development of a site-specific **feasible options** list from the original generic unconstrained options set using suitable screening criteria.

(3) **assessment of the feasible options** through consideration of yield, flexibility, implementation time and other factors/constraints including environmental and social impacts, costs, risks and uncertainty, and links and inter-dependencies.

(4) progression of an **economic appraisal** of the feasible options using the information in (3) and considering environmental and social costs and the cost of carbon.

(5) development of a **preferred options list,** initially through ranking of feasible options in ascending AISC order, followed by consideration of other factors. Further economic analysis may then be required on different combinations of options.

A Strategic Environmental Assessment (SEA) has been undertaken as part of stages (2) to (5) above, in relation to options highlighted following initial first pass EBSD screening. This includes assessment of the screened generic unconstrained options list and the site-specific feasible options list. The SEA has been undertaken as a parallel exercise in production of this WRMP and the SEA Environmental Report should be read in conjunction with it. An SEA scoping report was released in December 2007 (ESW, 2007d), and a draft of the SEA Environmental Report released in April 2008 which has now been updated following comments received during consultation.

9.2. Approach to Screening of Options

Guidance on the screening of options is provided in three different documents; namely the Water Resources Planning Guideline (Environment Agency, 2007a), the EBSD Guidelines (UKWIR/Environment Agency, 2002) and the

SEA Guidance (UKWIR, 2007d). ESW has therefore developed a unified approach to screening of options which can be summarised as follows:

(1) The first stage was to screen out options from a generic unconstrained options list (using EBSD Stage 4 screening criteria)

(2) The second stage was to apply SEA screening criteria on the remaining options from the first stage.

(3) The third stage was to use judgement to turn the remaining generic feasible options list into a specific feasible options list. This list was then in turn subject to both detailed SEA and EBSD assessment.

9.3. Generic Unconstrained Options List

This section presents the generic water management options that could be employed in the Essex and Northern/Central resource zones to address the predicted deficits in target headroom, and is equivalent to Stages 3, 4 and 5 of the EBSD framework (UKWIR/Environment Agency, 2002).

The Water Resources Planning Guideline (Environment Agency, 2007a) indicates that consideration should be given to considering options from each of the following four categories:

Option Category	Description
Customer Side Management	- Policies affecting customer use and supply pipe losses
Distribution Management	- Policies targeted at activities between distribution and the point of consumption.
Production Management	- Policies targeted at activities between abstraction and distribution input.
Resource Management	- Policies affecting deployable output.

This section has therefore been structured to reflect the above categories.

A list of generic unconstrained water management options considered is provided in the table overleaf.

It should be recognised that a rigorous base-load of demand (i.e. customer side and distribution) management measures has already been assumed within the initial Supply Demand Balance for each zone as described in Chapter 5. This includes measures to ensure compliance with Ofwat's water efficiency targets. Additional distribution side management options over those considered in the 'baseline' are identified and described within this Options Appraisal chapter.

List of Generic Unconstrained Water Management Options
(1) Customer Side Management Options • Meter Installation Policy (including Compulsory Metering) • Introduction/Modification of Tariffs • Water Efficiency & Water Conservation Measures (Seven option groups) **(2) Distribution Management Options** • Leakage Reduction Policy • Pressure Reduction Programme. • Supply Pipe Leakage Repairs • Replacement of Iron Pipes • Operational Mains/Service Reservoir Flushing **(3) Production Management Options** • Reduction of Raw Water Losses and Operational Use • Reduction of Treatment Works Losses and Operational Use • Outage Reduction Schemes **(4) Resource Management Options** • New River abstractions • New Groundwater abstractions • New Reservoir Storage • Extension of Existing Reservoirs • Conjunctive Use/Management of Resources • Aquifer Storage & Recovery (ASR) & Artificial Recharge • Desalination • Effluent Recycling • New/Extended Bulk Transfers • Large scale water transfers • Esoteric Options (e.g. sea tankering, towing flexible bags, towing icebergs etc)

9.4. Description of Generic Unconstrained Options

The generic unconstrained options are briefly described in the following section. Please note that more comprehensive descriptions are provided on the feasible options set subsequent to the initial screening stages.

9.4.1. Customer Side Management Options

<u>Meter Installation Policy</u>

Meter installation policy for the Essex & Suffolk supply areas is outlined in detail in Chapter 5.

In formulating the policy for the Essex supply area three options were considered for the Essex supply area, summarised as follows:

Option 1	2010 to 2015 - continue current option & selective policy 2015 to 2020 - compulsory metering 2020 - achieve 'universal metering' of 85%
Option 2	2010 to 2015 - compulsory metering 2015 - achieve 'universal metering' of 85%
Option 3	2010 to 2020 - compulsory metering 2020 - achieve 'universal metering' of 85%

The preferred option which has been assumed in ESW's Final Planning scenario is Option 1. As options 1 and 3 have the same aim to achieve universal metering by 2020, only Option 2 has been included in the options appraisal within this chapter.

Due to the higher existing levels of meter penetration in Suffolk and no supply demand deficit forecast in the next 10 years, Ofwat have not allowed selective metering in their Baseline (CIS) report. In Suffolk, for both the baseline and final planning scenarios, only optant metering will be continued during AMP5.

Introduction/Modification of Tariffs

Customers who currently have meters are generally on a simple metered tariff with a fixed standing charge and a variable volumetric charge. Ofwat considers this as "a useful starting point" and have commented that a tariff structure (if correctly reflecting all costs) should reveal "the value of water and allow customers to use water based on their perception of its value" (Ofwat, January 2008). Putting it simply Ofwat's view is that customers can choose to either use water more efficiently to reduce their bills or use more water if they are willing to pay for it.

Water Efficiency & Water Conservation Measures

There are a wide range of water efficiency and water conservation measures that can potentially be considered over those allowed for in base-load and ESW has been very successful in investigating and trialling a number of these options over the last decade. However, analysis of the effort required to meet the 1 l/property/day target set by Ofwat has demonstrated that over the 5 years period almost all customers will have been offered both a self audit leaflet and retrofit style audit, as well as other measures as outlines in Chapter 5. This will not leave provision to offer additional water efficiency measures. The work identifying water efficiency options previously presented in the draft WRMP has however informed the current evaluation of the most economic and effective ways to meet the Ofwat target.

9.4.2. Distribution Management Options

Leakage Reduction Policy

ESW's leakage reduction strategy is outlined in detail in Chapter 5. The level of leakage currently experienced is such that infrastructure (mains) renewal is seen as the main focus in the battle to maintain leakage at currently low levels.

A suite of leakage 'bands' below ELL can be envisaged for the purposes of option evaluation. The majority of any additional leakage effort would stem from information obtained from night flow areas.

Pressure Reduction Programme

There is a strong relationship between leakage and mains pressure. Where the pressure is a supply network is above the level required to provide an acceptable level of service then pressure reduction is an obvious, cost-effective means of reducing leakage.

Due to a pressure reduction programme having already been implemented and due to the flat topography of the Essex and Suffolk supply areas there is very little scope for any increased pressure reduction without impacting on customer levels of service.

Supply Pipe Leakage Repairs

Supply pipes are those located usually within a customer's property boundary that feed off a water company's main via a connecting water company communications (or 'comms') pipe. The junction of the supply pipe and comms pipe is, in the case of metered properties usually marked by the location of a water meter. Supply pipes fall under the ownership of customers and are currently therefore considered the customers responsibility in terms of maintenance and repair. However ESW has previously considered the option of repairing supply pipes within its Drought Plan.

Service pipes are defined as the combination of the customer owned supply pipe with the water company owned comms pipe. In areas where known leakage from service pipes is significant, an option would be the wholesale replacement of service pipes amongst a number of adjacent properties. Such a project is being planned in the Dagenham area of the Company's Essex supply area.

Replacement of Iron Pipes

Replacement of iron pipes will result in reduced leakage due not only to a reduction in background leakage but also a reduction in burst rates. This option is however an expensive one to pursue so would need to be concentrated in areas of greatest potential in order to obtain maximum benefit.

Operational Mains & Service Reservoir Flushing

Operational Main Flushing

Periodically, a number of ESW's distribution mains are 'flushed' to ensure there is no build up of sediment within them. This entails opening a hydrant to allow the water to pass through the main at an increased velocity; thus lifting any sediment and removing it from the main. Over many years this activity has been optimised to ensure no unnecessary flushing is carried out. The mains rehabilitation programme that was carried out to reduce discolouration of the water has also resulted in fewer mains remaining that require such cleaning. The activity is already very limited in scope and duration and the quantities of water involved overall very small, so there is very little scope to reduce the amounts of water any further.

Service Reservoir Cleaning

All of ESW's service reservoirs are cleaned and inspected periodically. This is primarily to protect water quality and to ensure there are no structural defects that require repair. The activity necessitates the reservoir to be emptied, cleaned, refilled and disinfected prior to return to service. The quantities of water lost are small as most of the contents of a reservoir can be emptied into supply and the remaining water used to help the cleaning process. A small amount of extra water is used to flush through any sediment present on the walls and floor. The process has been optimised to minimise the amount of water required and hence there is little scope to reduce further the quantities required.

9.4.3. Production Management Options

Reduction of Raw Water Losses and Operational Use

Raw water losses are defined as a combination of mains/aqueduct losses, open channel/very low pressure system losses and losses from break pressure tanks and small reservoirs. Raw water operational use is defined as the regular washing-out of mains due to sediment build-up and poor quality of source water.

Under normal operating conditions both raw water losses and raw water operational use are considered to be negligible within the ESW operating areas.

Reduction of Treatment Works Losses and Operational Use

Treatment works losses are defined as the sum of structural water loss and both continuous and intermittent over-flows. Treatment works operational use (TWOU) is equivalent to treatment process water which is defined as excluding water that is returned back to the source water such that it is available for potential re-abstraction.

In the Essex supply area TWOU is limited from the surface works, mainly due to the water being returned to source with the notable exception of a proportion of the process losses from Langford. By contrast a number of sourceworks within the Suffolk supply areas have process losses that are not returned to sourcewater; mainly reflecting the significant proportion of groundwater sources. Hence in this case the potential for recycling washwater could be an option to consider.

Outage Reduction Schemes

Outage can form a not insignificant component of WAFU such that any investigations as to how outage might be reduced could potentially have a positive impact on the supply demand balance for a particular resource zone. Some forms of outage are unavoidable whilst others have potential solutions in terms of reduction or elimination of outage. The most feasible of these are the water quality related outages in respect of algae. As such it is these outages that have been considered within the options assessment. ESW has also reviewed other significant outage elements identified in its supply forecasts. The reassement of outage indicated that other options such as nitrate reduction had little or no benefit in terms of ‘yield’ and hence were discounted.

9.4.4. Resource Management Options

New River and New Groundwater Abstractions

The potential for new ‘traditional’ resource development is governed by water availability in applicable catchments and the requirement to ensure abstraction is sustainable and prevents derogation of existing abstractions and unacceptable effects on the environment. Water availability is now defined explicitly within the Environment Agency’s Catchment Abstraction Management Strategies (CAMS).

CAMS have been produced for all applicable catchments in the Essex and Suffolk supply areas. The specific CAMS are as follows:

CAMS relevant to ESW Essex Supply Area
The Roding, Beam & Ingrebourne Catchment Abstraction Management Strategy, January 2006 The Combined Essex Catchment Abstraction Management Strategy, February 2007 The Cam and Ely Ouse Catchment Abstraction Management Strategy, March 2007
CAMS relevant to ESW Suffolk Supply Area
The Broadland Rivers Catchment Abstraction Management Strategy, March 2006 The East Suffolk Catchment Abstraction Management Strategy, January 2008

The applicable catchment units (these may be sub-catchments or groupings of catchments) are known as Water Resources Management Units (WRMUs) or Groundwater Management Units (GWMU). Each unit has an associated resource availability status which can fall into one of four categories; namely water available, no water available, over-licensed and over-abstracted. A resource availability status is indicated both for individual WRMUs and integrated WRMUs. In addition an aspirational target status is set for each WRMU at an appropriate future review point.

Of the WRMUs covering the ESW Essex supply area only the following have a current status of 'water available':

- The Upper Roach, Crouch and Mardyke rivers,
- The Rivers Beam, Ingrebourne and Lower Roding; and
- The Chalk Aquifer beneath the Beam, Ingrebourne and Lower Roding catchments.

ESW has previously undertaken desk studies and some investigations to assess the potential for development of new abstractions from the River Roding and the Chalk aquifer of the southwest extremity of the Essex supply area.

No resource development is possible within these catchments, largely due to reasons of poor water quality combined with relatively small quantities available which would make any resource development immediately uneconomic.

Of the WRMUs covering the ESW Suffolk supply area only the River Blyth (upstream of Blyford) and the Broads 'Confined Chalk' groundwater, have a current status of 'water available'. ESW had previously identified that the Broads groundwater may have merit, subsequent to further investigation.

In addition to consideration of developing new licences ESW has also reviewed the possibility of obtaining additional supplies via purchase and transfer of licences from other abstractors (licence trading). ESW itself purchased a licence from another abstractor in 2000 in order to facilitate transfer for licensing a new borehole at in Essex. The review has concluded that virtually all other third party licences would not be favourable due to either small yield (rendering options immediately uneconomic), poor quality, or non-consumptive use restrictions.

New Reservoir Storage

Provision of new impounding/pumped storage reservoir storage can be controversial but can be considered a technically robust response to climate change, in terms of capturing water in times of plenty to utilise in drier periods.

New reservoirs are usually considered in response to large potential deficits in supply over demand, and often are sized with the benefits of economic scale and adequacy of future headroom in mind.

ESW has principally explored new reservoir storage in respect of its Essex Resource Zone, mainly due to the size of previously projected deficits and current system characteristics. The last major review of reservoir storage options to support the Essex resource zone was undertaken between 1993 and 1998 starting with an initial study identifying 250 potential sites for further examination. A shortlist of six sites eventually resulted in 1995 after a number of screening phases. The majority of the sites were for the construction of entirely new reservoirs such as an entirely bunded reservoir in the Norfolk Fens. The remit of the project also considered reservoir extensions, of which raising Abberton reservoir was the only one to make the short list. Criteria used in developing the shortlist included visual/landscape, community, ecology, agriculture, cultural heritage, access and construction aspects.

The construction of entirely new reservoirs can be controversial for a number of reasons including environmental impact, loss of land, and effect on local residents.

Extension of Existing Reservoirs

Due to promotional, environmental and political constraints the extension of existing reservoirs can appear potentially attractive over completely new reservoir development due to reduced land take and reduced impact on landowners and the environment.

Extensions to both of ESW's existing pumped storage reservoirs (Abberton and Hanningfield) in Essex have been evaluated over the years. Hanningfield reservoir was quickly identified as not being suitable for extension whilst an extension (or effectively 'raising') at Abberton was identified as being possible. Subsequently a large number of investigations have been carried out over the last ten years into assessing the feasibility of raising Abberton reservoir.

Conjunctive Use/Management of Resources

Conjunctive use schemes rely on the flexible management of raw water abstraction from different sources (e.g. groundwater and surface water) in order to maximise allowable abstraction. In the case of ESW there are two examples of quasi-conjunctive use schemes that already exist but are limited by ‘emergency use’ clauses. These are as follows:

- ESW’s sourceworks at Langham in Essex, which routinely abstracts water from the River Stour. Under defined emergency conditions which effectively limit abstraction from the river, use of a number of Chalk boreholes on the site is permitted in order to ensure abstraction can continue. The emergency conditions include drought and impacts on river water quality preventing abstraction and treatment.

- ESW’s sourceworks at Barsham in Suffolk, which routinely abstracts water from the River Waveney at Shipmeadow. Under emergency conditions a Chalk borehole can be used to maintain levels of abstraction. The emergency conditions would include maintenance of the surface water abstraction structures.

In both the above cases licence constraints and Agency licensing policy (as reflected in CAMS) mean that no true conjunctive use of abstraction would be possible. Additionally having reviewed the wider CAMS policy and all its sourceworks ESW has concluded that no true conjunctive use of resources would be likely to be possible.

Aquifer Storage & Recovery (ASR) & Artificial Recharge

Aquifer Storage and Recovery (or ASR) as the name suggests involves injecting water into an aquifer at a time when water is plentiful (typically the autumn and winter) in order to support abstraction in time of need (typically the summer) in water stressed areas. Such schemes utilise the storage potential of underground rock media to store water.

The Company last investigated the potential for developing an ASR scheme in 1998 via a series of groundwater investigations centred on the confined Chalk aquifer around Abberton. Through undertaking a number of injection and recovery trials it was quickly established that the quality of the water injected was substantially modified by the insitu groundwater via a process of diffusion exchange. This unfortunately meant that any water yielded from the aquifer after storage would require substantial treatment. The costs for this treatment combined with the constraints of the Groundwater Regulations (requiring that only treated potable water could be injected) quickly made any notional scheme economic. Additionally however the limited projected yield and poor likelihood of guaranteed long-term success in the Chalk aquifer have meant that the Company has no plans to investigate further the potential for ASR within its supply areas.

Artificial recharge schemes not centred on discreet storage within fissures have had more success in the UK, most notably in the Chalk aquifer as in Thames Water's Enfield-Harringay scheme. Such as option would not be feasible within ESW's supply areas for long term abstraction management.

Desalination

In its simplest form desalination is the removal of salts from water high in salts to produce fresh water. Water 'high in salts' can range from a slightly brackish water with chloride ions present at about 500 parts per million (ppm) through to sea water with chloride in excess of 35,000 ppm. The salt content of the water to be put through the desalination process has a very significant effect on cost of the process and the negative environmental effects from energy use and salt content of the reject stream. In addition to the complexity of removing unwanted salts from the water it is rarely appreciated that the product water has not simply had the unwanted salts removed but has had virtually all salts removed. Water with no salt content is very aggressive to pipework and is unsuitable for household use. Thus the product water needs to be remineralised before it can enter the potable water cycle.

Desalination is basically a water treatment process that separates salts from saline water to produce a water that is very low in total dissolved salts (TDS). There are effectively two ways of achieving this;

(1) The traditionally most common method has been Multi-Stage Flash (MSF) distillation where the saline water is heated to cause a repeated flashing of stream from the saline feed-stock and the stream condensed to produce the desalinated water. Whilst this multi-stage process is more energy efficient than the traditional forms of distillation it does still have a high energy requirement and tends to be used where fresh water is scarce and primary energy sources are cheap. This accounts for the majority of these plants being situated in the Middle East. MSF would not be the chosen method for desalination in the UK, especially in the East or South East of England.

(2) The other method now becoming more widely used, especially where waters tend to the brackish end of the range, is Reverse Osmosis (RO). Whilst RO is not as widely used as MSF it is gaining as development of more efficient membranes has reduced the cost of operating the plants as well as the capital cost of a RO plant being significantly less than that of a MSF plant of equivalent volume. The principle of RO is that saline water is applied at high pressure on one side of a semi-permeable membrane. The pressure has to be greater than the osmotic pressure of the solution. This high pressure will reverse the initial osmotic flow of fresh water into the salty water, the force just the water from the saline side into the fresh water side of the membrane.

Effluent Recycling

ESW has been at the forefront of effluent recycling in the UK with its innovative Langford Recycling Scheme that was first introduced in 2003 and investigated for a period of several years before permissions were able to be obtained.

The Langford scheme centres around intercepting effluent from Chelmsford Sewage Treatment Works (STW) via a pipeline that crosses ESW's existing Langford WTW site. The effluent is treated to a very high standard at a purpose built recycling plant that has processes to remove nutrients and apply ultra-violet screening. Once treated the water is pumped 3km upstream into the River Chelmer where it augments the natural river flows and is available for re-abstraction via existing intakes supporting both Langford Water Treatment Works (WTW) and storage into Hanningfield Reservoir.

Similarly to Langford there are potentially opportunities for water companies to recycle effluents in other parts of the UK.

New/Extended Bulk Transfers

Being surrounded by other water utilities with similar challenges of operating in the dry east and south-east, means that the potential for developing new bulk transfers of water into either the Essex or Suffolk supply areas is likely to be limited. ESW has however discussed the possibilities with neighbouring water companies.

During the preparation of this WRMP, ESW has met with its major neighbouring water companies to explore any opportunities to share supplies. Neither Anglian Water nor Three Valleys have surplus supplies that could benefit the Essex water resource zone. ESW has explored the possibility of Anglian Water Services (AWS), for a temporary period, having a bulk supply from Abberton Reservoir (when it is raised) into Ardleigh Reservoir. However AWS have recently indicated that this does not form part of their WRMP.

Thames Water Utilities (TWU) do not have sufficient surplus to allow an increased supply into ESW's Chigwell WTW. This was reinforced during the drought of 2006 when, in addition to imposing restrictions on customer use, TWU invoked the clause in the Chigwell Agreement that reduced their supply to ESW by 25%.

In the future, beyond the planning horizon of the current plan, ESW may still be interested in an additional supply of water into Chigwell WTW that will come indirectly from the Upper Thames Major Resource Development that TWU are promoting. This option does not form part of ESW's current option appraisal due to the earliest implementation date being 2021, although we understand that 2025 may be more likely. This would mean an unacceptable time for the Essex water resources zone to remain in deficit.

Large Scale Water Transfers

National Water Grid

The option of large scale water transfers (of similar size to the EOETS or bigger) in what would effectively be a national “water grid” was evaluated by the Environment Agency in a report of September 2006 entitled “Do we need large-scale water transfers for south east England?” This report explored the concept of a water grid and highlighted the significant differences between such a concept and the current national electricity grid. Given that more than one hundred separate resource zones exist in England and Wales, with many not fully integrated, combined with the significant development and operational costs of pumping a ‘heavy’ material mean that although technically feasible, a water grid is not an easy option. The Agency concluded that “there is no new evidence of a need for large-scale transfers of water to south east England from the north of England or from Wales”. This view was arrived at through consideration of available alternatives, evaluation of droughts, and a high level consideration of costs and environmental effects. The Agency’s current position is that large scale water transfers are unlikely to be needed before the late 2020’s.

Canal Transfers

Similarly to the national ‘water grid’ concept is the potential for transfer of water via the British Waterways canal network. This offers the potential for transfers of water across long distances similar. The canal network provides a potential water transfer route from sources in north-west England and the Midlands, via the Grand Union Canal, to the River Nene and the Bedford Ouse, both of which provide links to the fenland area, from where water could potentially be diverted into the existing EOETS system.

River Trent Transfer

A transfer from the lower Trent offers the opportunity of a secure, significant volume of resource that could be maximised to achieve pumped reservoir refill in dry years. The key infrastructure investment is likely to be a pipeline to transfer the water from the River Witham near Boston to the Denver Sluice complex. It is possible that this transfer could also be achieved by linking a series of river systems. The rest of the transfer would be achieved by maximising and/or enhancing the existing Trent Witham Ancholme Transfer Scheme and the EOETS.

Extension of EOETS

Additional transfers from Denver in Norfolk via the Ely Ouse to Essex Transfer Scheme (EOETS) may provide additional water in dry periods, assuming water is available to transfer. This would require changes to the Agency’s governing abstraction licences at Denver and Blackdyke. A temporary version of this option was effectively in place for a five year period between November

1997 and November 2002 following a temporary licence variation. The variation was requested as a response to the 1995 to 1997 drought, and involved increasing the 18 month quantity of the licence and changing the Hands off Flow (HOF) profile of water that must be released to tide before abstraction can occur. In reality this variation was only used for a few days in 1998 due to the improving water resources situation at the time.

It was eventually recognised that any option to vary the Denver and Blackdyke licences, when combined with raising Abberton reservoir would result in additional synergistic yield benefits over the component parts and a more flexible option. Hence this option eventually became the 'Abberton Scheme', once works to upgrade the currently limiting transfer capacity was taken into account.

Under all the above options; whether importing more water into Essex from Denver in Norfolk, from the Canal Network or the River Trent, the existing capacity of the EOETS and Essex System transfer would require enhancing.

Esoteric Resource Management Options - Essex & Suffolk Supply Areas

ESW has considered those resource management options that could be developed, if remotely practical, regardless of the cost of water. These options are referred to as 'esoteric' options, and would only normally be considered as drought options (ESW, 2007a).

Options considered have included sea tankering from Norway, towing flexible bags, river barrages and towing icebergs.

Of these options towing icebergs was quickly considered too esoteric to define cost information, largely due to unproven feasibility and anticipated practical problems. The remaining options are regularly reviewed to see if changes in technology or other influences may begin to make them more viable.

Sea tankering of water for potable supplies is a proven method. The preferred water source for ESW would be from one of several suppliers located at hydroelectric power stations in Norway. It is likely that the water carried would be treated water thereby limiting the transfer of undesirable species in the cargo. Suitable tanker linings/coatings are available to preserve water quality. High unit costs for utilising sea tankering as a drought option means that it would only be considered after all other lower cost options have been exhausted.

The idea of towing flexible bags filled with freshwater from areas of surplus water to areas of shortfall came into fruition in the 1990's. Technology exists to attach flexible bags, made out of strong polypropylene (approved for drinking water use) to tugs that are able to tow the bags. Flexible bags could be used to transport water from Kielder water in the Northumbrian supply area, to either the Essex or Suffolk coastlines. As with the sea-tankering option berthing facilities would be required and a pipeline would be required to transfer the water to a suitable storage point. High unit costs for utilising flexible bags as a drought option means that it would only be considered after all other lower cost options have been exhausted.

River barrages are effectively reservoirs that impound the lower part of a river catchment and exclude brackish/seawater from the impoundment. Barrages present an opportunity to store freshwater that would otherwise be lost to the sea. Key issues that tend to limit the development of barrages for water supply purposes are cost and environmental impact. The estuaries of the rivers Stour, Crouch, Roach and Blackwater are all designated as European SAC and SPA sites under the Habitats Directive and Birds Directive respectively. Although this may not necessarily preclude the development of a barrage in these estuaries, it does represent a significant hurdle in terms of licensing and promotion. For this reason alone the option of River Barrages is not considered further by ESW.

9.5. First Pass Screen of Generic Unconstrained Options List using EBSD Criteria

As suggested in Stage 4 of EBSD, the following screening criteria were used in the initial (first-pass) screening of the generic unconstrained options list:

- Does the option address the problem?
- Is the option technically possible?
- Does the option avoid breaching any unalterable constraints (e.g. planning, health & safety etc)?
- Is the option promotable (does it meet customer and regulatory expectations)?

An additional criterion listed under Stage 4 EBSD was to evaluate if the risk of the option failing is acceptable. This element was not included in ESW's assessment as the Company considers that the answer would be the same for all options. Once capital expenditure is committed it is viewed as unacceptable for the option to fail.

No environmental criteria were used in this initial first pass screening, as SEA screening forms the next phase of options assessment and refinement. Additionally no cost criteria were evaluated at this stage.

The following table has been used to record the responses to the above screening criteria in the case of all options (with the exception of water efficiency) and indicates which options have fallen out of the assessment and have not been progressed to the feasible options set.

Water Resource Management Options Appraisal - First Pass Screening of Generic Options using EBSD Criteria

List of Generic Unconstrained Water Management Options	Screened Out ?	Does option address problem ?	Technically Possible ?	Breach of Constraints ?	Promotable ?	Comments
(1) Customer Side Management Options						
Meter Installation Policy	no	partially	yes	no	yes	
Introduction/Modification of Tariffs	yes	partially	yes	possible	possible	Option requires Ofwat permissions.
Water Efficiency & Water Conservation Measures (Seven Option Groups)	yes	partially	yes	no	yes	Included in baseline therefore removed.
(2) Distribution Management Options						
Leakage Reduction Policy	no	partially	yes	no	yes	
Pressure Reduction Programme.	yes	no	no	no	no	Pressure already at optimised levels. Little scope for further reduction.
Supply Pipe Leakage Repairs	no	partially	yes	no	yes	
Replacement of Iron Pipes	yes	partially	yes	no	yes	Included in baseline therefore removed.
Replacement of Service Pipes	yes	partially	yes	yes	no	No legal rights.
Operational Mains/Service Reservoir Flushing	yes	no	yes	no	yes	Quantities insignificant.
(3) Production Management Options						
Reduction of Raw Water Losses and Operational Use	yes	no	yes	no	yes	Raw water OU not significant in ESW supply areas.
Reduction of Treatment Works Losses and Operational Use	no	partially	yes	possible	yes	TWOU more significant in Suffolk supply areas.
Outage Reduction Schemes	no	partially	yes	possible	possible	
(4) Resource Management Options						
New River abstractions	yes	yes	yes	yes	no	The few river catchments with available water have very poor water quality
New Groundwater abstractions	no	yes	yes	no	yes	Only possible in catchments with water available (eg Blyth).
New Reservoir Storage	yes	yes	yes	possible	difficult	ESW previously looked at 250 potential sites in East Anglia; vast majority have technical and/or promotability issues.
Extension of Existing Reservoirs	no	yes	yes	no	yes	
Conjunctive Use/Management of Resources	yes	no	no	yes	unlikely	Few options available over existing (eg Barsham and Langham) already optimised,
Aquifer Storage & Recovery (ASR) & Artificial Recharge	yes	possibly	no	yes	possible	Seasonal nature can mean not always available when required.
Desalination	no	yes	yes	possible	possible	
Effluent Recycling	no	yes	yes	possible	yes	Experiences from Langford recycling show promotability and obtaining consents can be difficult.
New/Extended Bulk Transfers	no	yes	yes	no	yes	
Large scale water transfers	no	yes	yes	possible	possible	
Esoteric Options (eg. sea tankering, towing flexible bags, towing icebergs etc)	yes	only temporarily	yes	no	difficult	Considered more as last resort drought options than long term resource options.

shaded cells indicate likely barrier to progression beyond first pass screening

9.6. Second Pass Screen of Remaining Generic Options List using Strategic Environmental Assessment (SEA) Criteria

Prior to the preparation of this report, a SEA Scoping Report (ESW, 2007d) was prepared and finalised following consultation with the Environment Agency, Natural England and English Heritage. As well as setting out the approach and method for undertaking the SEA, the scoping report presented a series of SEA objectives and indicators. These were developed following a review of significant baseline environmental issues and of other policies, plans and programmes that could affect or be effected by ESW's WRMP.

The objectives and indicators cover a wide range of receptors including:

- Air [Quality]
- Biodiversity (Inc. flora and fauna)
- Climatic Factors (Inc. energy & climate change)
- Historic Environment (inc cultural heritage, architecture & archaeology)
- Human Health
- Landscape (and visual effects)
- Population
- Soil [Inc. geology and land Use]
- Waste
- Water (inc. material asset)

As suggested in UKWIR's SEA Guidance (UKWIR, 2007d), all generic unconstrained options not screened out using the EBSD Criteria have been assessed against the SEA objectives and indicators to establish early on whether they support or conflict with each other. This initial high level assessment identified potential environmental effects but did not make any detailed or quantitative assessment. The results of this SEA screening of generic unconstrained options are presented in the SEA Environmental Report. None of the remaining unconstrained options were screened out as part of this initial SEA assessment. Consequently, all of the unconstrained options became feasible options.

9.7. Development & Description of Specific Feasible Options

The screened Generic Feasible Options list was developed into a Specific Feasible Options list using judgement to consider the specific type of options and locations which would work best for the Essex and Suffolk supply areas.

The results of this process are summarised in the following table which considers options for the two resource zones where options are required to meet predicted supply deficits; namely Essex and Suffolk Northern/Central.

Summary of Development from Generic Unconstrained Options Set to Specific Feasible Options Set

Generic Unconstrained Water Management Options	ID	Specific Feasible Options for Economic Analysis Essex Resource Zone	Specific Feasible Options for Economic Analysis Suffolk Northern/Central Resource Zone
(1) Customer Side Management Options			
Meter Installation Policy (including Compulsory Metering)	**C1**	Metering Option 1 - Universal by 2015	-
	C2	Metering Option 2 - Universal by 2020	-
Introduction/Modification of Tariffs			
Water Efficiency & Water Conservation Measures (included in baseline)			
(2) Distribution Management Options			
Leakage Reduction Policy	**D1**	Leakage Bands below ELL	Leakage Bands below ELL
Mains & Supply Pipe Repair or Replacement	**D2**	Dagenham Supply Pipe Replacement	
	D3	Generic Mains Replacement	
Pressure Reduction Programme.			
Replacement of Iron Pipes			
Operational Mains/Service Reservoir Flushing			
(3) Production Management Options			
Reduction of Raw Water Losses and Operational Use			
Reduction of Treatment Works Losses and Operational Use	**P1**	-	Washwater Recycling
Outage Reduction Schemes	**P2**	Algae Outage Reduction via DAF	
(4) Resource Management Options			
New River abstractions			
New Groundwater abstractions	**R1**	-	North Lowestoft Groundwater Scheme
New Reservoir Storage			
Extension of Existing Reservoirs	**R2**	Abberton Scheme	
Conjunctive Use/Management of Resources			
Aquifer Storage & Recovery (ASR) & Artificial Recharge			
Desalination	**R3**	Reverse Osmosis Desalination	
Effluent Recycling	**R4**	Colchester Effluent Recycling	
New/Extended Bulk Transfers			
Large scale water transfers	**R5**	River Trent Transfer (includes Abberton Raising and Transfer Enhancement)	
	R6	Canal Transfer (includes Abberton Raising and Transfer Enhancement)	
Esoteric Options (eg sea tankering, towing flexible bags, etc)			

NB Options underlined screened out at initial stages

The resulting Feasible Specific options are described, where appropriate, in additional detail as follows:

9.7.1. Customer Side Management Options

<u>Options C1 & C2 - Meter Installation Policy</u>

Meter installation policy for the Essex & Suffolk supply areas is outlined in detail in Chapter 5.

For Essex the feasible options are:

- Option C1 – The alternative option of achieving 'universal metering' by 2015 via compulsory metering starting in 2010.

- Option C2 – the Company's baseline metering option of achieving 'universal metering' by 2020 via compulsory metering commencing in 2015. This option has been included for comparative purposes.

Due to much higher rates of existing meter penetration in the Suffolk supply area, no metering options were considered for the Northern/Central resource zone.

<u>Water Efficiency and Water Conservation Measures</u>

As these measures are included in our baseline (please refer to Chapter 5) they are no longer referred to in the options assessment.

9.7.2. Distribution Management Options

<u>Option D1 - Leakage Reduction Policy</u>

As previously described bands of additional leakage effort around the ELL have been considered for both the Essex and Suffolk Northern/ Central resource zones. The bands considered go down in 2% increments from the ELL and can be summarised as follows:

ELL Current Target -4% to Current Target -6%
ELL Current Target -2% to Current Target -4%
ELL Current Target to Current Target -2%

The above bands were considered as options for both the Essex and Suffolk supply areas. In the case of Essex each band is equivalent to an improvement in leakage of 1.16 Ml/d. This compares with a figure of 0.17 Ml/d for Suffolk reflecting lower leakage in Suffolk.

9.7.3. Production Management Options

Option P1 - Reduction of Treatment Works Losses and Operational Use

As previously indicated, unlike in Essex, a number of sourceworks within the Suffolk supply area have process losses that are not returned to source water; reflecting the greater significance of groundwater sources.

Losses at groundwater treatment works largely comprise of filter wash water. Filters remove solids from groundwater which overtime “blind” thus reducing their efficiency. Consequently, filters are regularly backwashed with either raw or partially treated groundwater in order to remove any accumulations of filtered solids. The backwash water is then often discharged to a settlement / attenuation lagoon where solids are settled, sometimes assisted through coagulant dosing, and the supernatant is discharged to a local receiving water course.

It is possible to recycle filter back wash water thus reducing treatment works losses and reducing the overall volume that needs to be abstracted in order to meet customer demand.

ESW has therefore considered a washwater recycling programme (Option P1) within the Suffolk Northern/Central resource zone

Option P2 – Algae Outage Reduction Scheme.

The assessment of outage at the Essex WTW’s indicated that temporary reductions in deployable output due to algae in the sourcewater was significant at both the Chigwell and Layer water treatment works. Accordingly a notional scheme based on either of these sites could be envisaged. The Chigwell site was finally chosen as the basis for such as option as historical information indicates average and peak outages of 1.6 Ml/d and 37Ml/d respectively.

A process known as Dissolved Air Flotation (DAF) can be used at the front end of a water treatment process to remove algae solids from raw water. The DAF process comprises the following stages:

(1) Addition of sulphuric acid and a chemical coagulant (coagulation)

(2) Mixing (flocculation)

(3) Introduction of oxygen saturated water within DAF tanks which forms micro-bubbles as the dissolved oxygen comes back out of solution. These bubbles attach to solids causing them to float to the surface where they are retained and subsequently removed via hydraulic desludging; and

(4) pH correction.

Such a process was recently installed at ESW's Lound WTW, and hence the Company has both cost and operational information on which to develop unit costs for the purposes of this WRMP.

9.7.4. Resource Management Options

Option R1 - North Lowestoft Groundwater Scheme

Lowestoft is located within hydrometric catchment 34/19b, which is the Tidal River Waveney catchment below Aldeby. The area falls within the Broadland CAMS and Groundwater Management Unit H (Confined Chalk) which currently has the status of 'Water Available' will a target status for 2011 of 'No Water Available'. This is in order to allow new abstraction licences to be developed where the need is justified and where abstraction is sustainable and does not affect existing abstractors or designated sites. Under the current fully licensed scenario the CAMS Tier 1 appraisal indicates a surplus of 81.9 Ml/d within this unit, although only a fraction of this amount is understood to be licensable.

The scheme is to target the local 'Crag' aquifer (more accurately known as the Crag Group aquifer and Bytham Sand and Gravel Formation), which lies above the Chalk aquifer and is separated from it by the Palaeogene clay deposits. ESW commissioned the British Geological Survey (BGS, 2008) to undertake an initial high-level 'Water Borehole Prognosis' report within the main target area of interest , which lies immediately north of Lowestoft and stretching as far north as Gorleston-on-Sea. This report recommended that three or four exploratory boreholes should be constructed within the 'Crag' aquifer and tested. A recommendation was also given regarding which area to focus on and highlighted the need to consider the effects of any potential for saline intrusion as part of the investigations.

During 2009/10, ESW intends to build on the BGS report findings and undertake a wider desk study to look into potential locations for the construction of investigation boreholes. The purpose of the boreholes will be to evaluate the yield and water quality characteristics of the shallow groundwater within the area of interest. As confirmed by BGS, the yields in the target area are unpredictable, such that it may well be that more than one individual borehole/well may be required to achieve an economically viable abstraction. Any investigations would also be required to establish that the target areas are suitably located to avoid any affects with surface water dependent features and designated sites, as well as interference with existing abstractions. Accordingly ESW will look to liaise with Natural England, the Environment Agency and other relevant bodies during the course of any investigations.

If attractive a scheme could be envisaged whereby raw water for the new Crag sources could be directed via new mains to the Company's Lound WTW site.

For the purposes of designing a scheme for the economic options assessment, an average yield of between 5 Ml/d has been assumed for this scheme. Since Crag groundwater quality is characterised by high iron and manganese concentrations, it has also been assumed that additional treatment structures would be required at Lound in order to treat the water.

This option is considered the only feasible resource management option for the Suffolk Northern/Central resource zone. All the others options described below are in the context of the Essex resource zone;

<u>Option R2 - Abberton Scheme</u>

The 'Abberton Scheme' includes the following elements.

1. <u>Abberton Reservoir Enhancement:</u> Provision of increased storage capacity at the existing Abberton Reservoir (located to the south of Colchester in Essex) by enlarging the reservoir, which will secure additional water resources and improve the reservoir's value for biodiversity.
2. <u>Denver Licence Variation:</u> Powers for increased abstraction (by the variation of abstraction licences held by the Environment Agency) from the River Ely-Ouse near Denver (located near to Downham Market in Norfolk), via the associated Cut-off Channel and Blackdyke intake (the latter located between Denver and Thetford).
3. <u>Transfer Enhancement:</u> Provision for increased conveyance of water from Denver to Abberton Reservoir through enhancement of the capacity of an existing water transfer system comprising the Environment Agency's 'Ely-Ouse to Essex Transfer Scheme' (EOETS) and NWL's 'Essex System', this will require the construction of two new pipelines.

ESW has been investigating and undertaking environmental assessments for the Abberton Scheme over a ten year period. The last few years have seen close liaison with the Environment Agency, Natural England and many other groups whilst the process to produce an all encompassing Environmental Statement (ES) was completed in December 2007. The application for permissions for the Scheme was also made in December 2007 to four local authorities. Planning permission was granted in Spring/Summer 2008 for the upper pipeline that forms part of the overall Scheme.

On 11 November 2008, Colchester Borough Council Planning Committee unanimously recommended to approve the application to raise Abberton Reservoir and to construct the pipeline from Wormingford to Abberton. Formal permission will be granted following the imminent settlement of the Section 106 Agreement.

On 30 July 2008, the NWL Board resolved to make a Compulsory Purchase Order at the earliest opportunity in order to ensure that the Abberton Scheme could be delivered on programme given the urgent need for the Scheme. The Compulsory Purchase Order will be considered at an Inquiry at the end of February.

Applications for Stopping-Up Orders (SUOs) pursuant to Section 247 and 253 of the Town and Country Planning Act 1990 have been submitted to Government Office for the North East in order to close or divert existing access routes, covering the diverted section of the B1026 and the stopping up of Lodge Lane. The proposed SUOs were advertised on 23 January this year and are currently subject to an objections period.

A further stopping up order applications will shortly be submitted, for a footpath that runs next to the main dam of the existing reservoir. This will need to be diverted for the purpose of construction as the footpath will be within the Reservoir construction site on the main dam. Following completion of construction the footpath will be re-instated.

Overall, the Abberton Scheme is programmed to be implemented and constructed between 2008 and 2014. This includes simultaneous construction of both the Kirtling Green to Wixoe and Wormingford to Abberton pipelines in 2010/11.

The creation of new wetlands adjoining the Western Section of the Reservoir as part of the preconstruction ecological works were completed in October 2008.

At the 1999 periodic review the Abberton Scheme was the chosen mid to long term option to meet demand over the planning horizon, and this was confirmed at PR04. As such an allowance in price limits was made for the early elements of the scheme. It is now proposed that the main Reservoir construction works will start in January of 2010 in order to ensure that concrete edge removal work can commence at the beginning of April for completion by the end of September, which minimises any effects on the bird populations that use the Reservoir

The following sections describe in more detail the various elements of the Abberton Scheme. More information can be found in the Abberton Scheme ES which is currently on the Company's web-site at www/eswater.co.uk/abberton.

Abberton Reservoir Enhancement

Abberton Reservoir was constructed between 1936 and 1941. It is a pumped storage reservoir, owned and operated by NWL. The reservoir is fed by minor natural inflow from the Layer Brook and larger quantities of pumped flows from the River Stour, which in turn can be supported by the EOETS and, occasionally (under drought conditions), from other groundwater sources. There is also some pumped input of water from the Roman River and from a borehole at Ball Lane, near Abberton village.

Abberton Reservoir is of international importance for waterfowl, particularly over winter and during the late summer moulting period; this is reflected in it being an SPA, Ramsar site and SSSI. The reservoir's importance for waterfowl is related to its location and physical characteristics, and its plant and animal populations, which provide important sources of food for the birds. The Abberton Scheme involves increasing by 58% the capacity for storing untreated water in Abberton Reservoir. This will be achieved by raising the top water level in the main, eastern part of the reservoir by 3.2 metres. This raising together with various habitat creation and management measures that form part of the Scheme have been designed to increase the value of the reservoir for birds and other wildlife. For example, most of the existing concrete edge to the reservoir will be removed and replaced with gently shelving edges, which are attractive to many species of waterfowl. Improved habitats will also be created around the margins of the reservoir. These works have also been designed to enhance the landscape. The new and enhanced habitats will be managed over the long-term to benefit wildlife and the landscape.

As well as habitat creation work, the Scheme includes a number of other aspects that will deliver environmental benefits or avoid or reduce adverse effects, either during construction or once the enhanced reservoir is in use. These are detailed in the Environmental Statement and include:

- implementation of an extensive range of measures relating to legally protected animal species and other flora and fauna;
- adoption of a traffic management plan to minimise effects of construction traffic on road users and others;
- adoption of pollution prevention measures during construction, in accordance with the Environment Agency's guidance;
- adoption of noise and air quality control measures;
- careful storage and handling of soils during construction;
- measures to minimise adverse effects on cultural heritage features;
- provision of a new and improved Essex Wildlife Trust Nature Reserve and Visitor Centre; and
- enhancement of public access routes around the reservoir and improved parking provision along the B1026.

Denver Licence Variation

As part of the Abberton Scheme, it is proposed that the Environment Agency's licence for the abstraction of surface water from the River Ely Ouse at the Denver Complex will be varied. The variation, which will not require any construction work, will make available additional water for transfer through the EOETS, thus securing the potential for a long-term, additional supply of water to a raised Abberton Reservoir. The increase in the total amount of water that can be abstracted over an 18-month period (starting in April) will be from 79,555 Megalitres (Ml) to 100,000Ml. This is required to accommodate the abstraction volume needed to meet the maximum predicted demand that is able to be met by the Essex System. A corresponding increase will also be required in the Agency's Blackdyke licence.

The water abstracted at the Denver Complex would otherwise flow either directly into the tidal River Great Ouse at Denver Sluice or via the Flood Relief Channel (a freshwater drainage channel, the flow and level within which are controlled by sluices at either end) to the tidal River Great Ouse just south of King's Lynn. The tidal River Great Ouse flows into the Wash, which is an SPA, because it supports internationally important migratory bird populations. The Wash also lies within the Wash and North Norfolk Coast Special Area of Conservation (SAC). It is listed as a Ramsar site, for its importance as an international wetland, and is notified as an SSSI. Part of the south-east Wash is also designated as a National Nature Reserve.

The quantity of water that flows from the River Ely Ouse to the tidal River Great Ouse is subject to a 'Hands-Off' Flow (HOF), which is a flow level below which abstraction cannot take place. This was designed to maintain adequate water quality but also has the effect of maintaining water levels and flows for irrigation, navigation and amenity purposes. There are set values for the HOF for each month and it is proposed to amend the monthly HOFs to be the same as those that applied during a temporary variation to the Denver Licence from 1997 to 2002, introduced to address drought problems in Essex. This would mean a reduction in HOF in October, November and December, and an increase in HOF in March and April, resulting in less water being available for transfer in spring but allowing transfer of more water in late autumn and early winter for storage in Abberton Reservoir.

There will be no change in the maximum licensed daily abstraction for transfer via the EOETS, which will remain at 455Ml.

Transfer Enhancement

The Transfer Enhancement will provide the means of transferring additional water, abstracted at the Denver Complex, to Abberton Reservoir. It will involve a system of pipeline and river transfers.

The existing EOETS does not have the pumping capacity to transfer the existing maximum licensed daily quantity of 455Ml/d. Therefore additional pumping capacity will be provided at Kennett Pumping Station to allow more water to be transferred.

Also as part of the Scheme, a new pipeline will run from the existing transfer route at Kirtling Green in Suffolk to Wixoe on the Essex/Suffolk border, where the additional water will be put into the River Stour. This pipeline, which will have a capacity of 145Ml/d, is needed as there is insufficient capacity in the upper River Stour to accommodate the proposed higher maximum rates of transfer. An additional pumping station will be provided near Wormingford, Essex, where water will be abstracted from the River Stour and transferred via a second new pipeline to Abberton Reservoir.

When the transfer of water from Denver is not operating, the Wormingford pumping station and the pipeline to Abberton will enable NWL to overcome the pumping and storage constraints that currently prevent it from utilising fully water available in the River Stour during naturally high flow conditions, usually during the winter. The combination of abstracting these higher natural flows from the River Stour and the potential for increased transfers from Denver will be used to fill the enlarged Abberton Reservoir.

The design for the construction and operation of the new pipelines includes the following measures:

- adoption of a traffic management plan to minimise the effects of construction traffic on road users and others;
- use of various tunnelling techniques to route the pipeline under the River Stour and River Colne, as well as the A12 road, the adjacent railway and London Road, Stanway;
- implementation of an extensive range of measures relating to legally protected animal species and other flora and fauna;
- avoidance of additional flood risk;
- adoption of pollution prevention measures in accordance with the Environment Agency's guidance;
- tree planting and other landscape works around structures associated with the pipelines;
- adoption of noise and air quality control measures;
- careful storage and handling of soils during construction;
- minimisation of adverse archaeological effects; and

- in the case of the new Kirtling Green to Wixoe pipeline, full flexibility to control the division of flows between the pipeline and River to allow more flexibility in management of the flow regime in the upper River Stour, thus reducing some of the existing adverse effects associated with high rate transfers.

Water is only transferred from Denver to Essex via the EOETS for water supply purposes when all of the following conditions are met:

- the level of Abberton and/or Hanningfield Reservoirs fall below a control level, which is separately defined for each month of the year by a control curve;
- there is insufficient natural flow in the River Stour or the River Pant/Blackwater to enable abstraction to take place in order to supply the reservoirs; and
- the full HOF is being released from the River Ely-Ouse to the tidal River Great Ouse.

The same conditions will also apply in future under the Abberton Scheme. Therefore, the EOETS is not in constant use, nor will it be under constant use under the Abberton Scheme. The amount it is required varies year on year depending on rainfall and demand for water. Based on modelling using current (2004) demand for water applied to climatic conditions (and natural river flows) that occurred over a 25 year time period (1972-96), the average quantity of water transferred in each 18 month period is about 18,000Ml. Without the Scheme, this is predicted to rise to about 22,000Ml by 2027 (and even this would not provide satisfactory security of supply). With the Scheme in place, the need for transfers would be about 19,000Ml on average in an 18 month period. The Abberton Scheme will provide water for transfer to mitigate against periods of prolonged dry weather and drought in Essex when otherwise supplies available in the Rivers Stour and Pant/Blackwater would not be able to meet the demand for water in the Essex Supply Area.

An explanation of how the yield was determined for this option is presented in Section 9.9 of this report.

<u>Option R3 – Reverse Osmosis Desalination</u>

As previously described the principle of RO is that saline water is applied at high pressure on one side of a semi-permeable membrane. The pressure has to be greater than the osmotic pressure of the solution. This high pressure will reverse the initial osmotic flow of fresh water into the salty water, the force just the water from the saline side into the fresh water side of the membrane.

This leaves the salts in the saline side to create an even more saline concentrate that becomes the reject (waste) stream. The rate of fresh water production from a RO plant is governed by the size of the membranes, the water temperature and the pressure of the saline water exerted on the membrane. High pressures, and hence high energy use, are required to feed the membranes, making the treatment process much more expensive than a traditional water treatment works that purifies river or ground water.

In addition to the membrane, a RO plant must also have a primary treatment stage to ensure that the membrane is protected from solid matter in the saline water fouling the RO membrane. Chemicals are also added to the feed water to prevent bio-fouling of the membranes.

The reject water from a RO plant presents a number of environmental issues associated with its disposal. When running efficiently a RO plant will convert between 85-90% of the feed water into product water. This means that for a 20Ml/d scheme between 2 and 3Ml/d of waste water is produced that now has a salt content 10-15% higher than the source water and contains the bio-fouling chemicals added for membrane protection. This presents a real problem for disposal which can only be satisfactorily carried out at sea. The eco-system of the sea is fragilely balanced to exist with the saline conditions it encounters but even small increases in salinity can cause enormous disruption to it. A saline solution, returned to the sea with a salinity of 10-15% higher than the surrounding sea water would devastate the life around the discharge area. Therefore the discharge from a desalination plant can only be made into an area of the coast with a relatively high natural dispersion. This does restrict the site of the plant.

Product Water

An RO plant produces what in effect is distilled water that is devoid of all minerals. The Total Dissolved Solids (TDS) will be in the order of 10ppm whereas the normally supplied water to Essex has a TDS between 500-600 ppm.

Listed below is a table showing the comparison between the likely analysis of a water that would be produced from a RO plant using sea water and Hanningfield Final Treated Water. These results come from a report the Company commissioned from The Centre International de Recherche sur l'Eau et l'Environnement (CIRSEE) into the effects of RO water on the distribution system.

Determinand/Units		Hanningfield Water	RO Water
Conductivity	µS/cm	620	18
pH		7.3	5.6
Total Hardness	mg/l $CaCO_3$	247	3.2
Total Alkalinity	mg/l HCO_3	150	<1
Calcium	mg/l	85	<1
Magnesium	mg/l	8.5	1.2
Sodium	mg/l	49	0.05
Potassium	mg/l	7	1.5

Determinand/Units		Hanningfield Water	RO Water
Chloride	mg/l	75	0.15
Sulphate	mg/l	120	1
Nitrate	mg/l	30	0.5
Carbon Dioxide	mg/l	16.3	3.7
Saturation Index		-0.7	-3.4

The above table clearly indicates the effectiveness of a RO plant to remove nearly all of the salts from water and also demonstrates the marked difference in the composition of RO water and the currently supplied water.
Worthy of especial note is the Saturation Index of each water. The Saturation Index, or Langelier Index as it is often referred to as, is expressed as a positive or negative figure each side of zero. In its simplest described form the Index represents a particular water's ability to either deposit chalk onto the inside of pipework (0 -+ve) or dissolve chalk already deposited onto pipework (0 - -ve). If water has a positive Index then the water will deposit chalk onto the pipework material and not be aggressive to the pipe material. The higher the positive index the more benign the water is to the pipes and the less metal is dissolved off the pipe into the water. Conversely the higher negative the index is the more aggressive the water is to pipe material and the more pipework metals become dissolved in the water.

The dissolution of metals from pipework can have two serious implications for water distribution systems. Firstly there is the regulatory requirement, on health and aesthetic grounds, for water supplied to a customers tap to have very low levels of metals. On aesthetic grounds the level of iron, which is the material of existing water mains is made from, is kept low because high levels lead to noticeably discoloured water and the staining of sanitary ware and clothes from washing machines. The other implication of aggressive water on a distribution system is that the constant loss of metal to the water eventually causes structural damage to the pipes which increases leakage and leads to bursts.

The analysis also shows Hanningfield Final having a slight negative index. This is more of a seasonal/operational phenomena as the intention is to keep it at either zero or slightly positive, but it is never strongly positive and so the water from the works is always close to being aggressive. Water with even a slight negative Langlier Index can cause the zinc from brass fittings to be dissolved leaving the fitting porous and causing leaks and finally failure of the fitting.

The importance of ensuring that any water distributed is not aggressive was such that expert opinion from CIRSEE was sought. The conclusions of this opinion show that only 10% of RO water can be mixed with the existing supplies to ensure that the resultant mixture does not become aggressive towards pipework material. With the flows from Hanningfield WTW generally ranging from 120-240Ml/d, the highest amount of water yielded from a RO desalination plant would be of the order of 25 to 30 Ml/d.

RO water is known to be an alien flavour to consumers of normal potable supplies. Customers used to receiving a supply of water of a constant mineral content that is changed even moderately are very sensitive to the change and may complain about the difference.

Additional factors such as plumbosolvency control confirm the need to limit the volume of RO water to 25 to 30 Ml/d.

Engineering Feasibility

Taking into account the above information consultants Entec produced an early stage feasibility report for ESW. The most important aspect of this study was to find an indicative location in Essex on which costs could be developed.

The following assumptions were made:

- A site that could supply at least 60Ml/d of raw water was required to enable the plant to produce 30Ml/d of potable water
- The product water from the desalination plant would have to be blended with "ordinary" treated water at around a 50:50 ratio, therefore a link to an existing major water treatment works would be necessary
- An outfall into an area of sea with relatively high natural dispersion would be required
- Environmental impacts should be minimised.

A purely indicative site at Bradwell adjacent to the nuclear power station was identified for the following reasons:

- the site fell within Essex;
- the intake could be located in the estuary, although the presence of brackish water at this point would be limited;

- this site could be linked to Hanningfield WTW;
- effluent from this site could be discharged into the open sea; and
- the site was within an already industrialised landscape and was considered to have minimal impact on the designated sites nearby.

The report confirmed that any plant built should be based on reverse osmosis, as opposed to multi-stage flash distillation, and because of the unavailability of brackish water within Essex, the plant would have to rely on sea-water. This would increase the energy consumption of the plant considerably and also create greater problems for the disposal of a much larger volume of strongly saline waste.

The report also quantified the large electricity requirement for such a plant, which for an RO desalination process creates ten times more greenhouse gases than a conventional treatment process.

Option R4 – Colchester Effluent Recycling Scheme

As previously highlighted ESW developed an innovative effluent recycling scheme as its Langford site in 2003, and investigated the scheme for a period of several years before permissions were able to be obtained.

Similarly to Langford there are potentially opportunities for water companies to recycle effluents in other parts of the UK. After considering likely sources of effluent of sufficient quantities within or near to its Essex supply area, ESW has considered a scheme based on the recycling of effluent from Anglian Water Service's (AWS's) Colchester STW.

AWS has also considered the option of recycling effluent from Colchester in its WRMP, and as such early discussions with AWS have indicated that quantities of the order of 10.20 Ml/d could be made available to ESW. A notional scheme has been developed on this basis which assumes construction of an effluent recycling plant on land to the south of the existing Colchester STW. As with the Langford scheme a suitable river is required in order to receive the recycled water and allow subsequent abstraction into ESW's supply network. ESW have therefore assumed a 12km pipeline connecting the recycling plant to the River Stour from which ESW currently abstract.

All the cost information from Langford construction and operation has been of benefit in defining the profile of such a scheme. Additionally AWS has provided ESW with details of the current effluent quality, the treatment of which has also been factored into the derivation of costs.

Experiences at Langford have demonstrated that development of an actual effluent recycling scheme carries a number of inherent difficulties including significant issues around promotion, effluent availability and ownership, regulatory consenting and operational complexity.

Option R5 - River Trent Transfer

A transfer from the lower Trent offers the opportunity of a secure, significant volume of resource that could be maximised to achieve pumped reservoir refill in dry years. The key infrastructure investment would most likely be a pipeline or linked river systems to transfer the water from the River Witham near Boston to the Denver Sluice complex, in combination with enhancement of the existing Trent-Witham-Ancholme Transfer Scheme and the EOETS.

The existing Trent-Witham-Ancholme system enables flows in the River Ancholme to be regulated in dry periods by transfers of water from the River Witham, which is in turn supported by transfers from the tidal River Trent at Torksey.

A scheme utilising water from the Trent would need to be combined with a route of sufficient capacity to transfer the water into the Essex System and a suitable volume of storage. Therefore it can be assumed that a similar scheme to the Abberton Scheme would be needed, with use of Trent-sourced water combined with EOETS uprating and the raising of Abberton Reservoir. Therefore the same constraints on yield would apply in terms of transfer and storage capacities and the same cost profiles would apply for the EOETS uprating and Abberton raising elements but with additional costs (and implicit high carbon emissions) for the transfers from the Trent.

The major drawback of this scheme is the high capital cost for the source element, which would need to be combined with enhancement to the EOETS and Abberton Raising. This cost could potentially be reduced if a river-based transfer could be achieved. The time to implement the whole scheme (Trent trilogy) would be likely to be prolonged (of the order of 10 to 15 years) and bringing in a new quality water, with its different chemistry and alien species, might prove ecologically and environmentally unacceptable to the SPA/SAC receptors affected.

Option R6 - Canal Transfer

Use of the British Waterways canal network offers the potential for transfers of water across long distances, similar in some respects to the River Trent transfer option. The canal network provides a potential water transfer route from sources in north-west England and the Midlands, using the Grand Union Canal via Braunston, to the River Nene or the Bedford Ouse, both of which provide links to the fenland area, from where water could potentially be diverted into the existing EOETS through existing infrastructure (in the case of the Bedford Ouse) or the use of connecting pipelines (in the case of the River Nene).

The key difference over the River Trent transfer option is the increased complexity (and therefore risk) associated with the canal transfer, which would

involve pumping stations where locks rise in the direction of required water flow and channel enlargement on narrow canals if transfers in excess of 100Ml/d were required. This could increase the time to implement the scheme to between 10 and 20 years, depending on the selected route. Vyrnwy Reservoir in the Upper Severn catchment is considered as a potential resource; however, extensive negotiations would be required with United Utilities to secure this. British Waterways would be keen to exploit the commercial opportunities of a large transfer but such an option would be likely to face opposition on environmental and possibly heritage grounds.
In a similar way to the Abberton Scheme and River Trent options, any scheme utilising water from the canal system would need to be combined with a route of sufficient capacity to transfer the water into the Essex System and a suitable volume of storage. Therefore it can be assumed that a similar 'trilogy' would exist with canal system source water combined with EOETS uprating and the raising of Abberton Reservoir. Therefore the same constraints on yield would apply in terms of transfer and storage capacities, and the same cost profiles would apply for the EOETS uprating and Abberton raising elements but with the additional costs of canal transfer and linking the canal system to Denver.

Like the River Trent transfer, the major drawback of this scheme is the high capital cost for the source water and the need to include both EOETS transfer scheme uprating and Abberton reservoir raising. The same ecological and environmental considerations that apply to River Trent transfer also apply to canal transfer and a similar timescale would be involved.

9.8. Marginal Yield Calculations for Abberton Scheme & Derivatives

This WRMP requires estimates to be made as to the additional yield that will be gained within the Essex resource zone as a result of implementing proposed schemes during the 25 year planning period. The additional yield provided by each scheme to the system deployable output is known as the marginal yield of the scheme.

In the case of the Abberton Scheme (option R2) calculation of the marginal yield of these options has been carried out using the Aquator model. The following sections outline the methodology used (including accounting for climate change) and the results of the marginal yield assessment.

9.8.1. Methodology

The model used for determining the Essex System baseline deployable outputs was copied and used for the marginal yield assessment. The infrastructure for all the Abberton Scheme and derivative options had previously been added to the baseline model schematic, but had been disabled in the baseline deployable output calculations. The scenario function in Aquator was used to create the different scenario options reflecting the possible combinations of schemes and climate change scenarios that should be considered.

The model was run using the historic yield calculation (known as the English & Welsh Method) for the critical drought period of record from 1933 through to 1934 for each scenario created. The difference between the historic yield figure provided and the associated baseline historic yield figure provided the marginal yield of the scheme under consideration.

Climate change scenarios were included in the marginal yield assessment in order to determine the likely affect of climate change on the schemes under assessment. Climate change was assessed using the same methodology as applied to the Essex System deployable output calculation (Arnell & Reynard, 2007).

9.8.2. Results

The marginal yield results for each scenario assessed are presented in the following table. The model runs carried out to generate these results were saved for audit purposes.

Scenario	No Climate Change		Climate Change Mid 2025	
	DO (Ml/d)	MY (Ml/d)	DO (Ml/d)	MY (Ml/d)
Baseline (with SAGS)	298		290	
Full Abberton Scheme	360	62	354	64

Scenario	Climate Change Wet 2025		Climate Change Dry 2025	
	DO (Ml/d)	MY (Ml/d)	DO (Ml/d)	MY (Ml/d)
Baseline (with SAGS)	321		259	
Full Abberton Scheme	396	75	300	41

DO = Deployable Output, MY = Marginal Yield

Given the 2025 scenarios it was possible to develop a time series for marginal yield across the planning horizon, using the same factors adopted for deployable output.

9.9. Strategic Environmental Assessment (SEA) of Feasible Options

As suggested in UKWIR's SEA Guidance (UKWIR, 2007d) feasible options have been subject to a SEA. Benefits and dis-benefits have been assessed qualitatively and semi-quantitatively against the SEA objectives and indicators using criteria presented in the SEA Environmental Report. The assessment has considered:

- Effect type: Adverse, Neutral, Beneficial, Unknown or None;
- Receptor Importance: International; National; County; District; Parish or Local;
- Effect duration: Short, Medium , Long Term or Unknown;
- Effect frequency: Continuous, Intermittent or Unknown;
- Effect permanency: Temporary, Permanent or Unknown;
- Cumulative effects: Secondary, Cumulative or Synergistic; and
- Effect significance: Significant or Not significant.

Where possible, effects have also been quantified and expressed in an appropriate unit (e.g. tonnes of CO_2 per Ml of water supplied).

It should be noted that SEA and sustainability appraisal is an iterative process. This assessment has been based on information available at the time of making the assessment. Consequently, as further information becomes available and always prior to promoting and implementing a scheme, further assessment will be undertaken.

The results of the SEA assessment are presented in "Feasible Options Assessment Matrices" located in the SEA Environmental Report appendix. Where appropriate, mitigation measures have been identified to prevent, reduce or offset significant adverse environmental effects.

9.9.1. Habitats Regulation Assessment.

The Agency's Final PR09 Water Resources Planning Guideline states that,

> *The water company, as a competent authority, will have to ensure that its plan meets the requirements of the Habitats Regulations (Conservation (Natural Habitats &c.) Regulations 1994) before implementation. The water company will need to determine if it is required to undertake a Habitats Regulation Assessment.*
>
> *The Habitats Regulations Assessment refers to the assessment of the likely or potential effects of a development plan on one or more European Sites (collectively termed 'Natura 2000' sites and comprising Special Areas for Conservation [SACs], candidate SACs [cSACs] and Special Protection Areas [SPAs]). If such effects are thought likely to be*

significant, an appropriate assessment will need to be undertaken. The HRA should conclude whether or not a proposal in a water resources management plan would adversely affect the integrity of a European site.

The HRA is based on the precautionary principle and therefore requires those undertaking the exercise to prove that the plan will not have a significant impact on these conservation objectives. Where uncertainty or doubt remains, an adverse impact should be assumed. The HRA should be undertaken by the water company but should include advice from Natural England/Countryside Council for Wales and ourselves.

The outcome of the HRA should be that the WRMP is not be passing down plans or projects that might fail HRA at the next, more detailed level (i.e. the HRA decision should not be deferred to when a licence is submitted and determined).

In terms of Essex & Suffolk Water's WRMP Final Planning Solution, only the Abberton Scheme was identified as having the potential to have effects on European sites, namely the Ouse Washes, The Wash, the Stour Estuary and Abberton Reservoir. It was concluded that the scheme would not significantly adversely effect the Ouse Washes, The Wash and the Stour Estuary. However, further studies were undertaken to inform an Appropriate Assessment for Abberton Reservoir. Following liaison with Natural England, these studies were also able to conclude that the scheme would not have significant adverse effects on the integrity of the site and so an appropriate assessment was not required. Indeed, Natural England stated that, "In our view, the Abberton Reservoir Scheme is likely to have a significant positive effect on the conservation status of the migratory and wintering waterfowl assemblages in the short-, medium- and long-term future of the statutorily designated site."

9.10. Economic Appraisal

9.10.1. Approach

A framework for the economic appraisal of water resource management options is provided by the 'Economics of Balancing Supply and Demand' or EBSD Guidelines (UKWIR/Environment Agency, 2002). However, as previously indicated in the early part of this chapter, ESW has combined the EBSD guidance with more recent guidance (principally relating to SEA) in order to create an up-to-date framework consistent with the requirements of both the Agency's WRPG (Environment Agency, 2007a) and the SEA Directive.

The original EBSD guidance identified four phases known in order as the Data Phase, the Modelling Phase, the Refinement Phase, and the Final Reporting

Phase. Within each phase are a number of stages which can be summarised as follows:

EBSD Stage	Description of Stage
Phase 1 - Data Phase	
Stage 1	Assemble the supply and demand forecasts
Stage 2	Identify the planning problem
Stage 3	Determine an unconstrained options set
Stage 4	Screen the unconstrained options set to identify feasible options
Stage 5	Quantify all impacts, costs and benefits of options
Phase 2 - Modelling Phase	
Stage 6	Decide on Modelling Framework
Stage 7	Decide on the Selection Routine
Stage 8	Calculate Average Incremental Costs for Options
Stage 9	Establish target levels of service
Stage 10	Apply the modelling framework and selection routine.
Phase 3 - Refinement Phase	
Stage 11	Improve the Solution by Taking Account of Indivisibilities
Stage 12	Consider Tariff and Demand Feedback
Stage 13	Improve Solution by Making Allowance for Risk, Environment & Equity
Phase 4 - Final Reporting Phase	
Stage 14	Review and Consolidate Stage Reports

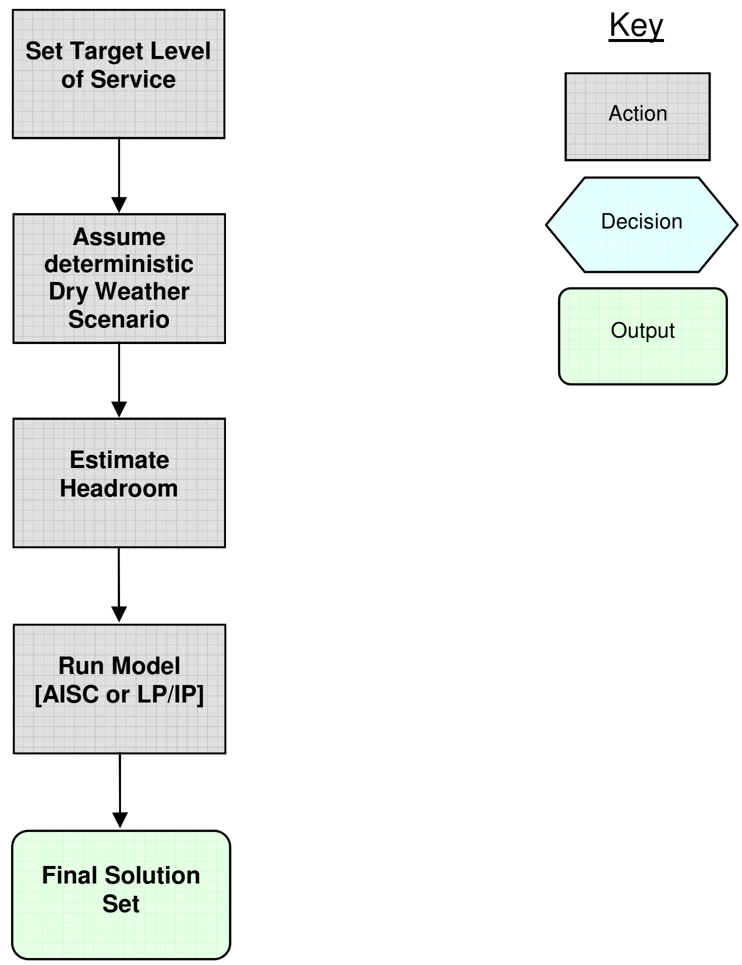
The elements identified within the 'Data Phase' have already been covered within previous chapters of this document. The main purpose of the subsequent 'Modelling Phase' is the definition of unit costs and the scheduling of water resources management options; which are the main focus of this chapter.

9.10.2. Modelling Framework

Stage 6 of the EBSD requires the selection of one of three possible modelling frameworks, known as the current, intermediate and advanced frameworks respectively.

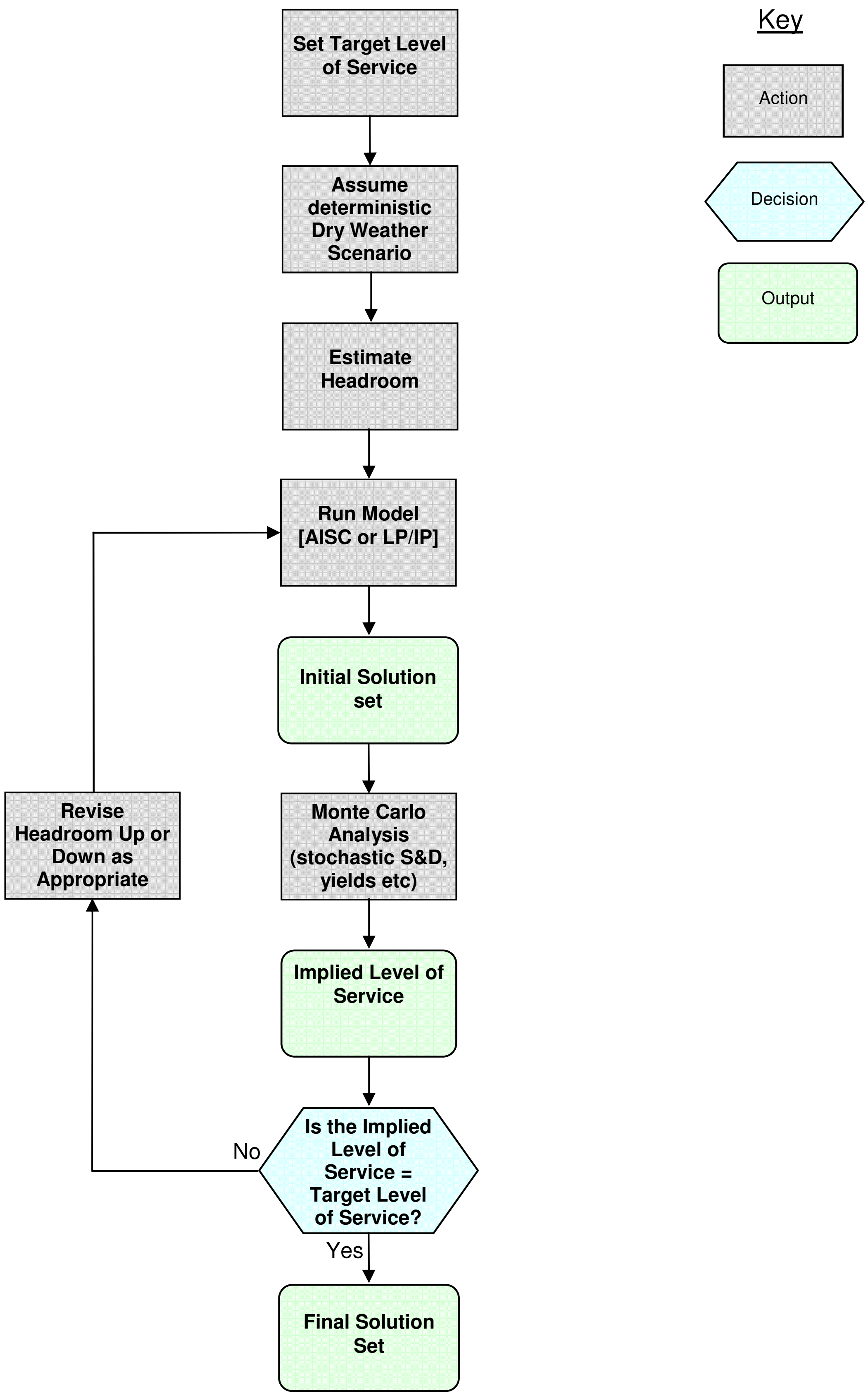
The current framework is deterministic, simple to apply and relies on using fixed user-defined levels of service and target headroom as inputs into a planning model which incorporates a solution algorithm. The solution algorithm could be based on an Average Incremental Cost (AIC) approach, or a more sophisticated linear or integer programme. The current framework can be summarised in the following diagram:

The Current Framework (UKWIR/Environment Agency, 2002)



The intermediate and advanced frameworks both rely on using Monte Carlo simulation to predict the reliability that will be provided by any given solution set. The advanced framework additionally requires the reliability to be set optimally on the basis of customer preferences or their 'willingness to pay'. The intermediate framework can be summarised in the following diagram:

The Intermediate Framework (UKWIR/Environment Agency, 2002)



Both the current framework and intermediate framework have been selected for the Essex resource zone. The current framework has been used in order to allow reporting of target headroom figures generated under the methodology outlined in Chapter 6. The intermediate framework (where target headroom is iteratively adjusted) has been used to provide additional justification for the selection of the optimum final planning solution. This has principally been required due to the high level of investment likely to be required to meet the projected supply deficit in this zone.

Only the current modelling framework has been deemed necessary for the Suffolk Northern/Central zone due to the very small number of water resource management options available to meet the deficit in supply.

9.10.3. Selection Routine

As presented in Stage 7 of the EBSD guidance, ESW has selected the Average Incremental and Social Cost (AISC) approach as the basis of its selection routine.

As recommended in the Agency's Water Resources Planning Guideline (Environment Agency, 2007a) the basis to this approach will be to present both as AISC and AIC (Average Incremental Costs) for each water management option considered.

9.10.4. Unit Cost Definition

In order to define unit costs the following base cost information was obtained for each water management option:

- Initial capital costs and replacement capital costs (£m) for different asset life categories.
- Fixed operating costs (£m/year)
- Variable operating costs (£/m^3) in operational, system and environmental categories.
- Environmental & social costs (£m/year).
- Carbon costs; expressed as both operational (£m/year) and embedded (£m capital) costs.

The capital and operating cost for each water resources management option were obtained from a variety of sources including reports, existing operational data, expert judgement, current cost-base models etc. Particular attention was paid to determining environmental, social and carbon costs as outlined in the following sections.

9.10.5. Assessment of Environmental and Social Costs of Feasible Options

The Agency's Water Resources Planning Guidelines suggest that potential environmental and social benefits and dis-benefits of WRMP options should be assessed and monetised using its 2003 Benefits Assessment Guidance (BAG).

As environmental and social impacts remain outside the 'market place', they are commonly referred to as 'external' effects or 'externalities'. However, monetary valuation allows the environmental and social impacts of a scheme to be summed and compared with the capital and operating costs. It relies on the use of techniques such as Benefits Transfer which uses monetary values taken from previous studies and then applies them to the water resources option being assessed.

Monetary valuations of environmental or social benefits or disbenefits are often based on an individual's willingness to pay for an environmental benefit or to be compensated for an environmental disbenefit (Environment Agency, 2003).

As BAG relies on the use of a standardised assessment process and existing surveys and data, the guidance states that the results of any assessment can be assumed to provide only rough indicators of the benefits or disbenefits that will be delivered by any single scheme. Consequently, the uncertainty surrounding the results should be acknowledged. In particular, the resulting estimates of the monetary value of benefits or disbenefits can be assumed to give only ball park estimate of the 'true' value of the impacts (Environment Agency, 2003).

The BAG assessment comprises two stages:

Stage 1 comprises screening to identify whether the option being assessed is likely to have significant environmental and social effects. This assessment was undertaken using the standard questions that are presented in the following parts of the BAG:

Part 2: Rivers and Groundwaters
Part 3: Reservoirs, Lakes and Broads
Part 4: Coastal Waters and Estuaries
Part 5: Work Related Impacts

The questions were answered using GIS to confirm the location and therefore potential effect of the option on abstraction, ecological, heritage, archaeology and landscape receptors. Additional information was used from a number of websites including the Environment Agency, councils, British Waterways and local fishing clubs.

The results of Stage 1 are presented in the supporting SEA document.

Stage 2 comprises a monetary assessment of potential significant environmental and social effects that were identified in Stage 1 and where an appropriate benefits transfer value was available. In terms of the latter, this means that the sites characteristics and the relevant population were both similar.

The results of both Stage 1 and 2 are presented in the table overleaf and alongside the results of the SEA Assessment in "Feasible Options Assessment Matrices" located in an appendix of the SEA Environmental Report.

9.10.6. Carbon Accounting & Cost of Carbon

Background

ESW with its consultants Aqua, has developed carbon accounting tools for use in estimating carbon emissions from new Company assets. The methodology and carbon models produced have been accepted by OFWAT and have been used to produce Whole Life Carbon quantities and costs based upon the Shadow Price of Carbon for each of the water resources feasible options.

The quantification of embodied and operational carbon was split between Civils Components and Mechanical and Electrical (M & E) components.

The following approach was used to review each option:

1. Model boundaries and coverage were defined.
2. Components of the option including key civils structures and key mechanical drives were determined using design drawings and reports.
   (a) For civil structures, a 'take off' of material quantities from sized structures was used to produce a bill of quantities considering in particular the main material quantities.
   (b) For M & E, equipment schedules were developed and appropriate weights (quantities) of materials allocated to each main item. M & E weights were estimated from literature, supplier data, previous installations or first principle calculations.
3. The sources for estimating carbon emissions were confirmed as materials, plant, labour and preliminaries as they are high carbon emitters.
4. Materials used were limited to include: concrete, metals, plastics, earthworks, bitumen and aggregates.

Receptor	Effect	Option																			
		Suffolk		Chigwell		North		Abberton		Bradwell		Colchester		Upper Thames		River Trent		Canal Transfer		Denver	
		Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)	Monetary Assessment	Benefit / Disbenefit (£)
Rivers & Groundwater	Informal Recreation	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	Angling	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	Aquaculture & Commercial Fisheries	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	In-Stream Recreation	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	Amenity, Property Prices & Regeneration	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	Abstractions	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	Heritage, Archaeology and Landscape	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Rivers & Groundwater	Biodiversity and Non-Use Values	No	£0	0		No	£0	0		0		No	£0	0		No	£0	No	£0	No	£0
Res & Lakes	Recreation	0		0		0		Yes	-£360,000	0		0		No		0		0		0	0
Res & Lakes	Heritage, Archaeology and Landscape	0		0		0		No	£0	0		0		No		0		0		0	0
Res & Lakes	Amenity, Property Prices & Regeneration	0		0		0		No	£0	0		0		No		0		0		0	0
Res & Lakes	Land Take	0		0		0		No	£0	0		0		No		0		0		0	0
Res & Lakes	Biodiversity and Non-Use Values	0		0		0		No	£0	0		0		No		0		0		0	0
Coast & Estuaries	Informal Recreation Along Coasts and Estuaries	0		0		0		0		No	£0	0		0		0		0		0	0
Coast & Estuaries	Coastal Bathing	0		0		0		0		No	£0	0		0		0		0		0	0
Coast & Estuaries	Water Sports	0		0		0		0		No	£0	0		0		0		0		0	0
Coast & Estuaries	Recreational Fisheries	0		0		0		0		No	£0	0		0		0		0		0	0
Coast & Estuaries	Shellfisheries	0		0		0		0		No	£0	0		0		0		0		0	0
Coast & Estuaries	Biodiversity and Non-Use Values	0		0		0		0		No	£0	0		0		0		0		0	0
Construction	Landtake	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0
Construction	Landscape	No	£0	No	£0	No	£0	No	£0	Yes	£80,000	Yes	£40,000	No	£0	No	£0	Yes	£2,100,000	No	£0
Construction	Property-Based Disamenity Effects	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0
Construction	Traffic Related Impacts	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0
Construction	Energy and Global Warming	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0	No	£0
	Cost (£)		£0		£0		£0		-£360,000		£80,000		£40,000		£0		£0		£2,100,000		£0

Summary of Work Related Impacts Environmental & Social Costs

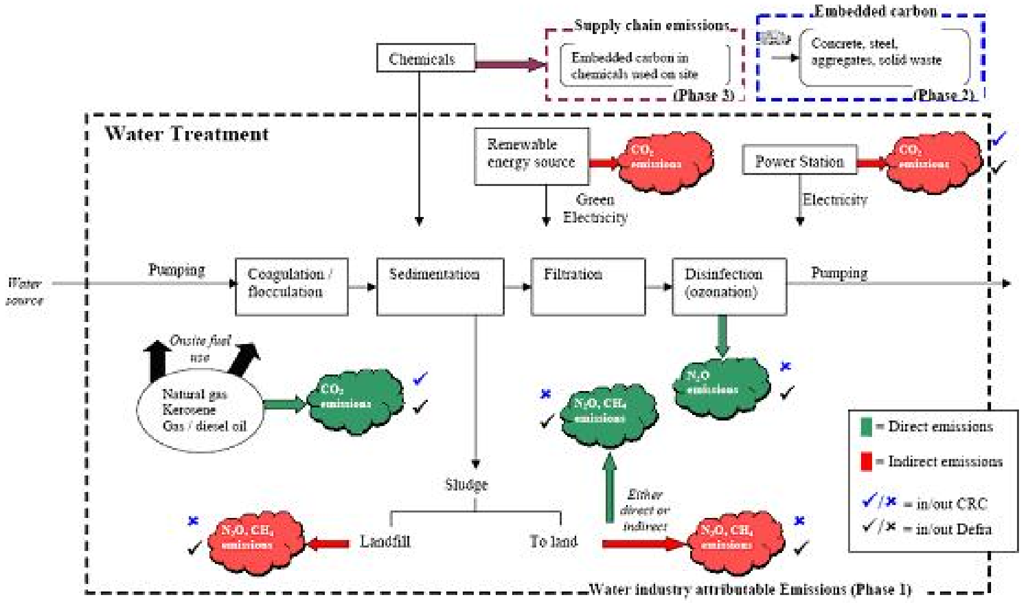
The table above does not included Energy and Global Warming effects as all schemes have been subject to a separate carbon assessment.

5. A table of emission factors was developed using standard composite emission factors from UKWIR guidelines (UKWIR 2007) and bespoke emission values generated from University of Bath (ICE V1.5a Beta 2006) coefficients.
6. The emission factors were then applied to the component quantities to determine the overall option embodied carbon.
7. Consistent with the UKWIR guidelines (UKWIR 2007), operational carbon emissions were based on proposed daily and annual flows.
8. Whole Life Carbon emissions and costs were determined using a net present value (NPV) determination methodology, with costs derived from the 2007 Defra Shadow Price of Carbon values.
9. Assumptions on estimating emissions were logged, including all references to data sources.

Boundaries and Coverage

<u>Operational Carbon Emissions</u>

The UKWIR carbon accounting methodology has been used for setting the boundaries and coverage of our operational emissions carbon assessment, as illustrated below:



Carbon emission scope (extracted from UKWIR 2007, p.8)

Of the two approaches shown above, the 'Defra approach' to carbon estimation has been used as it is more consistent with the Kyoto Protocol (UNFCCC 1997) and the IPCC guidelines (IPCC 2006). Carbon emissions associated with chemical use and transport have not been considered in this assessment although in some option assessments, operation emissions associated with existing equipment have been included as these are integral to the operation of the option.

Embodied Carbon Emissions

The scope of the embodied carbon emissions assessments was as follows:

1. Estimated embodied carbon emissions are from cradle to 'built asset', and do not include any capital maintenance items.
2. The Greenhouse Gas (GHG) emissions only include for CO_2 when estimating embodied emissions.
3. Operational emissions from construction plant have been considered. These include direct energy emissions from fossil fuels in terms of diesel, and indirect energy from electricity.
4. Labour emissions are calculated based upon travel from site to lodgings, with no allowance for emissions associated with off-site lodgings and subsistence. These emissions have not been calculated separately but are part of the general composite emission factor for the supply and placing of materials.
5. Emissions from material deliveries are assumed to be included within the composite emission factors given in the UKWIR guidelines for embodied carbon.
6. Estimates have not allowed for emissions associated with off-site (indirect) Contractor and Client overheads.
7. Material emissions exclude those associated with the manufacture of plant used for the extraction and processing of raw materials.

Estimated Emissions

Embodied Carbon Emission

The table below shows the estimated carbon emissions for the individual schemes:

Schemes	Aqua Embodied Carbon (tCO_2)
North Lowestoft Groundwater Scheme	806.64
Abberton Reservoir	185,516.72
Reverse Osmosis Desalination	48,154.50
Colchester Effluent Recycling	5,417.32
River Trent Transfer	70,231.61
Canal Transfer	37,443.53
Reduction of treatment works losses	181.00
Algae Outage Reduction	1,176.00

Scheme Embodied Carbon Emissions

Operational Emissions

Operational carbon emissions are summarised the tables below:

Scheme	Annual CO_2 [tonCO_2/yr]	Operation frequency [days/year]	Nominal flow [Ml/day]	Annualised daily average [kgCO_2/day]
Abberton	14359	-	231	39341
N. Lowestoft	297	365	7	812
Desalination	32914	365	65	90174
River Trent	15537	-	120	42567
Canal Transfer	20275	-	120	55548
Colchester Effluent	-	-	30	6302
Algae Outage	285	365	6.95	781
Treatment Losses	18	365	0.548	49

Operational Carbon Emissions

Scheme	Aqua kgCO_2/Ml/day
Abberton	170
N. Lowestoft	116
Desalination	1387
River Trent	355
Canal Transfer	463
Colchester Effluent Recycling	210
Algae Outage	112
Treatment Losses	89

Operational Carbon Comparison

As a comparative benchmark, a one way 747 flight from London to New York has been considered and estimated to generate 2 ton CO_2/passenger/flight or 740 ton CO_2/flight (chooseclimate.org 1999). Hence, relative to this flight, none of the schemes can be considered to have a high annualised daily operational carbon.

Estimated Quantities

The table below summarises the material quantities of each schemes and shows that the vast majority of CO_2 material emittors are metals, concrete, plastics and bitumen. Of these pipework is the biggest contributor due to the nature of the options on the water resource schemes.

Option Material Quantities

Material		Unit	Schemes								Total Qty	Total tCO2
			Abberton Reservoir	North Lowestoft Groundwater Scheme	Reverse Osmosis Desalination	Colchester Effluent Recycling	River Trent Transfer	Canal Transfer	Algae Outage Reduction	Reduction of treatment works losses		
Road	Asphalt	m3	11314.1				184.8	924.0			12422.9	103129.9
Iron	Pipes	m			1957.0		65116.2	14541.0		165.0	81903.2	72522.2
Steel	Pipe	m	43397.7	15.0	6840.0				360.0		50612.7	33540.6
Plastic	Pipes	m	3500.0	5150.0	35200.0					266.9	44116.9	17003.5
Concrete		m3	13380.5	21.6	5292.2	5895.4	1369.0	6845.0	646.0	167.6	33617.4	16236.3
Steel		t	1069.4		1291.6	884.3	214.0	1070.0	299.8		4829.1	6815.4
Plastic	General	t			802.7						802.7	2030.7
Masonry	Brick/Block work	m2	3769.3	172.8			3162.0	15810.0			22914.1	883.4
Concrete	Pipes	m	8601.0				144.0	720.0			9465.0	648.7
Fill Material	General	m3	40878.7	27.6		5970.6	43.2	216.0			47136.1	557.4
Valve	General	Nr	100.0		410.0		52.0	260.0	45.0		875.0	536.2
Steel	Cladding	m2			15712.0				2079.4		17791.4	444.8
Steel	Palisade fence	m					376.0	1880.0			2256.0	263.6
Steel	Openmesh flooring	m2			84.0		566.0	2830.0	303.9		3783.9	119.8
Iron	Cast	t			55.0						55.0	90.2
Plastic	GRP	m3		1.9			0.4	2.0			4.3	45.0
Steel	Handrails	m			306.6		60.0	300.0		16.7	683.3	11.6
Steel	Ladders	m			48.3						48.3	4.1
Steel	Reinforcement	m2		182.8						0.0	182.8	2.1
Sand		t				346.8				16.5	363.2	1.8

Whole Life Carbon Accounting

Whole Life Carbon emissions have been estimated for each water resources option using the embodied and operational emissions presented in the tables above. These emissions are estimated in accordance with UKWIR guidelines on ‘Embodied Carbon emissions’.

The table below estimates cumulative embodied and operational emissions (WLC) over a 40 year time horizon. All estimates have been evaluated on a non-financial method using the following assumptions:

- The central estimate on Shadow Price of Carbon (SPC) has been used and is derived from the 2007 SPC as specified by Defra (2007b). This is consistent with the Stern (2006) value;
- The SPC increases by 2% per year to account for increasing damage costs;
- A social discount rate of 3.5% has been used; and
- A high level notional 50 year design life has been used for all schemes. Within each option assets may have a shorter design life, but for this comparison capital maintenance has not been included (typically less than 5% of carbon emissions).

Schemes	Asset Life [Years]	WLC [tCO_2]	WLC Cost (using SPC)[£]
North Lowestoft Groundwater Scheme	50	11,498	239,398
Abberton Reservoir	50	702,440	15,517,969
Reverse Osmosis Desalination	50	1,233,058	25,441,334
Colchester Effluent Recycling	50	5,417	143,102
River Trent Transfer	50	629,563	13,264,451
Canal Transfer	50	767,343	15,877,389
Reduction of treatment works losses	50	829	18,000
Algae Outage Reduction	50	11,436	240,345

Whole Life Carbon (WLC) Emissions

The table above shows that the Desalination option generates 40% more carbon emissions than its closest option. As expected this due to the high operating cost of this type of process.

9.11. Unit Cost Modelling

Within the EBSD framework the approach adopted by ESW has been to define unit costs for each feasible water resources management option via the AIC/AISC approach using ESW's Long Run Marginal Cost (LRMC) model. This model was developed by NERA for the Company at the last periodic review. The model has been used to derive the unit costs for the distribution management, production management and resource management options, in addition to those required for the leakage and metering options.

Traditionally the approach has been to rank the resulting unit costs to enable a least cost approach to option selection. It is now recognised however, (principally via the SEA process) that further analysis may be required to evaluate option sets from an environmental perspective.

In the context of this WRMP the LRMC model has been used mainly for the purposes of determining unit costs of the feasible water resource management options. Output from the model has then been used in a secondary process in order to identify potential preferred schedules of water management options under both the Current EBSD and Intermediate EBSD frameworks.

9.11.1. Summary of Base Cost Information

The following tables present the basic cost information that was used to define the unit costs for each water management option. Additional information required to define unit costs included:

- Initial capital costs and replacement capital costs (£m) for different asset life categories.
- Precedence with other options.
- Capital cost and yield profiles in individual years prior to or after scheme implementation, dependent on the nature of the option.

In respect of yield profiles two approaches have been used as required under Section 11.5 of the WRPG; namely capacity based and utilisation based:

Capacity Based Unit Costs – Under this approach the total quantity of water the water resource management option can deliver (design yield) is assumed at the time it becomes available.

Utilisation Based Unit Costs – Under this approach only the likely quantity of water to be used is considered (in respone to forecast demand requirements).

COST INFORMATION BASE FOR ECONOMIC ANALYSIS (Part 1 of 2)

Option ID	Option	Yield (Ml/d)	First Year Possible	Baseline Capital Cost (£m)	Capital Costs (£m) plus embedded carbon	Environmental & Social Costs (£m/yr)	Environmental & Social Costs plus Operational carbon (£m/yr)	Fixed Operating Costs (£m/year)	Variable Operating Costs (£m/year)
C1	Universal Metering by 2015 (Essex)	9.63	2015	49.2200	49.2800		-0.025318		
C2	Baseline Metering Option - Universal by 2020 (Essex)	9.63	2020	51.0000	51.0300		-0.024248		
D1 (e)	Leakage Bands Above & Below ELL (Essex)								
	ELL - 6%	1.16	2010						4.2510
	ELL - 4%	1.16	2010						2.7070
	ELL - 2%	1.16	2010						1.7050
D1 (s)	Leakage Bands Above & Below ELL (Suffolk)								
	ELL - 6%	0.17	2010						0.8330
	ELL - 4%	0.17	2010						0.6600
	ELL - 2%	0.17	2010						0.5150
D2	Dagenham Supply Pipe Leakage Reduction								
	Year 1	0.5	2010	1.5200	1.5200				
	Years 1 to 10	5	2019	15.2000	15.2000				
D3	Generic Mains Replacement								
	DMA Group 1 - AMP5 Mains Renewals	2.65	2015	20.2651	20.2651				
	DMA Group 2 - AMP6 Mains Renewals	2.65	2020	18.8689	18.8689				
	DMA Group 3 - AMP7 Mains Renewals	2.65	2025	35.7805	35.7805				
	DMA Group 4 - AMP8 Mains Renewals	2.65	2030	34.8425	34.8425				
	DMA Group 5 - AMP9 Mains Renewals	2.65	2035	40.3541	40.3541				
	DMA Group 1 - any AMP Mains Renewals	2.65	2015	41.6147	41.6147				
	DMA Group 2 - any AMP Mains Renewals	2.65	2015	44.4370	44.4370				
	DMA Group 3 - any AMP Mains Renewals	2.65	2015	62.8082	62.8082				
	DMA Group 4 - any AMP Mains Renewals	2.65	2015	62.5674	62.5674				
	DMA Group 5 - any AMP Mains Renewals	2.65	2015	65.2322	65.2322				

Note:
- all costs in 2007/08 prices
- carbon costs defined for first year possible

COST INFORMATION BASE FOR ECONOMIC ANALYSIS (Part 2 of 2)

Option ID	Option	Yield (Ml/d)	First Year Possible	Baseline Capital Cost (£m)	Capital Costs (£m) plus embedded carbon	Environmental & Social Costs (£m/yr)	Environmental & Social Costs plus Operational carbon (£m/yr)	Fixed Operating Costs (£m/year)	Variable Operating Costs (£m/year)
P1	Washwater Recycling (Suffolk only)	0.13	2012	0.2170	0.2240	0.000000	0.000546	0.0500	0.0030
P2	Algae Outage Reduction Scheme - notional	1.6	2014	10.5162	10.5500	0.000000	0.008152	0.2689	0.1530
R1	North Lowestoft Groundwater Scheme (Suffolk only)	5	2014	4.1411	4.1504	0.000000	0.008839	0.2238	0.1450
R2	Abberton Scheme	64	2014	151.0000	152.0800	-0.036000	0.067326	0.4769	0.1930
R3	Reverse Osmosis Desalination	30	2018	123.4792	123.8705	0.015780	0.016605	6.4782	0.2961
R4	Colchester Effluent Recycling	10.2	2018	16.7600	16.9300	0.040000	0.040000	0.1510	0.7500
R5	River Trent	64	2018	178.6600	179.4000	2.100000	2.600490	0.4831	0.2239
R6	Canal Transfer	64	2018	266.8700	267.2700	0.023670	0.676796	0.4819	0.2239

Note:
- all costs in 2007/08 prices
- all options for Essex Resource Zone unless stated otherwise
- carbon costs defined for first year possible

9.11.2. Unit Costs Results

The results of the unit cost calculations are presented as follows:

Essex Resource Zone – Capacity-Based Unit Costs

ESSEX RESOURCE ZONE - UNIT COST COMPARISON OF FEASIBLE OPTIONS - BASED ON CAPACITY

Option ID	Scheme	Unit Cost (p/cm) AISC	Unit Cost (p/cm) AIC	Annual Yield Ml/d	Earliest Possible Year
	Customer Side Management Options				
C1	Universal Metering by 2015	137.08	137.83	9.63	2015
C2	Universal Metering by 2020	144.75	145.53	9.63	2020
	Note : Water efficiency & water conservation measures are included in 'baseline' (see Chapter 5) and therefore not in the options assessment.				
	Distribution Management Options				
D1	Leakage Reduction Bands Below ELL:				
	Current Target -4% to Current Target -6%	425.10	425.10	1.16	2010
	Current Target -2% to Current Target -4%	270.70	270.70	1.16	2010
	Current Target to Current Target -2%	170.50	170.50	1.16	2010
D2	Dagenham Supply Pipe Leakage Reduction:				
	Year 1	53.26	53.26	0.5	2010
	Years 1 to 10	53.26	53.26	5.0	2019
D3	Generic Mains Replacement				
	DMA Group 1 - AMP5 Mains Renewals	133.99	133.99	2.65	2015
	DMA Group 2 - AMP6 Mains Renewals	124.76	124.76	2.65	2020
	DMA Group 3 - AMP7 Mains Renewals	236.57	236.57	2.65	2025
	DMA Group 4 - AMP8 Mains Renewals	230.37	230.37	2.65	2030
	DMA Group 5 - AMP9 Mains Renewals	266.81	266.81	2.65	2035
	DMA Group 1 - any AMP Mains Renewals	275.15	275.15	2.65	2015
	DMA Group 2 - any AMP Mains Renewals	293.81	293.81	2.65	2015
	DMA Group 3 - any AMP Mains Renewals	415.28	415.28	2.65	2015
	DMA Group 4 - any AMP Mains Renewals	413.68	413.68	2.65	2015
	DMA Group 5 - any AMP Mains Renewals	431.30	431.30	2.65	2015
	Production Management Options				
P2	Algae Outage Reduction	180.67	178.81	1.6	2012
	Resource Management Options				
R2	Abberton Scheme	57.57	56.95	64	2014
R3	Reverse Osmosis Desalination	183.94	170.54	30	2018
R4	Colchester Effluent Recycling	109.87	108.42	10	2018
R5	River Trent Transfer	80.47	66.34	64	2018
R6	Canal Transfer	90.74	87.02	64	2018

Important observations on these unit costs are summarised as follows:

- Unlike the AIC unit costs the AISC unit costs take account of the cost of carbon (both embedded and operational) and environmental and social costs.
- Both the AIC and AISC costs for all the feasible options assume average yield profiles.

- Costs for bands of additional leakage control effort (reduction) have been linked i.e. the cost for a middle band of leakage reduction assumes that the lower bands must be completed first.

Essex Resource Zone – Utilisation-Based Unit Costs

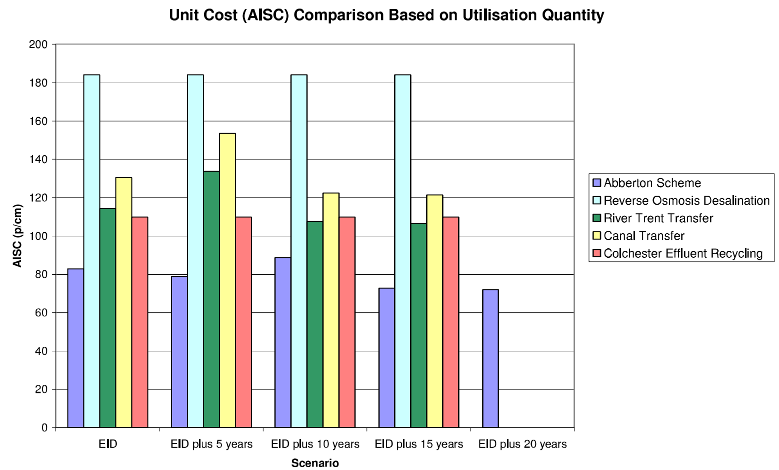
Under the utlisation-based approach, unit costs were determined for all water resource management options with capacities of greater than 10 Ml/d. Due to the size of the deficit in the Essex resource zone smaller schemes will not have utilisation-based unit costs that will vary significantly from their corresponding capacity based costs. Accordingly the options considered were the Abberton Scheme, Reverse Osmosis Desaliation, Colchester Effluent Recycling, the River Trent transfer, and the Canal Transfer. The approach adopted was to derive both AIC and AISC unit costs at 5 yearly intervals from theie Earliest Implementation Date (EID). The results are shown in the table and chart overleaf.

The results indicate that taking into account utilisation rather than capacity, the Abberton Scheme is still the most economic having comparatively the lowest unit costs at the various stages throughout the planning horizon. Even options that fail to meet the target headroom headroom requirement (ie Reverse Osmosis Desalination and Colchester Effluent Recycling) have significantly higher costs meaning that even without the addition of other smaller schemes to meet the deficit they are still uneconomic by comparison with the Abberton Scheme.

ESSEX RESOURCE ZONE - UNIT COST COMPARISON OF FEASIBLE OPTIONS - BASED ON UTILSATION QUANTITY

Option ID	Scheme	EID	Unit Costs at EID		Unit Costs at EID plus 5 years		Unit Costs at EID plus 10 years		Unit Costs at EID plus 15 years		Unit Costs at EID plus 20 years	
			AISC (p/cm)	AIC (p/cm)	AISC (p/cm)	AIC (p/cm)	AISC (p/cm)	AIC (p/cm)	AISC (p/cm)	AIC (p/cm)	AISC (p/cm)	AIC (p/cm)
R2	Abberton Scheme	2014	82.77	81.75	78.89	77.93	88.62	87.49	72.78	71.91	71.84	70.99
R3	Reverse Osmosis Desalination	2018	183.94	170.54	183.94	170.54	183.94	170.54	183.94	170.54	-	-
R4	Colchester Effluent Recycling	2018	109.87	108.42	109.87	108.42	109.87	108.42	109.87	108.42	-	-
R5	River Trent Transfer	2018	114.07	91.77	133.69	106.62	107.42	86.74	106.45	86.01	-	-
R6	Canal Transfer	2018	130.29	124.41	153.38	146.24	122.46	117.01	121.33	115.93	-	-

EID = Earliest Implementation Date
Utilisation Quantity calculated as that required to meet dry year annual average demand forecast
Figures in red indicate scheme is not sufficient on its own to meet target headroom requirement



Suffolk Northern/Central Resource Zone

The unit costs as determined for the Suffolk Northern/Central resource zone are presented in the table below

SUFFOLK NORTHERN/CENTRAL RESOURCE ZONE - UNIT COST COMPARISON OF FEASIBLE OPTIONS

Option ID	Scheme	Unit Cost (p/cm) AISC	Unit Cost (p/cm) AIC	Annual Yield Ml/d	Earliest Possible Year
	Customer Side Management Options				
C3	Water Efficiency & Water Conservation Measures (large number included in 'baseline' therefore no options assessment)				
	Distribution Management Options				
D1	Leakage Bands Above & Below ELL:				
	Current Target -4% to Current Target -6%	83.30	83.30	0.17	2010
	Current Target -2% to Current Target -4%	66.00	66.00	0.17	2010
	Current Target to Current Target -2%	51.50	51.50	0.17	2010
	Production Management Options				
P1	Washwater Recycling	136.19	134.98	0.13	2015
	Resource Management Options				
R1	North Lowestoft Groundwater Scheme	42.19	41.65	5	2014

Similar observation to those made for the Essex resource zone can be made on the above unit costs.

9.12. Considerations in Scheme Selection & Scheduling

9.12.1. EBSD Current Framework Assessment for Essex Resource Zone & Suffolk Northern/Central Resource Zone

Under the current EBSD framework, water management options are manually selected to meet supply deficits, as partially defined by a fixed level of target headroom, determined as illustrated in Chapter 7. Option selection under this regime is generally dominated by the least cost principle. That is to say that options of the lowest unit cost are implemented first. The only complication to this approach is the availability and earliest implementation dates of options under consideration and any additional considerations required under the SEA.

It should also be recognised that the least cost programme may not necessarily be the most practical or logical programme required to match the target headroom deficit.

Another key element to consider when developing a least cost programme is wider risk and uncertainty. Although some options may appear initially attractive in terms of unit cost, other issues such as promotability, and environmental and social acceptability may ultimately make them less attractive. A holistic approach to considering water management options is therefore required.

Essex Resource Zone

Scheme selection and scheduling in the Essex resource zone is affected mainly by yield and timing of earliest implementation of available feasible options. Specifically:

There is a lack of available options with enough yield in the short and medium term to address both the current and future predicted deficit in the balance of supply. In the context of feasible options key factors are as follows:

- Additional leakage reduction options over those assumed for baseline are available early in the planning horizon but only yield relatively small water savings.

- Bringing forward compulsory metering by five years from ESW's assumed baseline of 2020 will also have no effect on the need and timing for a large strategic water management option to be implemented as soon as practicable.

- Projects with potentially similar yield to the Abberton Scheme such as the River Trent Transfer and Canal Transfer have longer lead in times requiring substantial investigations and have no guarantee of success from a technical and/or regulatory perspective.

- Reverse Osmosis Desalination, although of moderate yield is also not available until at least 2018 and carries a number of risks including questions over likelihood of promotion and poor long term sustainability due to high carbon and environmental impacts.

- The algae reduction scheme is too low yielding to markedly affect the deficit in the balance of supply.

- The Colchester effluent recycling scheme would not be available until 2018 and, as demonstrated by ESW's experiences of developing the Langford scheme, would carry with it a number of difficulties in relation to promotion and consenting. The yield would not be enough to alone to close the predicted deficit in the balance of supply.

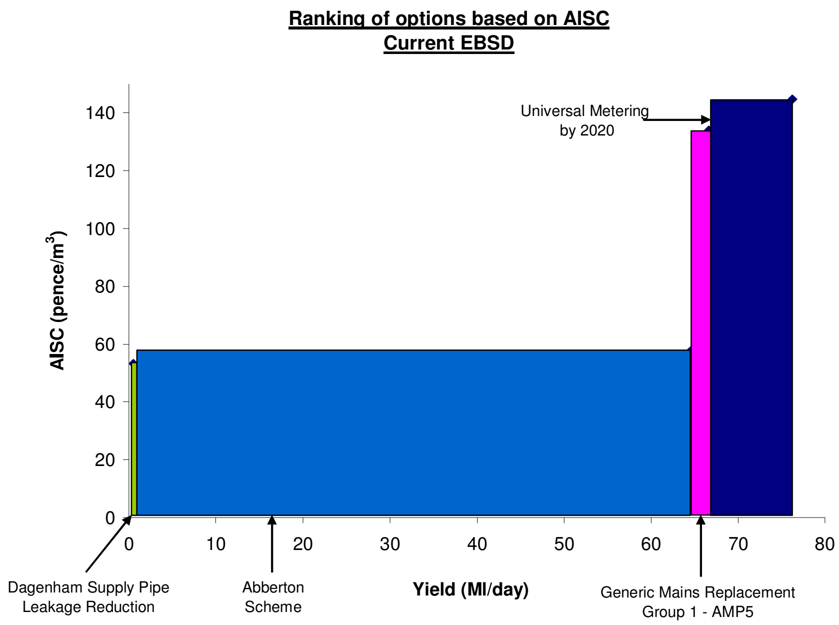
Considerations in respect of cost can be summarised as follows:

- From a purely business planning perspective the case was made for the implementation of the Abberton Scheme at the last periodic review. As the scheme straddles two AMP periods (the current AMP4 and AMP5) investment has already been accounted for in some planning elements of the scheme during AMP4.

- The Dagenham supply pipe replacement scheme (leakage reduction) is the most favourable on cost with an AISC of 53 p/m^3
- After the Dagenham supply pipe scheme, the Abberton Scheme has the next most favourable unit AISC of 58 p/m^3.
- The River Trent Transfer, Canal Transfer and Colchester effluent recycling options have the next level of unit costs, with the River Trent Transfer option having a unit cost of 80 p/m^3.
- The earlier generic mains replacement schemes are more favourable than those in later AMPS, with the AISC for AMP5 renewals at 134 p/m^3
- Options such as metering, Reverse Osmosis Desalination, and algae outage reduction schemes appear amongst the least economic of all the feasible options considered (ranging from 137p/m^3 to 183p/m^3).

Cognisance of all the above information on feasible option availability, yield, and cost has resulted in defining a preferred programme of water management options under the Current EBSD framework to meet the current and predicted deficit in the balance of supply in Essex. The preferred programme can be summarised in the table overleaf.

Additionally as recommended in the WRPG, the following chart showing the ranking of AISC options under the preferred programmes is provided as follows:



Current EBSD Preferred Programme of Water Management Options for the Essex Resource Zone

Option ID	Option	Implementation Date	Maximum Yield/Demand Saving Ml/d	AISC Unit Cost p/m^3
C2	Universal Metering by 2020	2010-2020	9.63	137.08
D2	Dagenham Supply Pipe Replacement	2010-2019	5.00	53.26
D3	Generic Mains Replacement – AMP5 and beyond	2010-2015	2.65	133.99
R2	Abberton Scheme	2010-2014	64.00	57.57

Incremental unit cost of programme (p/m^3)	69.27

Note : D3 - figures for AMP5 mains replacement used in determination of incremental costs.

Suffolk Northern/Central Resource Zone

Scheme selection and scheduling in the Suffolk Northern/Central resource zone is affected mainly by the limited number of feasible options generally, and of these only one (the North Lowestoft Groundwater Scheme) has sufficient yield to close the anticipate balance of supply in 2019/20. For a scheme of this size in Suffolk, the AISC unit cost of 42 p/m^3 is not unattractive, although it is recognised that investigations will be required to confirm the yield of the scheme.

Washwater recycling appears expensive with a unit cost of 136 p/m^3 and has only a very small yield, no where near enough to close the predicted future deficit in the balance of supply. Similarly all the additional leakage reduction options are more expensive that the North Lowestoft Groundwater Scheme and yield limited water savings of little value in closing the future supply deficit.

9.12.2. EBSD Intermediate Framework Assessment for Essex Resource Zone

The Company has adopted probabilistic methods for determining outage and headroom since the last periodic review (as indicated in Sections 3.3 and 7 respectively) so it remains appropriate to consider the merits of adopting a non-deterministic economic Framework as provided by the Intermediate EBSD approach.

This section will outline the Intermediate Modelling Framework approach and detail the methodological assumptions made by ESW for this PR09 Intermediate Framework assessment.

The Intermediate Modelling Approach

The Intermediate EBSD process involves ten steps, as detailed in the EBSD Guidelines (UKWIR/Environment Agency, 2002) and illustrated in the flow chart shown previously in Section 9.10.2 of this WRMP.

Under the Intermediate Framework a target level of service is first established, which may be set in response to a regulatory requirement (e.g. a DG standard), on the basis of assumed or estimated customer willingness to pay for various service levels, or in an attempt to maintain or improve upon current levels of service.

A forecast for the supply-demand balance using dry weather forecasts of supply and demand, and an initial estimate of headroom is then required. The Intermediate Framework differs from the Current Framework as it eliminates the problem of determining the appropriate headroom required for a target level of service before the solution set is found. In fact, the final solution is largely insensitive to the initial forecast scenarios assumed, as the full distribution of demand and supply scenarios are taken into account in later stages of the planning process.

The chosen selection routine (e.g. AISC) is applied to the supply-demand balance (after headroom has been taken into account) to produce an initial planning solution set which solves the planning problem over the planning horizon. Monte Carlo analysis is then applied to the initial solution set to determine whether the selected option or set of options remains valid for different supply and demand forecast outcomes, and for uncertainties in the yields or savings of selected options. The Monte Carlo analysis will also provide a measure of the actual level of service that the options in the solution set should provide. If the predicted level of service is equal or sufficiently close to the target level of service then the solution set stands and becomes the final solution.

If there is a discrepancy between the predicted and the target level of service, the headroom estimate should be revised either up, if the predicted level of service is too low, or down, if the predicted level of service is too high, and the selection routine re-applied to refine the solution set. The Monte Carlo analysis is then repeated to determine the new predicted levels of service. By iteration of this process it is intended that the final optimum solution set is found.

Intermediate Framework Approach for Essex Resource Zone

The guidance documents, The Economics of Balancing Supply and Demand (EBSD) Main Report, Guidelines and Decision-Maker's Summary (UKWIR/Environment Agency, 2002) were used to develop a methodology for applying to the ESW Essex Water Resource Zone.

The guidelines bring together components of the supply-demand balance, headroom estimates, and the initial solution resulting from the AISC selection routine. During an iterative process involving the revision of headroom and balancing supply and demand to meet a target level of service, water resource management options are used to solve yield deficits and unacceptably low headroom where appropriate, thus developing a potential solution to the planning problem.

Methodological Assumptions

The guidelines developed by NERA do not represent a methodology for the Intermediate Framework and so numerous assumptions had to be defined in order to develop the guidelines into a practical working methodology. These are detailed below:

Step 1 – Set a target level of service

The level of service chosen as an input to the planning process was a 1 in 10 year demand restriction, which corresponds to a call for restraint on water use. This is the first level of demand restriction that ESW would impose on customers. When using stochastic modelling methods such as Monte Carlo, this return period corresponds to the 90 percentile of the probability distributions and is consistent with the figures chosen to represent outage allowance and estimates of headroom until 2019/2020.

Step 2 – Forecast the supply/demand balance

Forecasts of supply and dry weather demand over the planning horizon were used as detailed in the previous sections of this report using current guidelines and methodologies.

Step 3 – Estimate Headroom

Initial Headroom estimates used in this methodology are those detailed in Section 7, developed using the current UKWIR methodology, as outlined in An Improved Methodology for Assessing Headroom (UKWIR, 2002).

Step 4 – Apply selection routine

The average incremental social cost (AISC) approach is the chosen selection routine applied to the supply-demand balance to produce the initial planning solution, as detailed in previous sections, and will be used to select schemes for each subsequent iteration. This selection routine considers the yields (Ml/d) and costs (p/cm) relating to the implementation of schemes and the first year each scheme can be implemented. Schemes are ranked for preference based on first year possible and least cost.

For the purposes of this assessment, the initial solution set represents implementation of the Abberton Scheme, which incorporates the Denver licence variation providing 8 Ml/d from 2009/2010, increasing to 63 Ml/d in 2013/2014 when the reservoir is raised.

Step 5 – Apply Monte Carlo model

The Intermediate Framework does not provide a methodology for applying a Monte Carlo model to the outcome of Step 4. ESW have therefore developed a methodology whereby the Monte Carlo simulation takes into account probabilistic supply and demand, and headroom estimates as outlined in the EBSD Guidelines. Crystal Ball software is used to perform 5000 iterations of the simulation, which is consistent with the outage and headroom methodologies.

Probability distributions have been created to model the uncertainty around supply and demand forecasts due to weather conditions and climate change. The resulting forecast figures are combined with headroom estimates and the marginal yield of resource schemes in the solution set to give a final balance of supply and demand forecast figure that can be related to the target level of service. The components of the methodology include the following:

- Modelling the uncertainty of demand combined two tiers of Monte Carlo simulation to incorporate both variation in weather conditions and climate change.

  a) A separate triangular probability distribution was created for each of the demand forecast weather scenarios, dry, normal and wet, using three climate change scenarios. The minimum figures were taken as demand with no climate change, mode or most likely as demand with low climate change and maximum as demand with medium-high climate change.

  b) Assumption figures resulting from each of the three demand weather scenarios were then used to create a second tier of triangular distribution to give a final forecast figure for demand for each year of the planning horizon. The wet year figure was used as the minimum in the final demand distribution, normal year as the most likely, and dry as the maximum.

- Uncertainty in supply relating to climate change was modelled using triangular distributions created with the three climate change scenarios, wet, mid and dry. Taking the dry scenario as the minimum, mid as the most likely and wet as the maximum in the supply distribution.

- The distributions for the three demand weather scenarios and supply are correlated in the Monte Carlo simulation to ensure that figures are chosen from the same climate change conditions for each pass of the simulation.

- The balance of supply and demand (BSD) is calculated by the following equation:

$$\text{BSD} = \begin{matrix}\text{supply forecast}\\ \text{distribution}\end{matrix} - \left(\begin{matrix}\text{final demand}\\ \text{forecast prediction}\end{matrix} + \begin{matrix}\text{headroom}\\ \text{estimate}\end{matrix}\right)$$

- If for a particular year in the planning horizon demand plus headroom exceeds supply, and there is additional yield available through scheme implementation as determined by the solution set, then this yield is incorporated to give a final figure for the BSD. The yield figures used for this assessment are those based on capacity of the schemes.

Step 6 – Ascertain implied level of service

The output from Crystal Ball consists of a forecast report, one for each year of the planning horizon. The report summarizes the statistics of the simulation and gives the BSD forecast figures, in Ml/d, relating to a range of percentiles. The target level of service relates to the 90 percentile. The aim is to achieve a forecast figure of 0±1Ml/d for the 90 percentile for each year of the planning horizon as this indicates that the target level of service has been met.

Step 7 – Determine whether more iterations are required

If a forecast figure relating to the 90 percentile for a particular year in the planning horizon is below zero by more than 1 Ml/d then this indicates the target level of service has not been achieved for that year. Conversely, if a forecast figure relating to the 90 percentile is above zero by more than 1 Ml/d then this indicates the target level of service has been exceeded. In these cases headroom must be amended accordingly as described in step 8.

Step 8 – Revise headroom

If for any year in the planning horizon the target level of service has not been achieved then headroom is amended to enable balance of supply and demand. If during this process headroom must be decreased below PR09 Headroom estimates, (which represents a situation with an unacceptable level risk) then additional yield must be sought when determining the revised solution set. If the target level of service is exceeded then headroom is reduced so as not to be in excess of requirements.

The EBSD Main Report (UKWIR/Environment Agency, 2002), states that "headroom should be revised up or down by the amount specified by a standard numerical root finding process (for example, using the standard Newton-Raphson method)". The Newton-Raphson method employs calculus to numerically evaluate the root of complicated mathematical functions, when the root cannot be found algebraically. The ESW headroom estimates are derived using the current methodology (UKWIR, 2002) and are forecast figures produced by Monte Carlo simulation representing the 90 percentile of the probability distribution for each year of the planning horizon. Headroom estimates are presented as simple numerical figures and as such it is unclear how the Newton-Raphson method can be applied where no complicated mathematical function exists.

For this Intermediate Framework assessment it was decided to amend headroom by the amount that the BSD forecast figure deviates from zero (the target level of service). During the iterative process, this method results in an alternation between balancing supply and demand and optimising headroom for each year of the planning horizon.

Step 9 – New iteration

If the required level of service has not been met and headroom figures are adjusted, a subsequent iteration of the process is conducted using a revised solution set. The revised set of headroom figures produced in step 8, are entered into the model along with the yield profile of a revised solution set. The full range of options, with respect to the Essex Resource Zone, considered for this assessment is listed in the following table:

Scheme Options		Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year
	Customer Side Management Options			
C1	Universal Metering by 2015	137.08	9.63	2015
C2	Universal Metering by 2020	144.75	9.63	2020
	Distribution Management Options			
D1	Leakage Reduction Bands Below ELL:			
	Current Target -4% to Current Target -6%	425.10	1.16	2010
	Current Target -2% to Current Target -4%	270.70	1.16	2010
	Current Target to Current Target -2%	170.50	1.16	2010
D2	Dagenham Supply Pipe Leakage Reduction:			
	Year 1 (up to a maximum of 10 years)	53.26	0.5	2010
D3	Generic Mains Replacement:			
	DMA Group 1 - AMP5 Mains Renewals	133.99	2.65	2015*
	DMA Group 2 - AMP6 Mains Renewals	124.76	2.65	2020*
	DMA Group 3 - AMP7 Mains Renewals	236.57	2.65	2025*
	DMA Group 4 - AMP8 Mains Renewals	230.37	2.65	2030*
	DMA Group 5 - AMP9 Mains Renewals	266.81	2.65	2035*
	DMA Group 1 - any AMP Mains Renewals	275.15	2.65	2015*
	DMA Group 2 - any AMP Mains Renewals	293.81	2.65	2015*
	DMA Group 3 - any AMP Mains Renewals	415.28	2.65	2015*
	DMA Group 4 - any AMP Mains Renewals	413.68	2.65	2015*
	DMA Group 5 - any AMP Mains Renewals	431.30	2.65	2015*
	Production Management Options			
P2	Algae Outage Reduction	180.67	1.6	2014
	Resource Management Options			
R2	Abberton Scheme	57.57	64	2014
R3	Reverse Osmosis Desalination	183.94	30	2018
R4	Colchester Effluent Recycling	109.87	10	2018
R5	River Trent Transfer	80.47	64	2018
R6	Canal Transfer	90.74	64	2018

* Year indicates the end of the AMP when maximum yield achieved

Water resource management options are chosen based on the AISC selection routine approach, where preference is determined by the year in which the option can be implemented. If there are a number of options with the same first year possible then selection is based on the least-cost first principle.

Step 10 – Final solution

The final solution set has been reached when,

a) the BSD 90 percentile forecast figure for each year of the planning horizon is 0±1Ml/d (indicating target level of service has been met) and;
b) the revised headroom meets the minimum acceptable level of risk as determined by the PR09 Headroom estimates.

Results

Seven iterations of this Intermediate Framework methodology were required to reach the final planning solution which includes the following options:

- R2. Abberton Scheme
- D1. Leakage Reduction Bands Below ELL
  - Current target to current target -2%
  - Current target to current target -4%
- D2. Dagenham Supply Pipe Leakage Reduction
- D3. Generic Mains Replacment
  - DMA Group 1 – AMP 5 Mains Renewal
  - DMA Group 2 – any AMP Mains Renewal
  - DMA Group 3 – any AMP Mains Renewal
  - DMA Group 4 – any AMP Mains Renewal

The tables below detail the scheme options included in each iteration of the assessment, listed in the order in which the scheme yields were called for.

After the tables are a series of graphs that illustrate the way in which the model balances supply and demand in each iteration, and how the additional yield provided by the schemes increases the revised headroom until it meets the acceptable level of risk as determined by the PR09 headroom estimates.

Solution set		Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year	Years in which scheme implemented in model	
					First	Last
Initial Solution	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
Revision 1	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2. Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
Revision 2	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2. Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 1 - AMP5 Mains Renewals	133.99	0.53*	2010	2010/2011	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.06*	2011	2011/2012	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.59*	2012	2012/2013	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	2.12*	2013	2013/2014	-

* Yields are the annual cumulative proportion of the maximum yield achievable by the end of the AMP (i.e. 2.65 Ml/d in 2014/2015)

Solution set		Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year	Years in which scheme implemented in model First	Last
Revision 3	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2. Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 1 - AMP5 Mains Renewals	133.99	0.53*	2010	2010/2011	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.06*	2011	2011/2012	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.59*	2012	2012/2013	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	2.12*	2013	2013/2014	-
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-2%	170.50	1.16	2010	2010/2011	2013/2014

* Yields are the annual cumulative proportion of the maximum yield achievable by the end of the AMP (i.e. 2.65 Ml/d in 2014/2015)

Solution set		Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year	Years in which scheme implemented in model First	Last
Revision 4	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2. Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 1 - AMP5 Mains Renewals	133.99	0.53*	2010	2010/2011	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.06*	2011	2011/2012	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.59*	2012	2012/2013	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	2.12*	2013	2013/2014	-
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-2%	170.50	1.16	2010	2010/2011	2013/2014
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-4%	270.70	1.16	2010	2011/2012	2013/2014

* Yields are the annual cumulative proportion of the maximum yield achievable by the end of the AMP (i.e. 2.65 Ml/d in 2014/2015)

Solution set		Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year	Years in which scheme implemented in model	
					First	Last
Revision 5	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2. Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 1 - AMP5 Mains Renewals	133.99	0.53*	2010	2010/2011	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.06*	2011	2011/2012	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.59*	2012	2012/2013	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	2.12*	2013	2013/2014	-
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-2%	170.50	1.16	2010	2010/2011	2013/2014
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-4%	270.70	1.16	2010	2011/2012	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 2 - any AMP Mains Renewals	293.81	0.53*	2010	2011/2012	-
	DMA Group 2 - any AMP Mains Renewals	293.81	1.06*	2011	2012/2013	-
	DMA Group 2 - any AMP Mains Renewals	293.81	1.59*	2012	2013/2014	-

* Yields are the annual cumulative proportion of the maximum yield achievable by the end of the AMP (i.e. 2.65 Ml/d in 2014/2015)

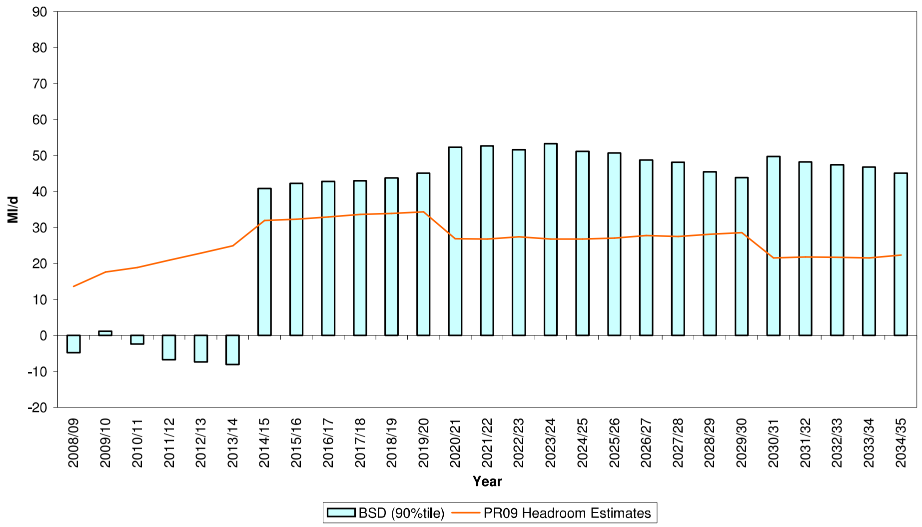
Solution set			Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year	Years in which scheme implemented in model: First	Last
Revision 6	R2.	Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
		(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2.	Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
	D3.	Generic Mains Replacement					
		DMA Group 1 - AMP5 Mains Renewals	133.99	0.53*	2010	2010/2011	-
		DMA Group 1 - AMP5 Mains Renewals	133.99	1.06*	2011	2011/2012	-
		DMA Group 1 - AMP5 Mains Renewals	133.99	1.59*	2012	2012/2013	-
		DMA Group 1 - AMP5 Mains Renewals	133.99	2.12*	2013	2013/2014	-
	D1.	Leakage Reduction Bands Below ELL					
		Current target to current target-2%	170.50	1.16	2010	2010/2011	2013/2014
	D1.	Leakage Reduction Bands Below ELL					
		Current target to current target-4%	270.70	1.16	2010	2011/2012	2013/2014
	D3.	Generic Mains Replacement					
		DMA Group 2 - any AMP Mains Renewals	293.81	0.53*	2010	2011/2012	-
		DMA Group 2 - any AMP Mains Renewals	293.81	1.06*	2011	2012/2013	-
		DMA Group 2 - any AMP Mains Renewals	293.81	1.59*	2012	2013/2014	-
	D3.	Generic Mains Replacement					
		DMA Group 4 - any AMP Mains Renewals	413.68	0.53*	2010	2010/2011	-
		DMA Group 4 - any AMP Mains Renewals	413.68	1.06*	2011	2011/2012	-
		DMA Group 4 - any AMP Mains Renewals	413.68	1.59*	2012	2012/2013	-
		DMA Group 4 - any AMP Mains Renewals	413.68	2.12*	2013	2013/2014	-

* Yields are the annual cumulative proportion of the maximum yield achievable by the end of the AMP (i.e. 2.65 Ml/d in 2014/2015)

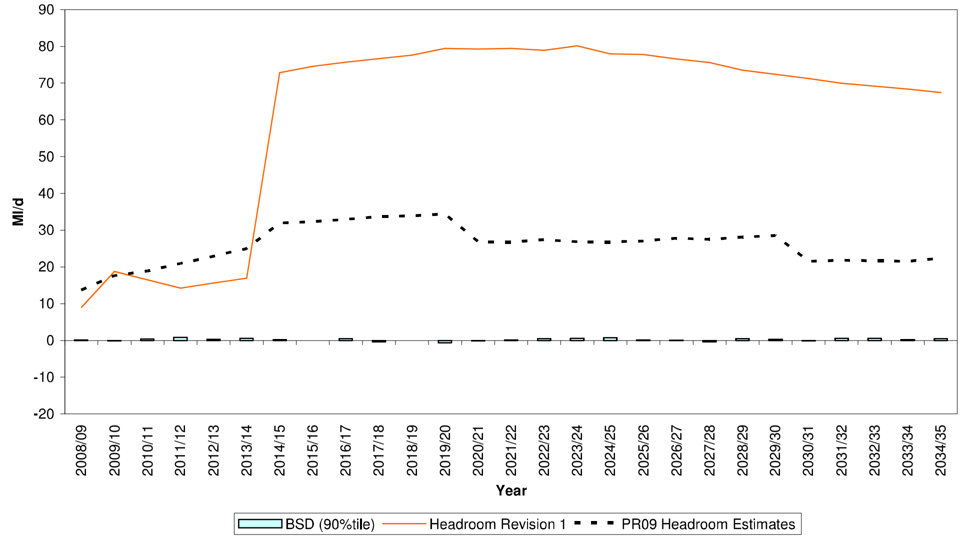
Solution set		Unit Cost AISC p/cm	Annual Yield Ml/d	Earliest Possible Year	Years in which scheme implemented in model First	Last
Final Solution	R2. Abberton Scheme	57.57	64	2014	2014/2015	2034/2035
	(Incorporates Denver Licence Variation)		8	2009	2009/2010	2013/2014
	D2. Dagenham Supply Pipe Leakage Reduction	53.26	0.5	2010	2010/2011	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 1 - AMP5 Mains Renewals	133.99	0.53*	2010	2010/2011	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.06*	2011	2011/2012	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	1.59*	2012	2012/2013	-
	DMA Group 1 - AMP5 Mains Renewals	133.99	2.12*	2013	2013/2014	-
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-2%	170.50	1.16	2010	2010/2011	2013/2014
	D1. Leakage Reduction Bands Below ELL					
	Current target to current target-4%	270.70	1.16	2010	2011/2012	2013/2014
	D3. Generic Mains Replacement					
	DMA Group 2 - any AMP Mains Renewals	293.81	0.53*	2010	2011/2012	-
	DMA Group 2 - any AMP Mains Renewals	293.81	1.06*	2011	2012/2013	-
	DMA Group 2 - any AMP Mains Renewals	293.81	1.59*	2012	2013/2014	-
	D3. Generic Mains Replacement					
	DMA Group 4 - any AMP Mains Renewals	413.68	0.53*	2010	2010/2011	-
	DMA Group 4 - any AMP Mains Renewals	413.68	1.06*	2011	2011/2012	-
	DMA Group 4 - any AMP Mains Renewals	413.68	1.59*	2012	2012/2013	-
	DMA Group 4 - any AMP Mains Renewals	413.68	2.12*	2013	2013/2014	-
	D3. Generic Mains Replacement					
	DMA Group 3 - any AMP Mains Renewals	415.28	0.53*	2010	2011/2012	-
	DMA Group 3 - any AMP Mains Renewals	415.28	1.06*	2011	2012/2013	-

* Yields are the annual cumulative proportion of the maximum yield achievable by the end of the AMP (i.e. 2.65 Ml/d in 2014/2015)

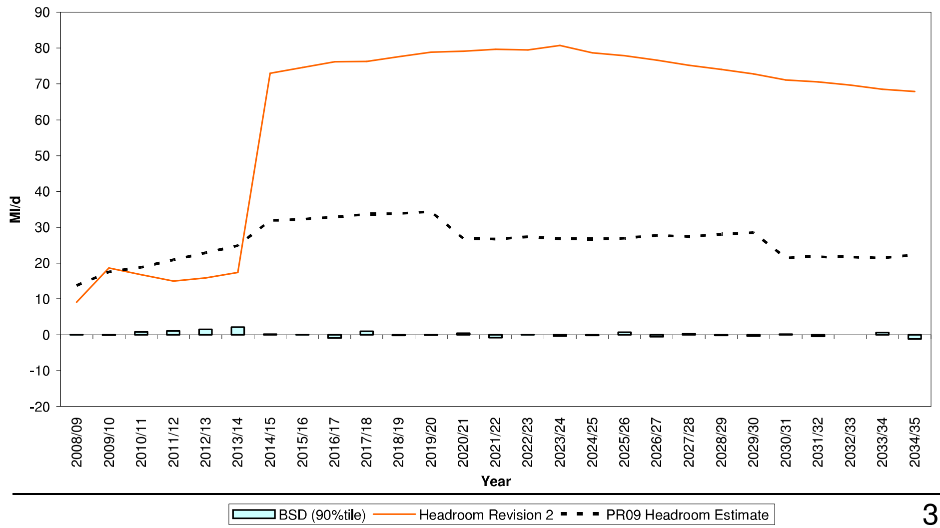
Essex Resource Zone Intermediate Framework Assessment
Graph (a): Initial Solution Set & PR09 Headroom Estimates



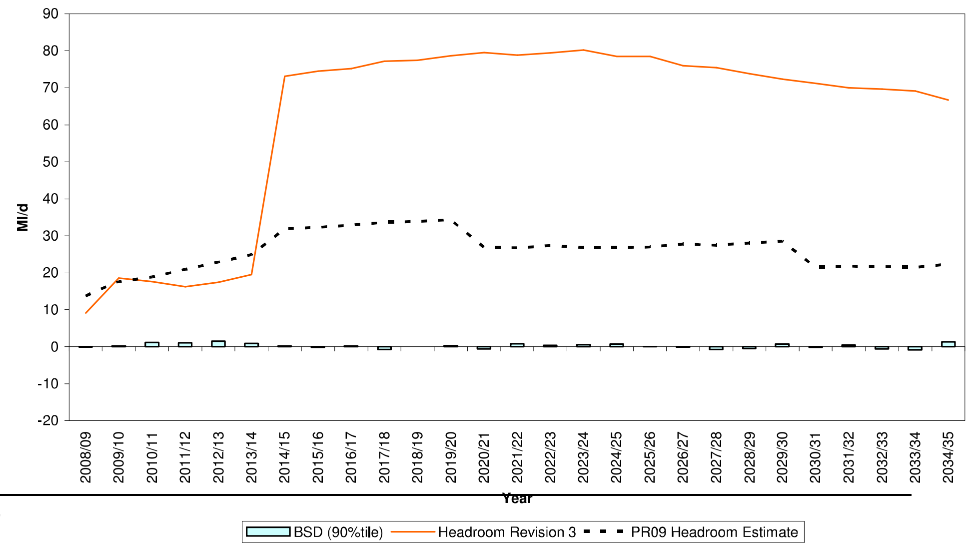
Essex Resource Zone Intermediate Framework Assessment
Graph (b): Iteration 1



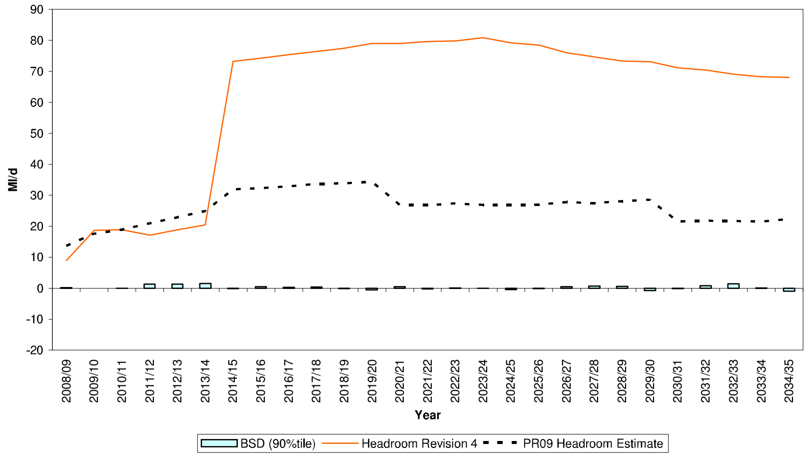
Essex Resource Zone Intermediate Framework Assessment
Graph (c): Iteration 2



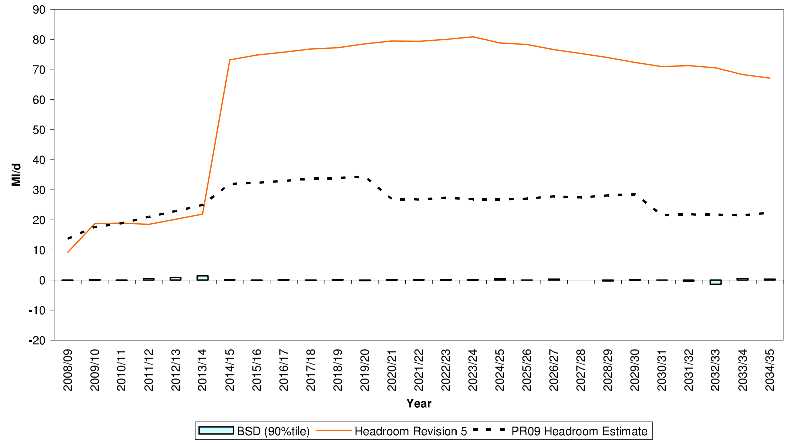
Essex Resource Zone Intermediate Framework Assessment
Graph (d): Iteration 3



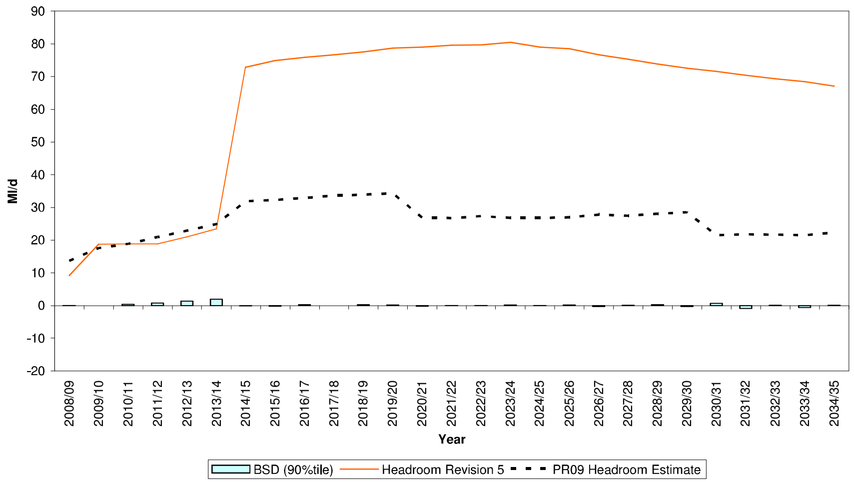
Essex Resource Zone Intermediate Framework Assessment
Graph (e): Iteration 4



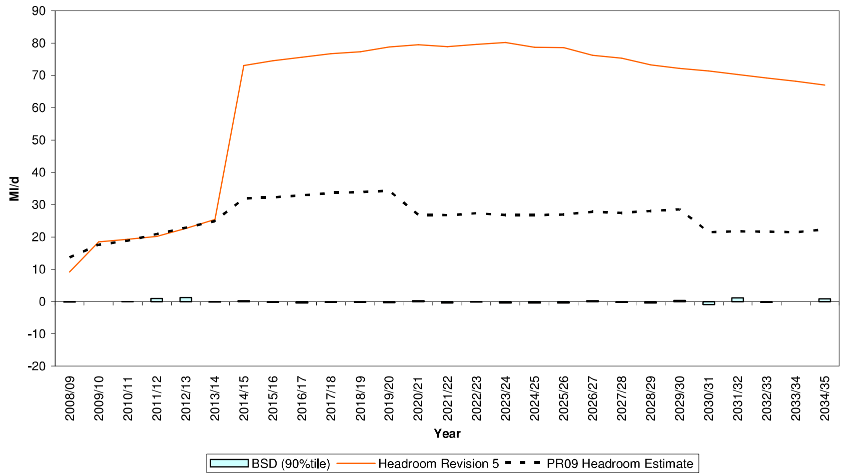
Essex Resource Zone Intermediate Framework Assessment
Graph (f): Iteration 5



Essex Resource Zone Intermediate Framework Assessment
Graph (g): Iteration 6



Essex Resource Zone Intermediate Framework Assessment
Graph (h): Iteration 7 - Final Planning Solution



Initial assessment

Input data for the initial assessment included the PR09 target headroom estimates and the yields provided by the initial solution set, namely the Abberton Scheme option. Graph (a) presents the imbalance between supply and demand over the planning horizon with a deficit until 2013/14 and then a surplus until 2034/35. For the purposes of this assessment, the aim is to balance supply and demand to 0±1 Ml/d.

Iteration 1

Headroom was amended following the methodology detailed previously so that when the Monte Carlo analysis was re-run the BSD figures achieved the target of 0±1Ml/d. The Monte Carlo analysis was then run using the revised headroom figures and revised solution set. To reduce the BSD deficit in the early years of the planning horizon, the Dagenham Supply Pipe Leakage Reduction Scheme option was chosen and implemented in its first year possible (2010/2011) and for 3 subsequent years until 2013/2014. This scheme was chosen as it has the earliest possible year compared to the other schemes, except the distribution management options of reducing leakage below the ELL. The Dagenham Supply Pipe Leakage Reduction scheme was chosen in preference due to its lower unit cost.

Graph (b) shows that the balance of supply and demand has been achieved but the revised headroom does not meet the minimum acceptable level of risk as determined by the PR09 headroom estimates in the years 2010/11 to 2013/2014; after which time headroom exceeds requirements due to Abberton scheme implementation.

Iterations 2 to 6

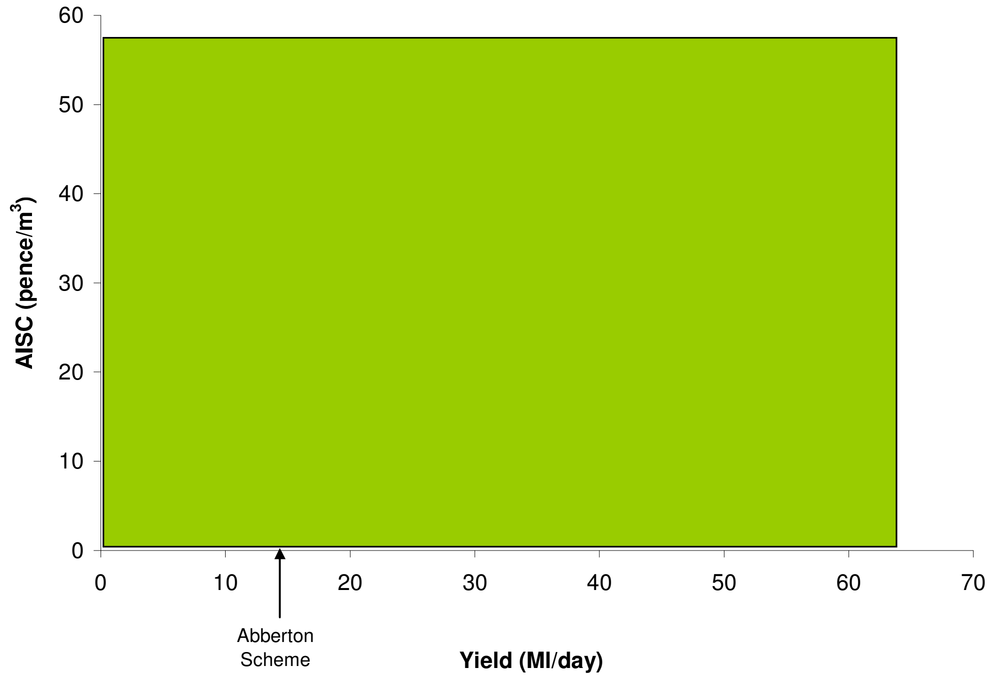
During the iterations a number of schemes are implemented in an attempt to balance supply and demand whilst maintaining sufficient headroom in the early years of the planning horizon before the implementation of the Abberton Scheme. This is illustrated by graphs (c) to (g) with incremental increases in the revised headroom.

Iteration 7 - the final planning solution

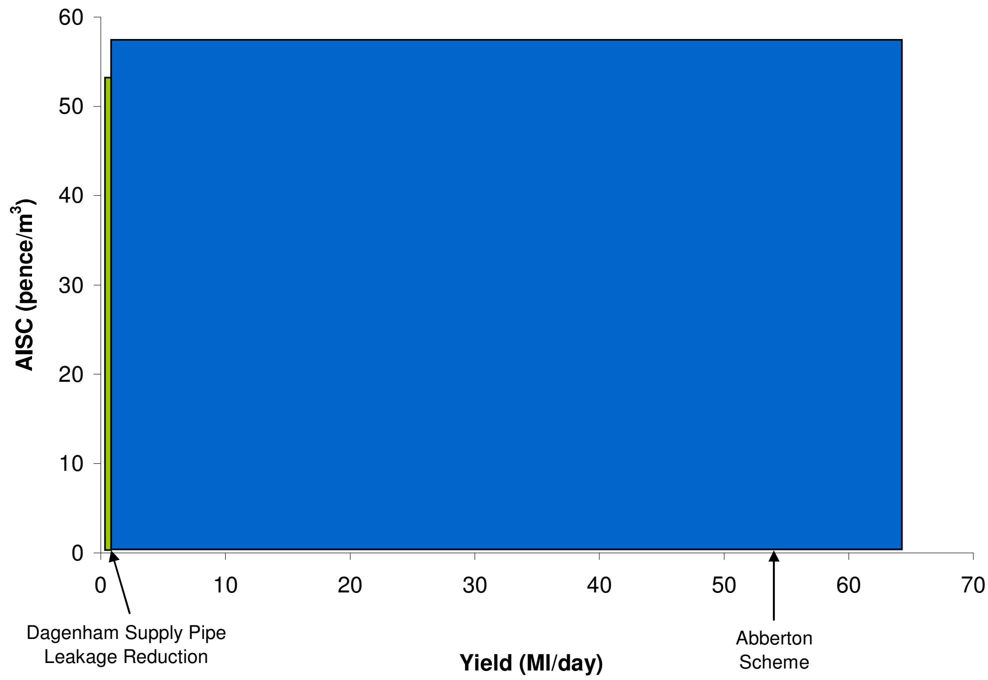
Iteration 7 represents the final planning solution. The cumulative yield of all the schemes implemented is marginally sufficient to balance supply and demand whilst also ensuring the minimum acceptable level of risk, as determined by the PR09 headroom estimates, is met.

The following charts rank the options implemented in each iteration by AISC.

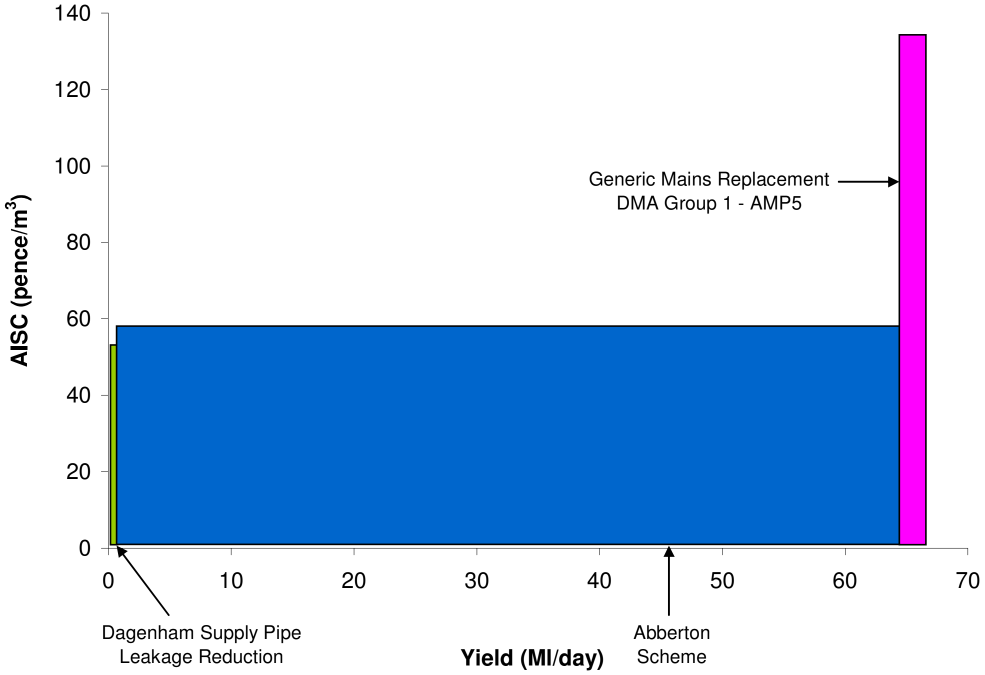
Ranking of options based on AISC
Intermediate Framework - Initial Solution



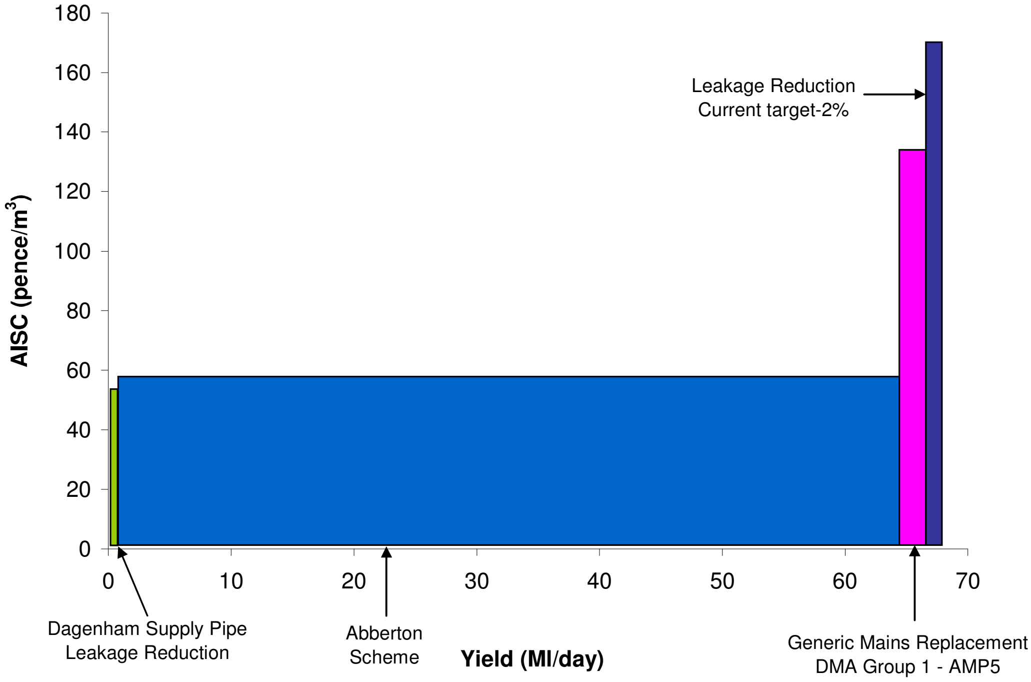
Ranking of options based on AISC
Intermediate Framework - Iteration 1



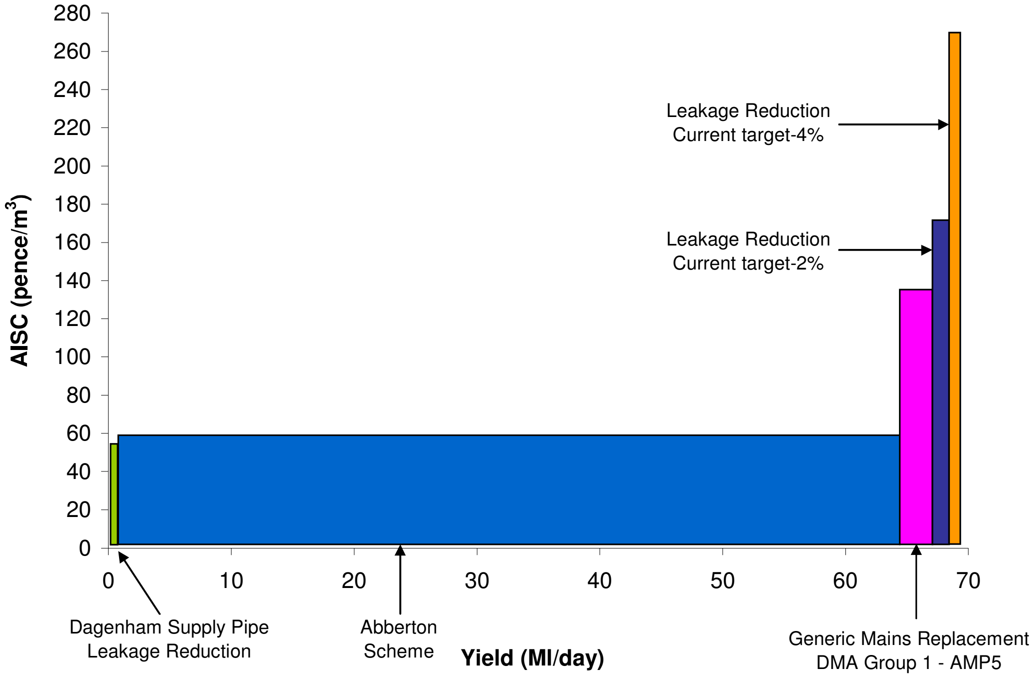
Ranking of options based on AISC
Intermediate Framework - Iteration 2



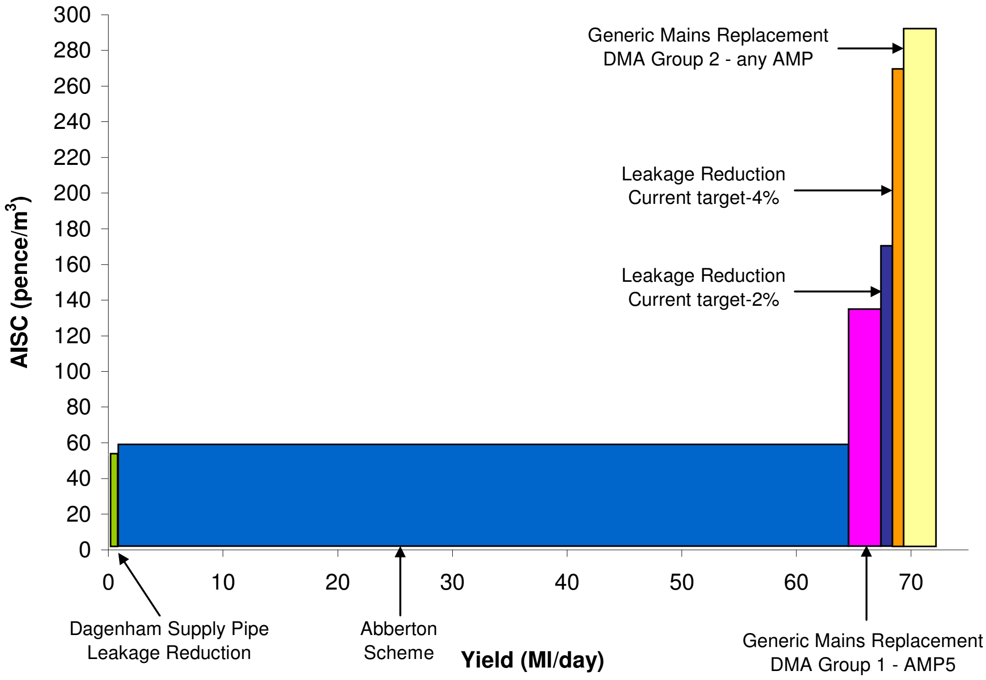
Ranking of options based on AISC
Intermediate Framework - Iteration 3



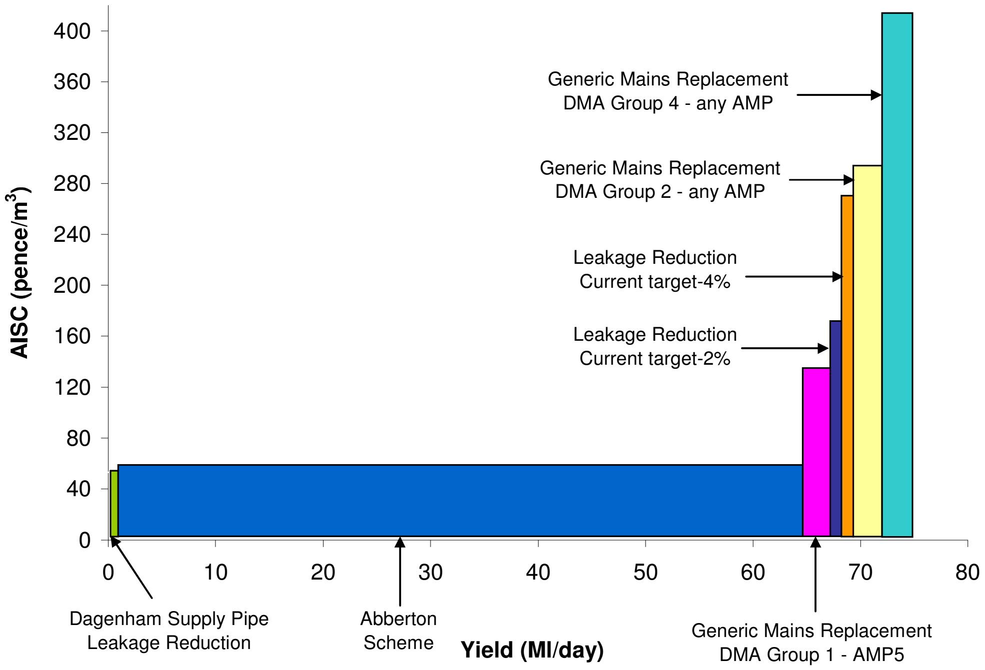
Ranking of options based on AISC
Intermediate Framework - Iteration 4



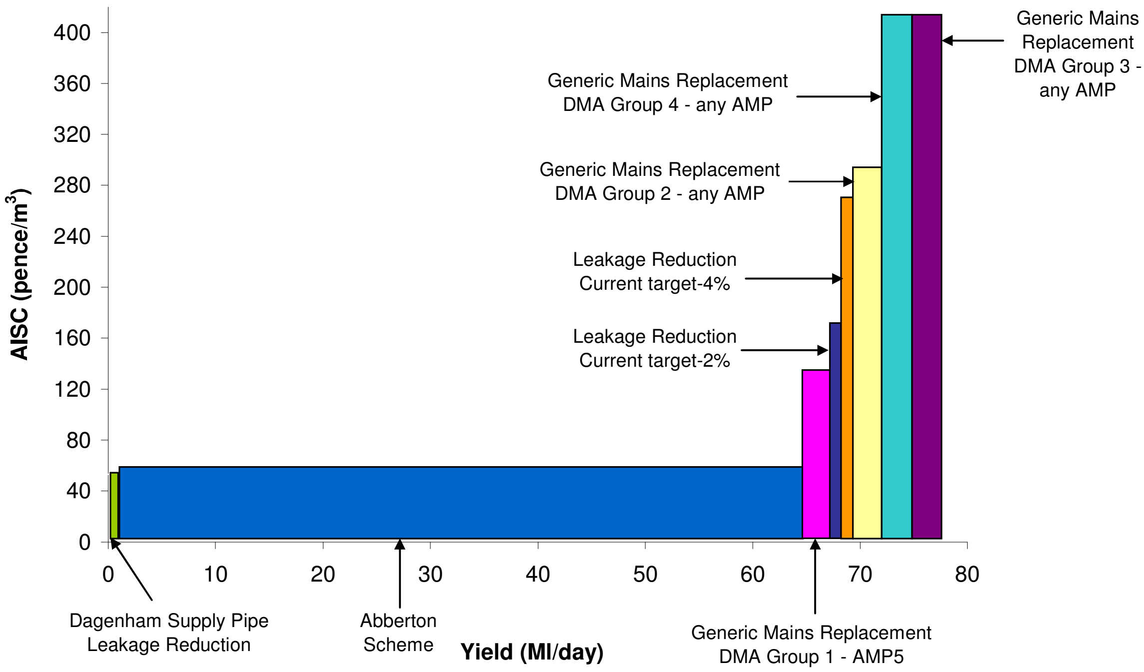
Ranking of options based on AISC
Intermediate Framework - Iteration 5



Ranking of options based on AISC
Intermediate Framework - Iteration 6



Ranking of options based on AISC
Intermediate Framework - Iteration 7 Final Planning Solution



Summary of Economic Analysis of Iterations

Economic analysis of the iterations considered has resulted in the following incremental unit costs for each schedule of schemes (or ‘programme’):

Programme	Incremental Unit Cost (p/m^3) based on AISC
Initial Solution	58.88
Iteration 1	58.83
Iteration 2	61.67
Iteration 3	63.91
Iteration 4	68.07
Iteration 5	80.60
Iteration 6	91.72
Iteration 7 – Final Solution	102.04

This shows that subsequent to iteration 1 the programmes in the next iterations become more expensive due to the need to incorporate more options to close the deficits in the balance of supply. The above costs compare with an incremental unit cost of 69.27 p/m^3 determined for the preferred programme identified under the Current EBSD.

Discussion & Conclusion of Intermediate Framework Analysis

The Intermediate Framework guidelines, produced by NERA (UKWIR/Environment Agency, 2002) have been interpreted to develop a methodology aiming to solve the ESW water resource planning issue. The final solution should be considered as theoretical and is subject to the practicalities and cost/benefit analysis of scheme implementation. For example, using the leakage reduction option to balance supply and demand in the years before the Abberton scheme provides additional yield is theoretically possible but would require significant and arguably unaffordable allowance in price limits.

The results of the analysis confirm that excluding the Abberton Scheme there are no options available to ESW within the required timeframe to meet the deficit in actual headroom by increasing supply or reducing demand. Therefore, the Intermediate Framework does not appear to provide a significantly different solution set to that of the Current Framework for solving the planning problem.

The Intermediate EBSD methodology employed is useful in supporting the choice of solution set determined under the Current EBSD framework; namely that the Abberton Scheme complemented by leakage reduction schemes such as Dagenham supply pipe renewal and generic mains replacement is an economically sound solution to the deficit in balance of supply in Essex. The only difference of note is that the preferred solution under the Current framework includes universal metering by 2020. Although uneconomic, metering is important in sending the right price signals and potentially in developing tariff structures for water.

9.13. Preferred Options & Schedule of Options

Essex Resource Zone

Although application of the Intermediate EBSD framework to a resource zone such as Essex might be questionable due to the limited number of options of sufficient yield and availability, it should be recognised that the resulting solution set from using this approach does generally support the conclusions of the Current EBSD framework.

ESW has decided to adopt the outcome of the Current EBSD framework.

In summary the preferred schedule is:

(1) continue with implementation of the Abberton Scheme which is scheduled for completion in 2014/15.

(2) implement the programme of supply pipe replacement in the Dagenham area over the next ten years.

(3) generic mains replacement during AMP5 and beyond.

(4) continue progress towards achieving universal metering by 2020.

The above schedule is compliant with the SEA process outlined in a supporting document to this WRMP.

Suffolk Northern//Central Resource Zone

ESW will adopt the result of the Current EBSD Framework for the Northern/Central resource zone; namely that the North Lowestoft Groundwater scheme will be investigated with the intention of implementing it in time to address the predicted deficit in the balance of supply in the early 2020s.

9.14. Emissions of Greenhouse Gases

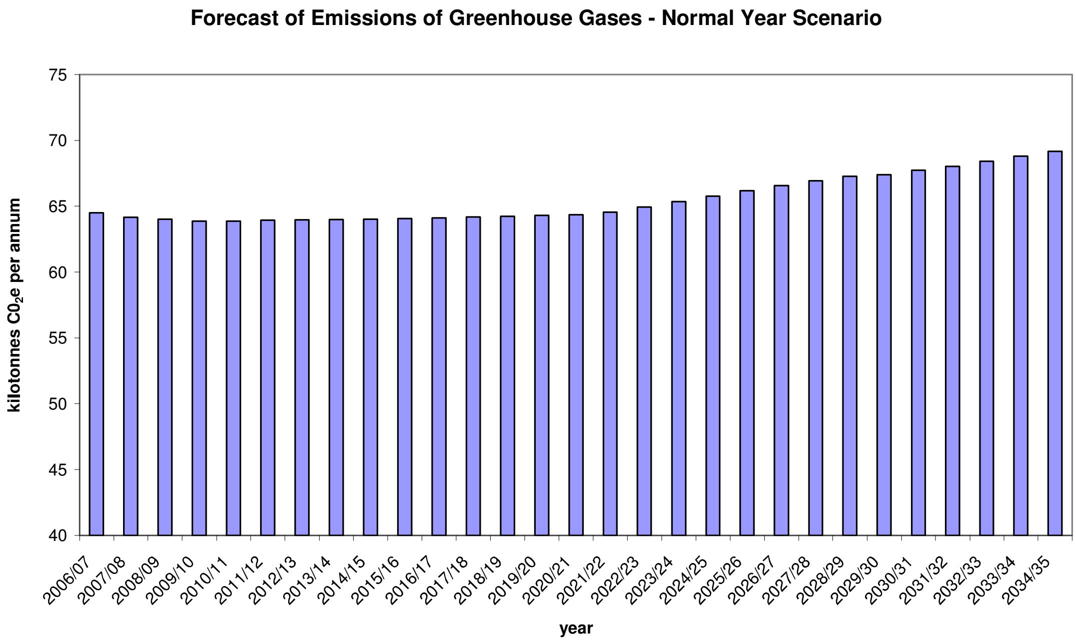
As required under Section 3(c) of the Water Resources Management Plan Direction 2007 ESW has considered the emissions of greenhouse gases which are likely to arise as a result of supplying water to its customers throughout the planning horizon.

The baseline situation was evaluated using figures from carbon dioxide equivalent information from 2006 derived from ESW's energy use and operational profile data (including both direct emissions and those from transport). This amounted to 64.5 kilotonnes of $C0_2e$. By proportioning this to the normal year demand forecast a profile of baseline gas emissions can be forecast into the future.

The results of greenhouse gas profiling are illustrated in the following table and graph:

Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
2006/07	**2009/10**	**2014/15**	**2019/20**	**2024/25**	**2029/30**	**2034/35**
64.50	63.85	64.01	64.30	65.77	67.40	69.18

Forecast Greenhouse Gas Emissions for ESW Water Supply
in kilotonnes CO_2e per annum for normal year scenario



Specific data of the emissions resulting from feasible water resources management options are outlined iearlier in this section.

10. FINAL WATER RESOURCES STRATEGY

10.1. Justification of the Optimum Solution

10.1.1. Water Resources Planning Problem

The baseline supply demand balance in Chapter 8 confirmed the nature of the balance of supply for each resource zone. Both dry and normal year scenarios were considered in this analysis. As the dry year scenario forms the fundamental basis of the final planning scenario, only this has been presented within this Chapter. The balance of supply information is reproduced as follows:

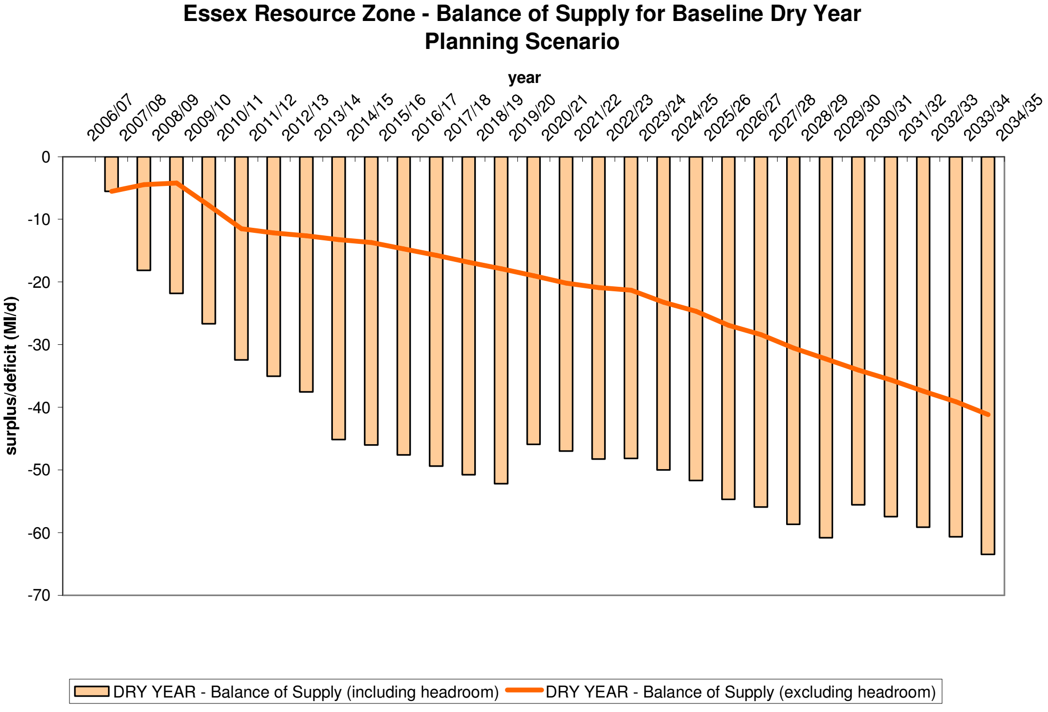
Essex Resource Zone

The following table summarises the forecast balance of supply for the Essex resource zone for the dry year baseline planning scenario:

Planning Scenario	Base year 2007/08	End of AMP4 2009/10	End of AMP5 2014/15	End of AMP6 2019/20	End of AMP7 2024/25	End of AMP8 2029/30	Planning Horizon 2034/35
No HR	-5.51	-4.21	-13.21	-17.88	-23.23	-32.28	-41.17
With HR	-5.51	-21.82	-45.14	-52.23	-50.02	-60.83	-63.51

Balance of Supply for Essex Resource Zone in Ml/d with no Interventions
(HR = Headroom)

Across the planning horizon the balance of supply can be summarised as follows:



With no interventions existing supply deficits under the dry year planning scenario would increase throughout the planning horizon reaching 41.2 Ml/d in 2034/35 assuming no headroom requirement, and 63.5 Ml/d assuming ESW's calculated target headroom requirement.

If no action is taken then under a period of sustained dry weather elements of the Company's Drought Plan (ESW, 2007a) would need to be implemented which may include the need for restrictions. Eventually drought measures would not be enough and supply failures would result.

The timing of the problem is such that water resource management options are required now to address the deficit in actual headroom and absence of target headroom in Essex.

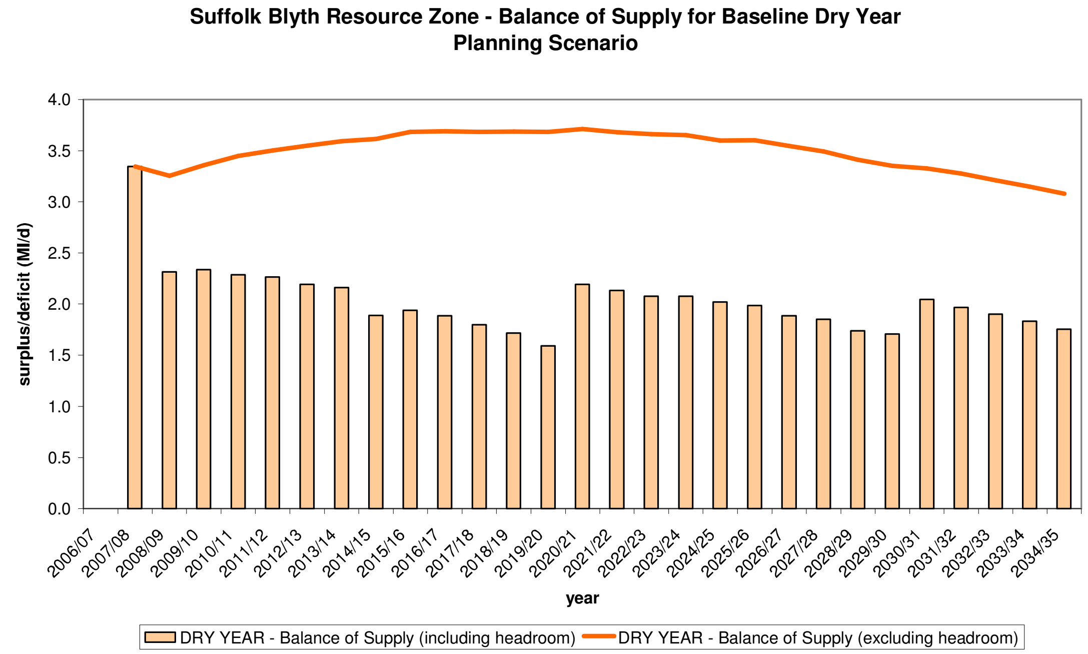
Suffolk Blyth Resource Zone

The following table summarises the forecast balance of supply for the Suffolk Blyth resource zone for the dry year baseline planning scenario:

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
No HR	+3.35	+3.36	+3.61	+3.68	+3.60	+3.35	+3.08
With HR	+3.35	+2.34	+1.89	+1.59	+2.02	+1.71	+1.75

Balance of Supply for Suffolk Blyth Resource Zone in Ml/d – Baseline
(HR = Headroom)

Across the planning horizon the balance of supply can be summarised as follows:



Under the baseline dry year scenario supply surpluses under the dry year planning scenario would decrease throughout the planning horizon from around 3.35 Ml/d in 2007/08 to 3.08 Ml/d in 2034/35 assuming no headroom requirement, and 1.75 Ml/d assuming ESW's calculated target headroom requirement.

If no action is taken then under a period of sustained dry weather demand would continue to be met in all years of the planning horizon.

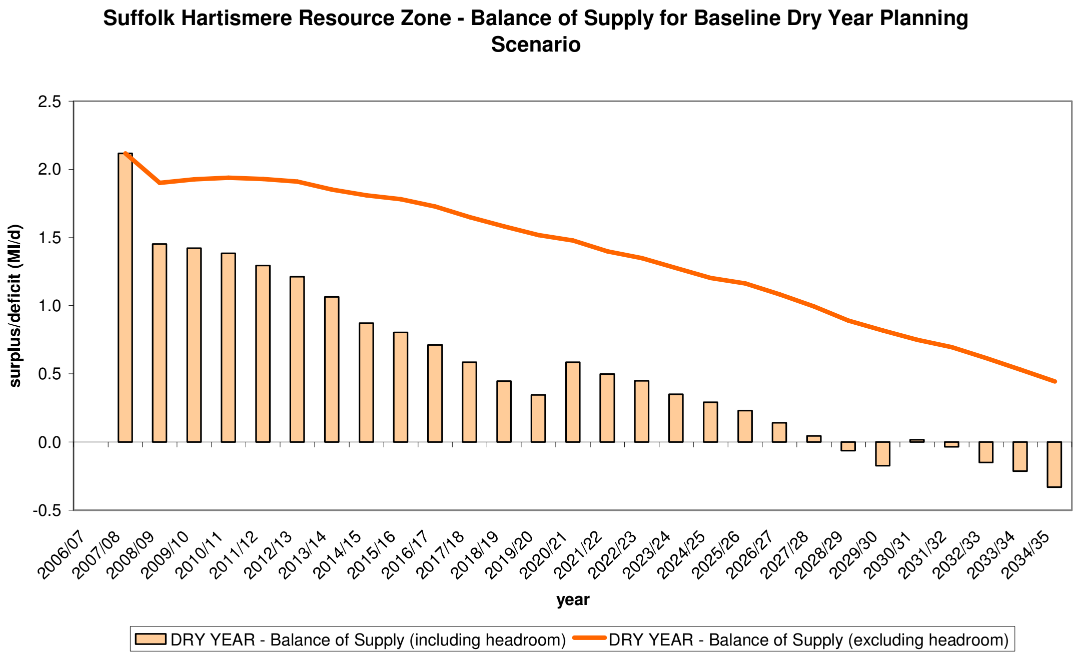
Suffolk Hartismere Resource Zone

The following table summarises the forecast balance of supply for the Suffolk Hartismere resource zone for the dry year baseline planning scenario:

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
No HR	+2.12	+1.93	+1.81	+1.52	+1.20	+0.82	+0.45
With HR	+2.12	+1.42	+0.88	+0.35	+0.29	-0.17	-0.33

Balance of Supply for Suffolk Hartismere Resource Zone in Ml/d – Baseline (HR = Headroom)

Across the planning horizon the balance of supply can be summarised as follows:



Under the baseline dry year scenario surpluses in supply under the dry year planning scenario would decrease throughout the planning horizon from 2.12 Ml/d in 2007/08 to 0.45 Ml/d in 2034/35 assuming no headroom requirement.

Assuming ESW's calculated target headroom requirement then the balance of supply would go into deficit in 2028, reaching a maximum shortfall of 0.33 Ml/d by 2034/35 under the dry year planning scenario.

If no action is taken then under a period of sustained dry weather demand may not be met from 2028 onwards. However given the relatively small deficit it is possible that measures from ESW's Drought Plan (ESW, 2007a) may temporarily restore the balance of supply.

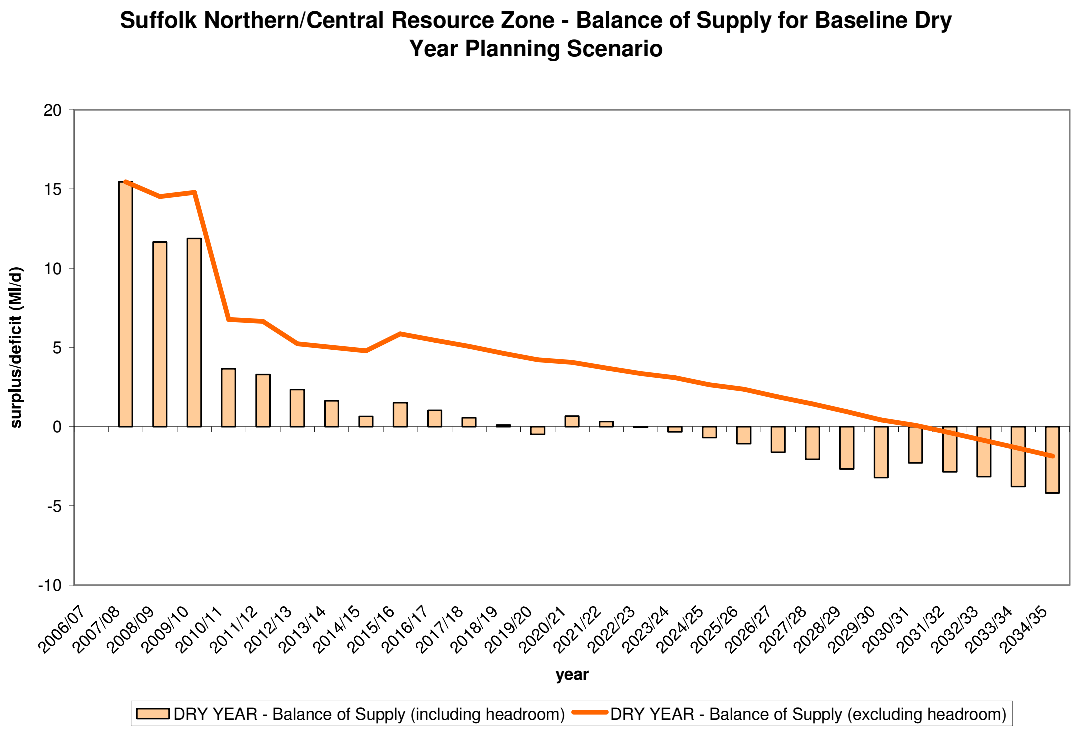
Suffolk Northern/Central Resource Zone

The following table summarises the forecast balance of supply for the Suffolk Northern/Central resource zone for the dry year baseline planning scenario:

Planning Scenario	Base year 2007/08	End of AMP4 2009/10	End of AMP5 2014/15	End of AMP6 2019/20	End of AMP7 2024/25	End of AMP8 2029/30	Planning Horizon 2034/35
No HR	+15.44	+14.79	+4.79	+4.23	+2.65	+0.43	-1.86
With HR	+15.44	+11.88	+0.64	-0.48	-0.69	-3.21	-4.20

Balance of Supply for Suffolk Northern/Central Resource Zone in Ml/d – Baseline (HR = Headroom)

Across the planning horizon the balance of supply can be summarised as follows:



Under the baseline dry year scenario surplus in supply under the dry year planning scenario would decrease throughout the planning horizon from around 15.4 Ml/d in 2007/08 to zero in 2031/32 assuming no headroom. From 2031 onwards the zone experiences an increasing deficit to 1.86 Ml/d in 2034/35.

Assuming the current EBSD determined headroom requirement then the balance of supply would go into deficit in 2023, reaching a maximum shortfall of 4.2 Ml/d by 2034/35 under the dry year planning scenario.

If no action is taken then under a period of sustained dry weather demand may not be met from 2023 onwards. In the years immediately after this date it is possible that measures from ESW's Drought Plan (ESW, 2007a) may temporarily restore the balance of supply; but this is unlikely to be a sustainable solution for the future water supply of the zone.

10.1.2. Consideration of Solutions to Planning Problem

Chapter 9 has outlined the options evaluated to address the deficits in the balance of supply in both the Essex and Suffolk Northern/Central resource zones. Integral to the development of these options was the SEA and EBSD processes used for screening and evaluating options. In the case of Essex both the Current and Intermediate EBSD frameworks were used in consideration of a preferred options set, whilst for the Suffolk Northern/Central zone only the Current EBSD framework was appropriate. Section 9.13 outlines the factors that were considered in assessing the suitability of the feasible options for incorporation into potential planning solutions.

The proposed planning solutions have also taken account of:

- Industry best practice methodologies for the calculation of the supply and demand components and economic analysis; as detailed in the Agency's WRPG.

- Uncertainty and risk through adoption of target headroom calculated under industry best practice guidance, and incorporation of climate change with supply and demand forecasts; and

- Selection of distribution management options via consideration of sustainability; specifically through carbon accounting, environmental and social costs, and the wider SEA process.

10.1.3. Identified Planning Solutions

The final planning solution for each resource zone is indicated as follows:

Essex Resource Zone

For the Essex resource the final planning solution to address the current and predicted future deficits in the balance of supply is summarised as follows:

Option ID	Option	Date	Maximum Yield/ Demand Saving Ml/d
C2	Universal Metering by 2020	2010-2020	9.63
D2	Dagenham Supply Pipe Replacement	2010-2019	5.00
D3	Generic Mains Replacement	2010-2015	2.65
R2	Abberton Scheme	2010-2014	64.00

Final Planning Solution for the Essex Resource Zone

This solution is in addition to ESW's baseline demand management as described in Chapter 5 which assumes implementation of water efficiency measures employed to meet Ofwat water efficiency targets

Suffolk Blyth Resource Zone

For the Suffolk Blyth resource zone no interventions are required as a predicted surplus in the balance of supply is predicted over the planning horizon.

Suffolk Hartismere Resource Zone

For the Suffolk Hartismere resource zone a deficit in the balance of supply is predicted from 2028 onwards, but only under the baseline planning scenario in respect of distribution input. Due to the final planning distribution input being lower than that for the baseline (largely due to the impact of water efficiency projects required to meet Ofwats targets) then the deficit identified under the baseline scenario is effectively removed. This means that no additional investment is predicted to be required to maintain the supply demand balance in this zone throughout the planning horizon.

Suffolk Northern/Central Resource Zone

Similarly to the Suffolk Hartismere resource zone a decrease in distribution input experienced in the final planning scenario (due to the effect of water efficiency initiatives being used to meet Ofwats target) means that the deficit in the balance of supply is effectively delayed by five years. For the Suffolk Northern/Central resource the final planning solution required to address this predicted future deficits in the balance of supply can be summarised as follows:

Option ID	Option	Date	Maximum Yield Ml/d
R1	North Lowestoft Groundwater Scheme	2026	5.0

Final Planning Solution for the Suffolk Northern/Central Resource Zone

As previously indicated an ongoing desk study to investigate this option is currently ongoing.

10.1.4. Reasoned Justification

For the two resource zones where planning solutions are required (i.e. Essex and Suffolk Northern/Central zone) and necessitate investment, justification is provided for the choice of final planning solution based on economic, social and environmental criteria as suggested in the Agency's WRMP. This is provided in the following sections:

Essex Resource Zone

Economic Justification

- Of all the feasible options only Dagenham supply pipe replacement has a lower unit cost than the Abberton Scheme, and hence ESW plan to implement both options. The Dagenham scheme would not have anywhere near sufficient yield on its own to meet the gap in the balance of supply.

- Effluent recycling, the River Trent Transfer and Canal Transfer options are significantly more expensive than the Abberton scheme, and the Reverse Osmosis Desalination and algae reduction schemes are uneconomic.

- As the Abberton Scheme straddles two AMP periods (the current AMP4 and AMP5) significant investment has already been incurred in developing the scheme including environmental and engineering assessment, planning applications and land purchase. For this reason the existing level of sunk costs in the Abberton Scheme should also be considered.

Social Justification

- Sharing of resources is a socially admirable aim. ESW has explored the possibilities of sharing resources with neighbouring water companies including Anglian Water and Thames Water, and will continue to consider such options in the future.

- Given the current deficit in the balance of supply it is right that action should be taken at the earliest opportunity to implement a sustainable option such as the Abberton scheme.

Environmental Justification

- All the highest yielding feasible options (Canal and Trent transfers, Reverse Osmosis Desalination, and Abberton Scheme) have the highest embedded carbon costs of all the feasible options considered. This is not totally unexpected however due to their large size and infrastructure construction requirements. However when viewed as unit costs per unit of yield the cost differential with lower yielding schemes are not so marked. In fact all of water management options have relatively small embedded carbon when compared to other activities and wider population and housing growth.

- The Abberton Scheme has been designed to have low operational CO_2 emissions and be as sustainable as possible; for example by utilising local materials, avoiding transport movements and creating new areas of habitat. Additionally the Abberton Scheme is the only option to have negative environmental and social costs (ie environmental benefits).

- The Abberton Scheme has been demonstrated to be significantly beneficial to the environment with numerous positive effects anticipated from reduced stress on the water environment and enhanced habitats for wildlife.

- Alternatives such as Reverse Osmosis Desalination and the Canal Transfer have high and potentially unacceptable environmental and social costs.

- The option of universal metering by 2015 has slightly higher embedded CO_2 costs than the baseline option of universal metering by 2020.

Other Factors

- Bringing forward compulsory metering by 5 years from ESW's preferred target date of 2020 would also have no effect on the need and timing for a large strategic water management option to be implemented as soon as practicable.

- Projects with potentially similar yield to the Abberton Scheme such as the River Trent Transfer and Canal Transfer have longer lead in times requiring substantial investigations and have no guarantee of success from a technical and/or regulatory perspective.

- Reverse Osmosis Desalination, although of moderate yield is also not available until at least 2018 and carries a number of risks including questions over likelihood of promotion and poor long term sustainability.

- The notional algae outage reduction scheme is too low yielding to markedly affect the deficit in the balance of supply on its own.

- The Colchester effluent recycling scheme would not be available until 2018 and, as demonstrated by ESW's experiences of developing the Langford scheme, would carry with it a number of difficulties in relation to promotion and consenting. An additional factor is that unlike Langford, there would be no automatic claim to any effluent availability adding further complications.

Suffolk Northern/Central Resource Zone

The few available feasible options in this resource zone mean that justification for the final planning solution is much more straightforward than it would be for a resource zone with a large number of feasible options. In summary:

- From an economic perspective the North Lowestoft Groundwater Scheme is significantly cheaper than Washwater recycling, additional leakage reduction, and over half of the water efficiency options considered.

- Of all the feasible options only the North Lowestoft Groundwater Scheme has sufficient yield to close the anticipated deficit in the balance of supply in the early 2020s.

10.2. Final Planning Supply-Demand Balance

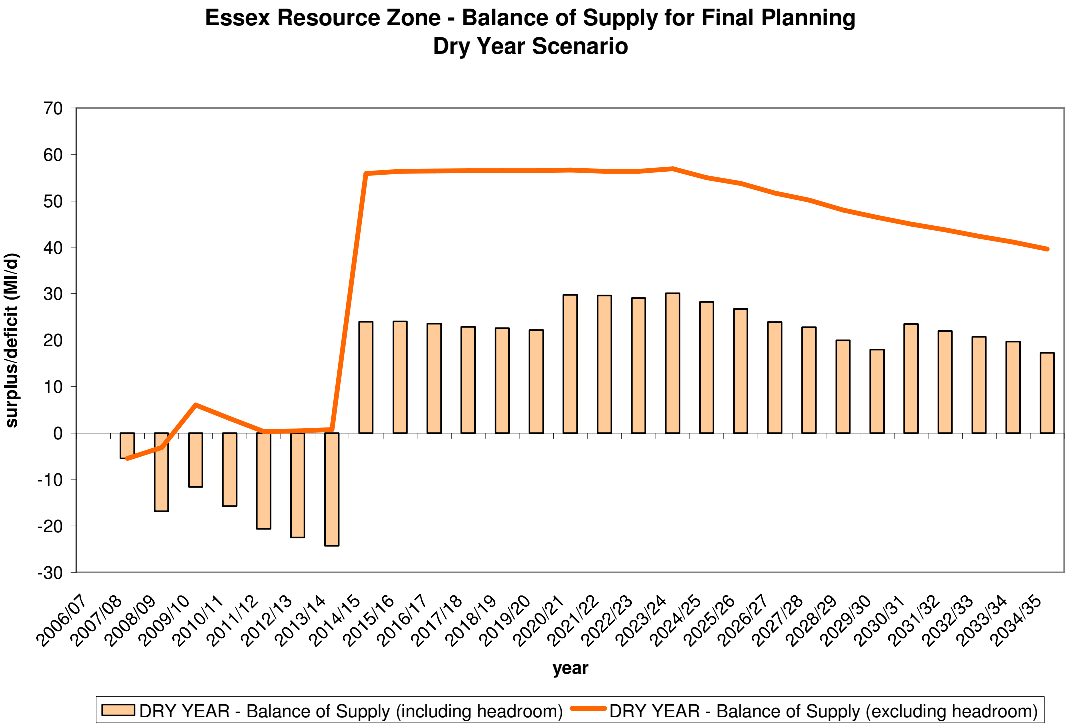
Essex Resource Zone

The following table summarises the forecast balance of supply for the Essex resource zone for the dry year final planning scenario (assuming implementation of the proposed planning solution):

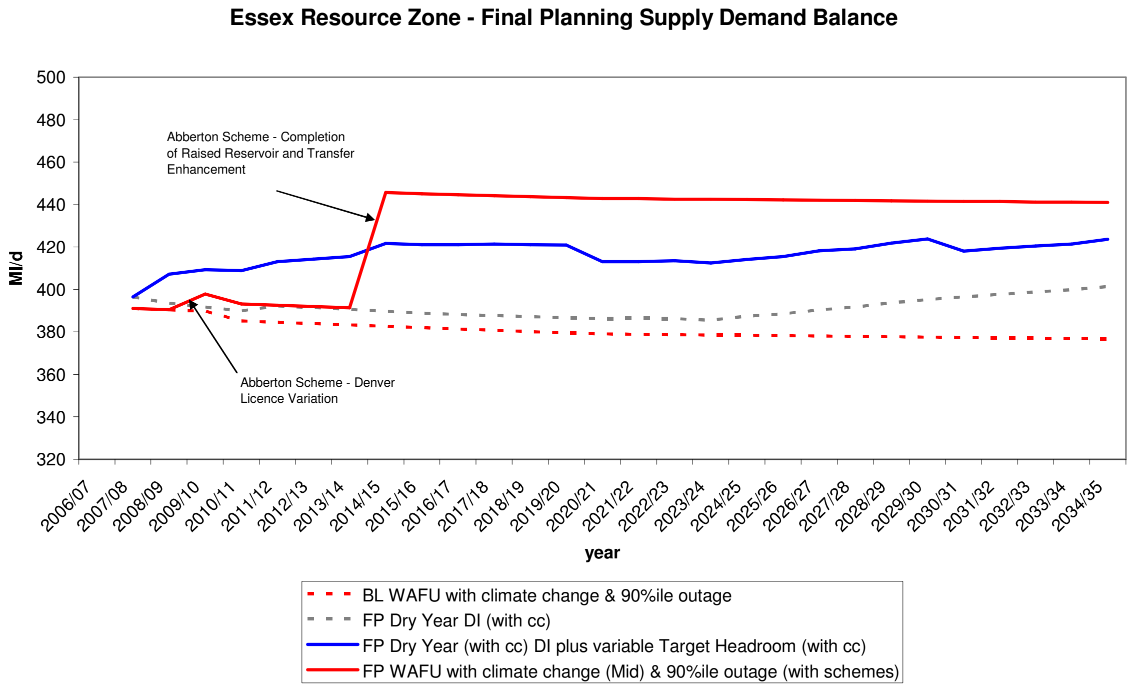
Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
No HR	-5.52	6.04	55.84	56.49	54.95	46.44	39.60
With HR	-5.52	-11.57	23.91	22.15	28.17	17.89	17.25

Balance of Supply for Essex Resource Zone in Ml/d under Final Planning Solution
(HR = Headroom)

Implementing the final planning solution will substantially reduce the risk of needing to implement restrictions or of experiencing supply failures under a sustained period of dry weather. Across the planning horizon the final planning balance of supply can be summarised as follows:



The final planning supply demand balance for the zone is summarised as follows:



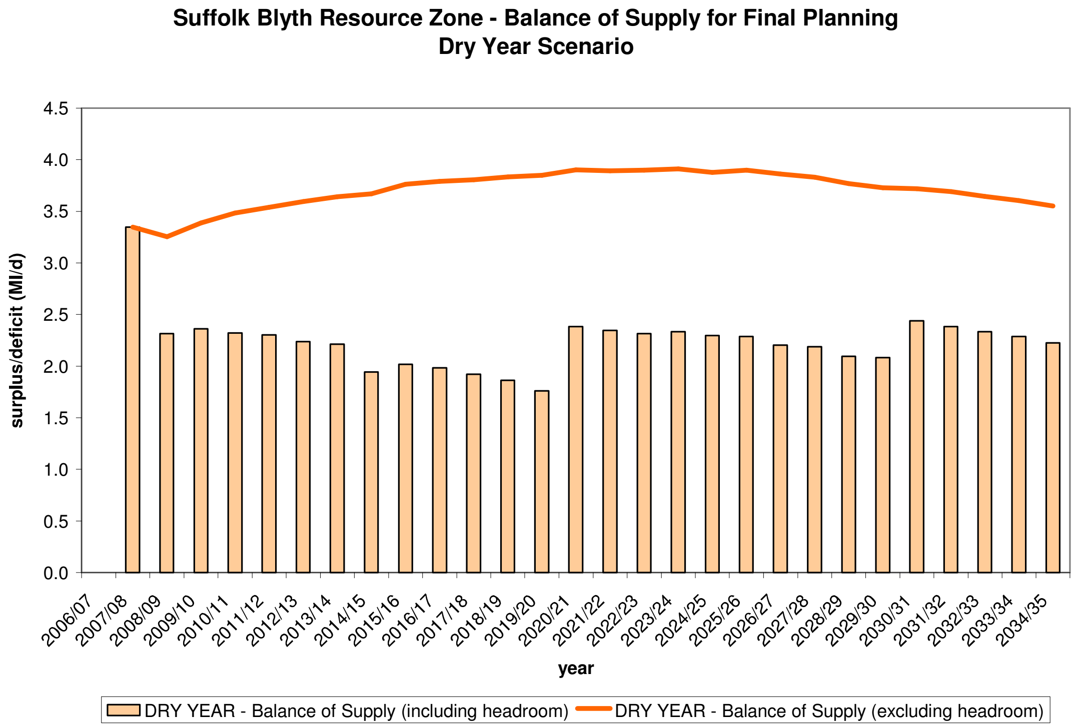
Suffolk Blyth Resource Zone

Although no deficit is predicted in this zone, figures are provided for the forecast balance of supply for the dry year final planning scenario due to the difference in baseline and final planning demand scenarios. This is largely due to the incorporation of water efficiency projects as required to meet Ofwat's targets.

Planning Scenario	Base year 2007/08	End of AMP4 2009/10	End of AMP5 2014/15	End of AMP6 2019/20	End of AMP7 2024/25	End of AMP8 2029/30	Planning Horizon 2034/35
No HR	3.35	3.39	3.67	3.85	3.88	3.73	3.55
With HR	3.35	2.36	1.95	1.76	2.30	2.08	2.23

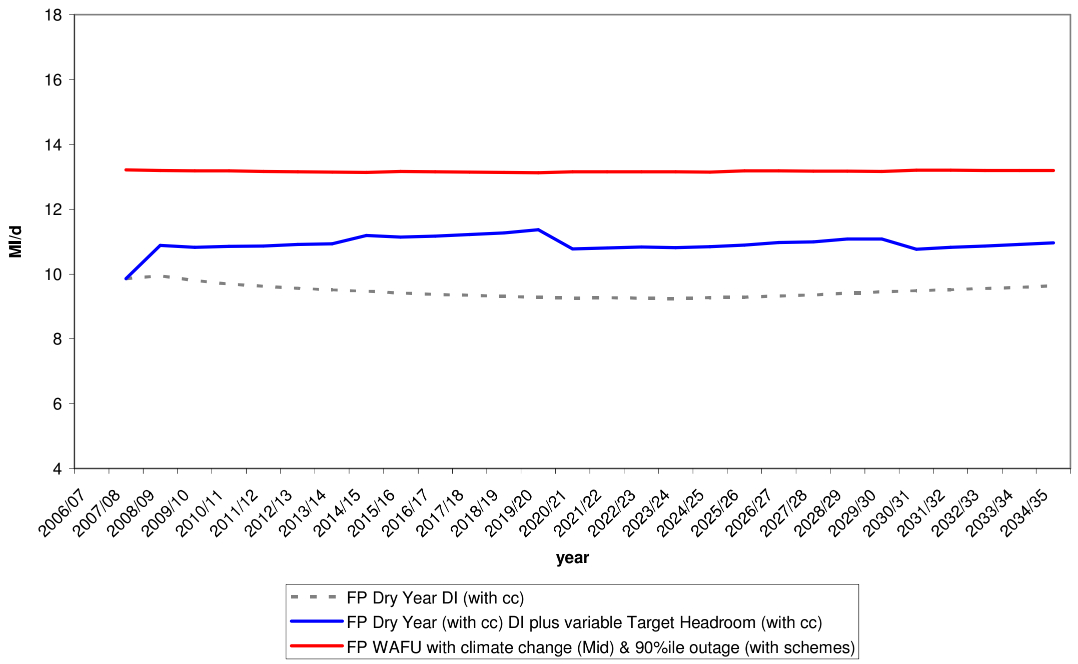
Balance of Supply for Suffolk Blyth Resource Zone in Ml/d under Final Planning Solution (HR = Headroom)

Across the planning horizon the final planning balance of supply can be summarised as follows:



The final planning supply demand balance for the zone is summarised as follows:

Suffolk Blyth Resource Zone - Final Planning Supply Demand Balance



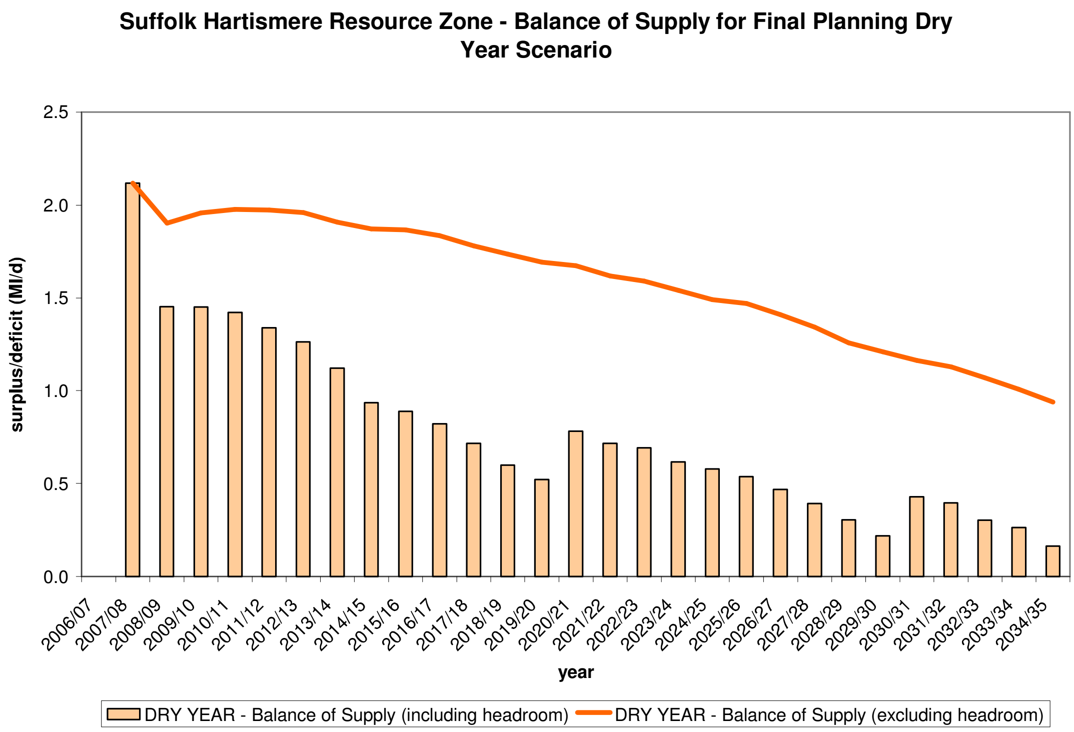
Suffolk Hartismere Resource Zone

The following table summarises the forecast balance of supply for the Suffolk Hartismere resource zone for the dry year final planning scenario. As with the Suffolk Blyth resource zone, this is presented to illustrate the difference between the baseline and final planning demand forecasts.

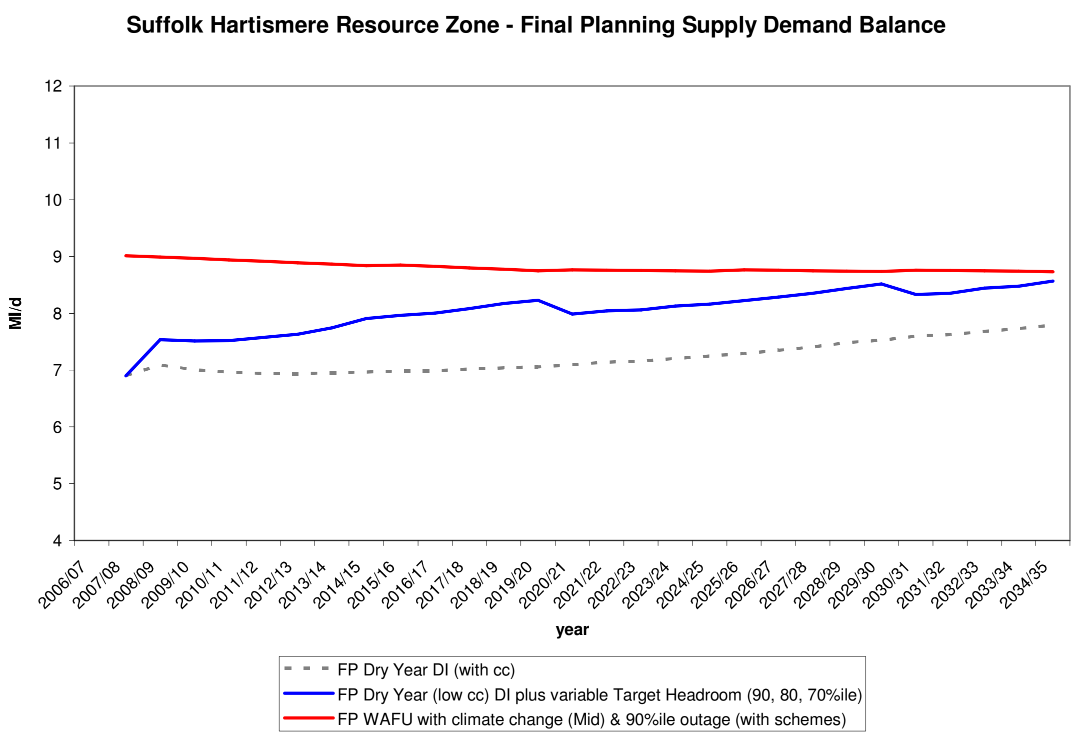
Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
No HR	2.12	1.96	1.87	1.69	1.49	1.21	0.94
With HR	2.12	1.45	0.94	0.52	0.58	0.22	0.16

Balance of Supply for Suffolk Hartismere Resource Zone in Ml/d under Final Planning Solution (HR = Headroom)

Across the planning horizon the final planning balance of supply can be summarised as follows:



The final planning supply demand balance for the zone is summarised as follows:



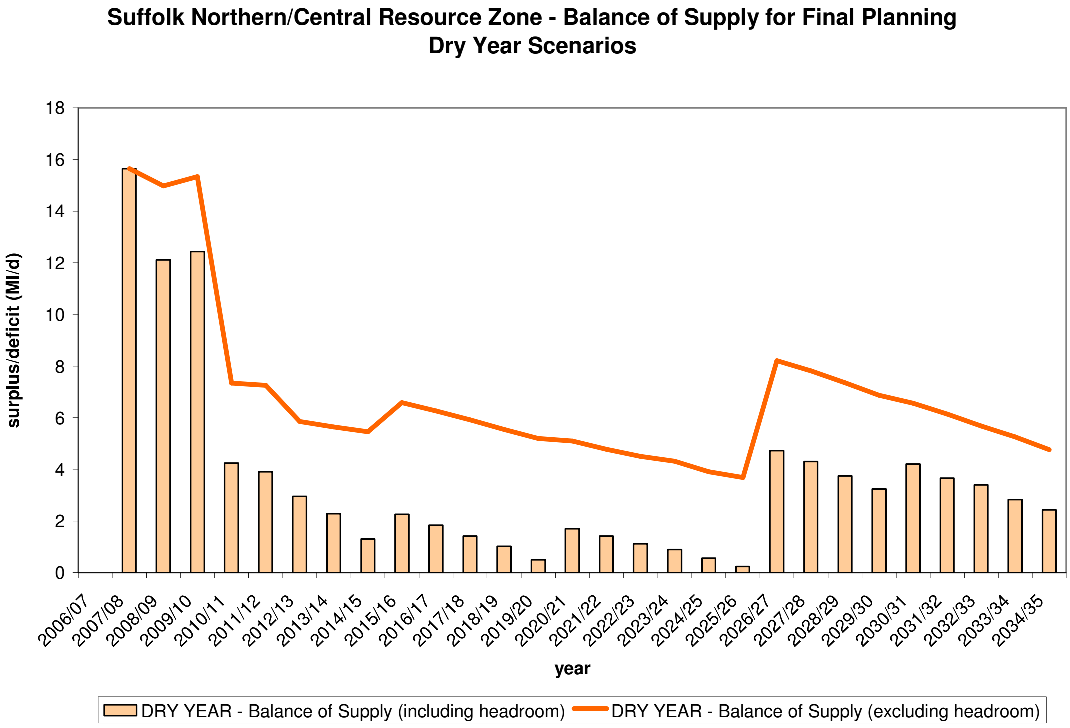
Suffolk Northern/Central Resource Zone

The following table summarises the forecast balance of supply for the Suffolk Northern/Central resource zone for the dry year final planning scenario (assuming implementation of the proposed planning solution):

Planning Scenario	Base year	End of AMP4	End of AMP5	End of AMP6	End of AMP7	End of AMP8	Planning Horizon
	2007/08	2009/10	2014/15	2019/20	2024/25	2029/30	2034/35
No HR	15.65	15.33	5.45	5.20	3.91	6.88	4.77
With HR	15.65	12.43	1.30	0.50	0.56	3.24	2.43

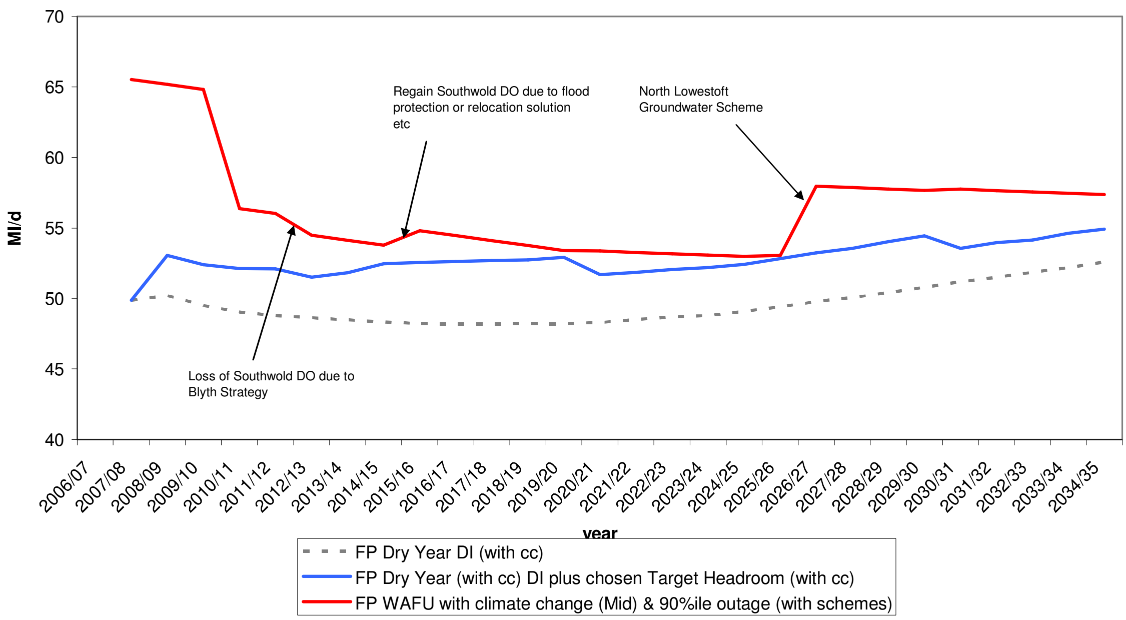
Balance of Supply for Suffolk Northern/Central Resource Zone in Ml/d under Final Planning Solution (HR = Headroom)

Across the planning horizon the final planning balance of supply can be summarised as follows:



The final planning supply demand balance for the zone is summarised as follows:

Suffolk Northern/Central Resource Zone - Final Planning Supply Demand Balance



Implementing this solution will avoid the predicted supply deficit in the early 2020's onwards and ensure the balance of supply remains positive throughout the planning horizon. In turn under a sustained dry weather scenario the need for restrictions and the possibly of supply failures should be avoided.

It should be recognised that an additional requirement in maintaining the supply demand balance will be identification of a solution in relation to the implications of the Agency's Blyth Strategy that will require investment as identified in ESW's wider PR09 business planning process.

10.3. Summary of Overall Water Resources Strategy

ESW's proposed overall water resources strategy over the next twenty five years (including AMP5 which is the main focus of this periodic review) can be briefly summarised as follows.

10.3.1. Companywide Strategy Elements

Baseline Leakage

ESW intends to maintain the agreed AMP4 target for leakage at 66.6 Ml/d. The Company proposes to carry out a large scale supply pipe replacement programme in the London Borough of Barking and Dagenham over the next ten years in order to lower the Economic Level of Leakage down to the current target. Additionally some generic mains renewal activity is anticipated to take place during AMP5.

Baseline Water Efficiency

ESW's baseline water efficiency will include in AMP5 continuation of the annual programme of water efficiency audits starting with H_2eco in the remaining parts of Chelmsford. In addition ESW will continue with its philosophy of annually reviewing project effectiveness to improve approach, undertaking projects of research value and improving the measurement of impact and water savings. ESW customers will continue to be offered a range of free and subsidised products such as cistern displacement devices and water butts, and information and advice for a range of customer groups will be provided through well proven and innovative methods. ESW remains committed to sharing experiences and results, and working in partnership with others.

From April 2010 ESW will undertake a range of water efficiency activity to comply with Ofwat's 1 l/prop/day target.

10.3.2. Essex Resource Zone Strategy

Abberton Scheme

The Company will continue its strategy for implementing the Abberton Scheme. Currently all the necessary planning consents have been obtained and a number of the environmental enhancements around the western section have been completed. ESW will continue to work closely with the Environment Agency and other groups to deliver the scheme.

Baseline Metering

ESW is committed to achieving universal metering in Essex by 2020. To do this it intends to apply for powers to compulsory meter from 2015 onwards.

10.3.3. Suffolk Supply Area Wide Metering Strategy

Suffolk has an already high meter penetration (by comparison with Essex) and for this reason optant metering will continue during AMP5 and onwards. Although no selective metering metering is planned in AMP5 this strategy will be reviewed at the next periodic review. Specific actions for the Suffolk Northern/Central area are outlined as follows:

10.3.4. Suffolk Northern/Central Resource Zone Strategy

Southwold Security of Supply

The result of investigations undertaken for ESW by Royal Haskoning and the University of East Anglia, and a Flood Resilience Assessment subsequently undertaken by ESW is summarised in section 3.2.4 of this report.

As a result of the above studies ESW has assumed a complete loss of DO from the Southwold sourceworks from 2012. It has then been assumed that an option to secure supply would be available from 2014.

The result of ESW's option assessment is that an alternative supply from Barsham WTW to Alder Carr tank (via an enhanced treated water main) is the preferred option for maintaining levels of service in the Southwold DMA. Application for an allowance in price limits to cover the implementation of this option has been included in the Company's final Business Pan.

North Lowestoft Groundwater Scheme

The main findings of a report undertaken for ESW by BGS into the hydrogeological potential of the North Lowestoft area are summarised in section 9.7.4 of this report.

During 2009/10, ESW intends to build on the BGS report findings and undertake a wider desk study to look into potential locations for the construction of investigation boreholes and hence further evaluate the potential for scheme development.

11. WATER RESOURCES PLANNING TABLES

11.1. Completed Tables

A series of Water Resources Planning (WRP) tables represent the supply demand balance of the plan for each of the Company's water resource zones and also provide information for organisations to understand and appraise the plan.

As indicated in the Agency's WRPG, a suite of tables is available in an individual workbook for each water resource zone; as follows:

WRP Table	Content
Summary	Requires no input but shows graphical information taken from the rest of the tables. Contains three graphs: baseline components of demand, final planning components of demand and headroom
WRP1 – BL	Baseline supply-demand components
WRP1a – BL	Baseline supporting transfer and deployable output reduction data
WRP2	Feasible list of water management options
WRP3	Preferred list of water management options
WRP4 – FP	Final planning supply demand components
WRP4a – FP	Final planning supporting transfer and deployable output reduction data
WRP5	Resource zone deployable output reconciliation
WRP6	Breakdown of measured households (dry year baseline)
WRP7	House micro-component consumption (dry year baseline)
WRP8	Non-household sector consumption (dry year baseline)
WRP9	Normal year supply demand components

The fundamental basis of the tables is the dry year annual average scenario and both baseline and final planning data are presented within the same workbook for each resource zone, along with only baseline information for the normal year planning scenario.

As no critical period scenarios were appropriate for any of the ESW resource zones, only four workbooks have been required. These have been named in accordance with the convention indicated in the Agency's WRPG and are as follows:

Resource Zone	WRP Table Workbook File Name
Essex	DryYr_Essex_DraftPlanFinal_VersionNo2_Jan 2009.xls
Suffolk Blyth	DryYr_SuffolkBlyth_DraftPlanFinal_VersionNo2_Jan 2009.xls
Suffolk Hartismere	DryYr_SuffolkHartismere_DraftPlanFinal_VersionNo2_Jan 2009.xls
Suffolk Northern/Central	DryYr_SuffolkNorthernCentral_DraftPlanFinal_VersionNo2_Jan 2009.xls

The tables have been provided on CD to regulators in the first instance.

Copies of these tables are available on request to other consultees or interested parties, and will be made downloadable from our website at www.eswater.co.uk.

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13. SECURITY INFORMATION

The draft WRMP was independently security checked for ESW by Halcrow and was also subject to final approval by Defra prior to release into the public domain.

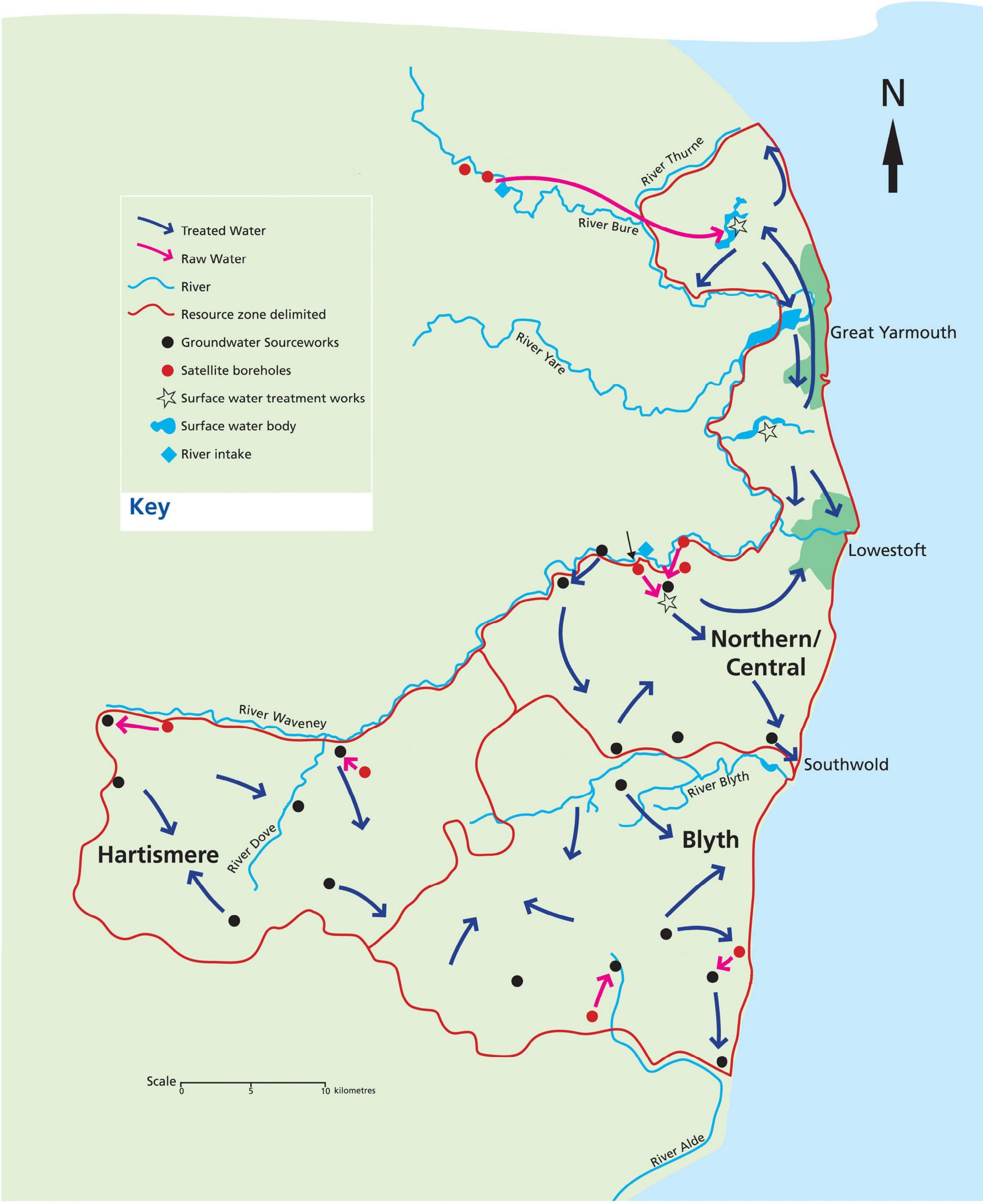
As a result of this process, location sensitive information has been removed from Figures 1, 2 and 3 of all versions of this document.
No further changes have been made to the Final version of the Plan that required any text or data to be excised from the draft revised version of the Plan sent to Defra.

FIGURES

Figure 1
Essex and Suffolk Supply Areas and Transfer Scheme Infrastructure

Figure 2
Essex Resource Zone and Associated Infrastructure

Figure 3
Suffolk Resource Zones and Associated Infrastructure



APPENDICES

APPENDIX A

REPRODUCED EXPERIAN REPORT: HOUSEHOLD AND POPULATION ESTIMATIONS AND PROJECTIONS METHODOLOGICAL GUIDE

and

REPRODUCED DEMOGRAPHIC DECISIONS REPORT: ILLEGAL IMMIGRANT AND SHORT TERM MIGRANT POPULATION ESTIMATES

Reproduced Experian Report 2008:- Household and population estimations and projections – methodological guide.

Household and population estimation and projections: Methodological guide

South East Water Companies
Multi Client Study

October 2008

For and on behalf of Experian	
Approved by:	Tim Lyne
Position:	Head of Economic Modelling
Date:	21/10/2008

Household and population estimation and projections: Methodological guide

October 2008

Contents

Introduction

The participants in the study are the water companies that serve properties in and around the South East region, namely Bournemouth & West Hampshire Water, Essex & Suffolk Water, Folkestone and Dover Water, Mid Kent Water, South East Water, Southern Water, Sutton and East Surrey Water, Thames Water, Veolia Water and Portsmouth Water.

Experian were commissioned to produce a range of household and demographic data to inform water resource planning activity and meet other company requirements. Output Area (OA) level population and household projections have been prepared that take account of the latest information on planned new build activity, including locations of future housing growth as proposed in the draft regional plans.

There are four distinct project requirements from this multi client study, namely:

1. **A trend-based household and population projection**, 2001-2040, for all OAs within the water resource zones (WRZ) that comprise each water company, utilising Census 2001 and the most up-to-date sub-national population estimates and projections from National Statistics.

2. **A policy-driven household and population projection**, 2001-2040, which aligns trend based estimates with housing allocations, promulgated in the draft regional plans.

3. **A most likely scenario projection**, 2001-2040, given the expected divergence between the trend and policy projections, the most likely scenario is Experians best estimate of population, given all the available information.

4. **A written report** that references data sources, describes the forecast methodologies and details the assumptions made in compiling the datasets.

This methodological report represents the fourth of the project outputs. The data outputs have been provided in separate tables within a series of excel spreadsheets or access databases.

The population and household projections produced as part of this report comply with the Environment Agency guidelines for producing household projections for forecasting the customer base. The trend based households are produced using the latest official ONS population projections and CLG household representative rate projections. The policy based projections are produced using the housing allocations contained within the latest available Regional Spatial Strategies combined with CLG household representative rates. The most likely scenario is designed to reconcile the difference between trend and policy given that Regional Spatial Strategies are being revised to move population towards trend at the national level. The projections necessarily cover a long time series and should be viewed as long-term projections. They are not designed to capture short-term fluctuations in housing demand and supply resulting from economic drivers. Such factors are not captured by either the official trend based household and population projections nor the Regional

Spatial Strategies. An attempt to capture economic volatility would be inconsistent with the Environment Agency guidelines.

For further information regarding the contents of this report, please contact Richard Dennis at Experian on 020 7746 8231 or by e-mail at richard.dennis@uk.experian.com.

The Household projections

Introduction

To meet this objective Experian has produced population and household forecasts at OA level for all OAs within each water companies boundaries.

Choosing OAs as the building block has enabled Experian to aggregate the data and create user-defined areas such as water resource zones.

Three sets of projections have been provided:

A trend-based projection, based on ONS local authority and unitary authority district (LAUAD) level population estimates and projections.

A policy-driven projection, based on a combination of ONS population projections aligned to LAUAD housing allocations as promulgated in the draft regional plans.

A most likely scenario projection, based on combination of the population growth from the policy based projections constrained to the total national trend based projection.

Across all sets of projections, new housing developments are allocated to specific OAs utilising property pipeline planning information from Emap Glenigan.

Data sources

A whole host of datasets are utilised to create the population and household projections. The key data inputs and their vintage are listed below. Further details of these sources are provided in Annex A.

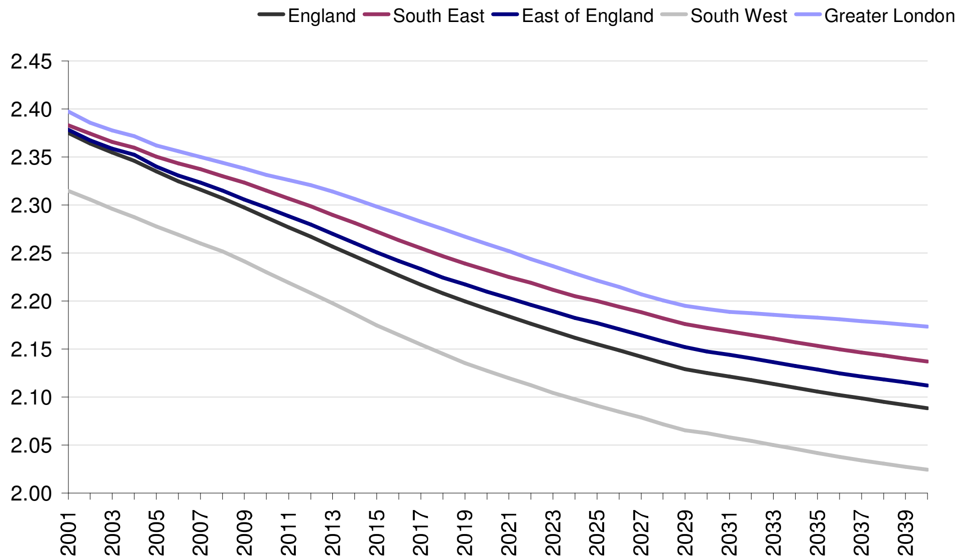
Census of Population, 2001;
ONS sub-national mid year estimates of population, 2001-2006, by gender and quinary age bands;
ONS 2006-based sub-national population projections, 2006-2031, by gender and quinary age bands;
ONS 2006-based national level population projections, 2006-2056, by gender and quinary age bands;
Experian Output Area level datasets, (2007 JICPOPs estimates, 2008-2040 projections, 2001-2006 backcasts). OA level household and population estimates are created using a wide variety of small area data sources to estimate and track household and population change over time, including 2001 Census results, Postal Address File (PAF), lifestyle data and Experian's UK Consumer Dynamics Database (UKCDD). The estimates take account of changing postal geography and are also calibrated to Local Authority District/Unitary Authority level (LAUAD) targets based on the most recently available government household and population estimates and projections. They also take account of people and households that were not recorded in the 2001 Census (under-enumeration). They are updated annually to allow for changes in housing stock and population changes due to births, deaths,

migration, and the ageing of the population. Household and Population Estimates for all levels agree with the Joint Industry Committee for Population Standards (JICPOPs) Postal Sector and Administrative District (i.e. LAD and Unitary Authority (UA)) estimates;
Property Pipeline information supplied by Emap Glenigan (January 2008); and Anglia University / CLG 2004-based projections of household representative rates, by age and gender, by LAUAD, 2001-2029 (fixed from 2029 to 2040).

Methodology
District level household and population targets
The starting point for our OA level population and household projections is to create a set of district level population and household targets, which are used as control totals for the subsequent OA level work.

The district level population and household targets are based on a combination of the most up-to-date sub-national estimates and population projections from National Statistics applied to projections of household representative rates from CLG (2004-based) to derive a district level projection of the number of households. Implicit in the CLG household representative rates are assumptions that average household size will fall over the length of the projections; regional summaries are shown below. As the end point in the CLG household representative rate projections is 2029, we have assumed that the rates, by age, gender and district are fixed at 2029 levels to 2040. Despite this assumption, the changing demographic structure between 2029 and 2040 results in the average household size continuing to fall in all regions, albeit at a reduced rate.

Figure 1: Average Household Size Projections, England & Regions



Source: CLG, Experian

We have smoothed the population projections around 2031 where the ONS district level projections end and the national level projections take effect.

This first-cut of household projections is purely trend based: it is neither a forecast of what analysts expect to happen nor a statement of policy. To account for planned future developments, policy-driven household and population projections are constructed. Housing projections in the draft regional plans are integrated into our projections at the LAUAD level. As regional plans typically contain housing projections to 2026 only, we have assumed the change in the trend-based projections also apply for the policy-based projections beyond the point where each regions policy based projection ends.

Estimates of district level policy based population are recalculated by applying projections of average household size from the trend-based projections to the policy-driven household projections, above.

OA population and household targets

The next phase is to drill down below these district level targets to a more refined geographic area. Experian have used OAs (e.g. 33UGFY0003) for the analysis of small spatial areas. This is so that information from Census 2001, the key source of data for small area demographics, can be bought up to date with information from alternative sources such as the electoral role and lifestyle surveys. Moreover, it facilitates the incorporation of new property developments that are easily coded at OA level.

The various stages taken to construct the OA population and household projections are set out below:

Age forwards Census 2001 OA residents in households using a cohort survival approach (e.g. the number of 20_24 year olds this year is based on 4/5 times the number of 20_24 year olds in the previous year (i.e. 1/5 move up to the next age group) plus 1/5 times the number of 16_19 year olds the previous year (i.e. 1/5 move up to the 20_24 year olds from the 16-19 age group).

Births are estimated by applying district level fertility rates to its constituent OA level population of females aged 15_44. Death and migration rates at OA level are also estimated by applying district level rates.

Calibrate OA population counts to align with LAUAD level population targets for both the trend-based and policy-driven approaches for the period 2001-2040.

Source OA level counts of communal population from Census 2001, the counts are fixed post 2001.

Calculate household population by subtracting communal population from total population.

Estimates of the number of households in each OA are taken from Census 2001 and pushed forward by combining the growth in OA household population (from Stage 5) with changes to average household size in its encompassing district.

Calibrate the OA household estimates to align with district level household targets for the trend-based and policy-driven approaches.

At this stage we have an initial set of household and population projections, 2001-2040, by OA. The methodology that we use to build residential property pipeline information into our demographic forecasts utilizes site level planning application and contract progress data that is sourced from Emap Glenigan. To

utilize Emap Glenigans site level planning application and contract progress data in our demographic forecasts we first need to establish the likelihood that each site in the property pipeline has of being "built-out". To do this we use a procedure (developed in consultation) with Emap Glenigan that assigns "build out" probabilities according to the stage that each site has reached in the planning /contracting process and the insight (based on experience) that this information provides regarding the likelihood that the associated scheme will be completed (for more details, see appendix D).
All projects are assumed to start and be completed between 2007 and 2020. All developments are aggregated to OA level. This adjustment adds additional local flavour to the household projections by accounting for possible new developments.
Overall constraining procedures are applied to the OA household and population projections to ensure that they are consistent with our broader view of population and household projections at the district level for the trend-based and policy-driven approach. Not every output area will have housing projects sourced from Emap Glenigan. As a consequence of the LAUAD constraint, those OAs without a new development will see a reduction in housing growth to balance developments elsewhere in the district for the LAUAD target to be achieved.

Bespoke spatial analysis
Experians household and population calculations for each of the WRZs areas were carried out using Alteryx 2.5 and Micromarketer, two spatial analysis programmes.

Three inputs are fed into the calculations:
Client supplied WRZ GIS boundaries
Output Area (OA) boundaries
Census population and area (in sq km) for each OA and postcode

The Alteryx programme first identifies which OAs are located entirely within each boundary of a given WRZ. The sum of the total population of all of these OAs can then be derived and will account for the majority of each WRZs total population.

This leaves only areas around the borders of the WRZs for examination, areas which will not contain any complete OAs but will be made up typically of elements of a number OAs (the remainder of the OA falling into another WRZ or falling outside each water companies total area). For each of these OAs we calculate the proportion of cut OA population that is inside each WRZ as a proportion of the full OA population using Census postcode area level data. These rates are kept fixed in the forecast.

The proportions are then applied to the population and households of these OAs to give the population falling inside the given WRZs. For each WRZ these population shares can then be aggregated, and combined with the population calculated from the 'whole' OAs we reach a final figure for the WRZs total population.

An example of the Alteryx output is shown below for a small DMA in the East of England. The total population for this DMA is comprised of the sum of the seven OAs that fall entirely within the DMAs boundaries plus the shares of an additional twelve OAs where the DMA boundary splits the OA boundary. Note that where the Output Area splits the DMA that the share values can range between 0% and 100%. Where the share is 0% the OA cut census population is zero however some of the OA area falls within the DMA boundary. Where the share is 100%, the OA cut census population equals the full census population but not necessarily all of the OA area falls within the DMA boundary.

Output Area falls entirely within DMA

DMA	OutputArea	CutArea	CutCensusPop	FullArea	FullCensusPop	Share
Example	X00KFNA0015	0.016	276	0.016	276	100%
Example	X00KFNA0021	0.084	334	0.084	334	100%
Example	X00KFNA0023	0.017	298	0.017	298	100%
Example	X00KFNA0028	0.028	272	0.028	272	100%
Example	X00KFNA0030	0.020	305	0.020	305	100%
Example	X00KFNA0031	0.043	254	0.043	254	100%
Example	X00KFNA0032	0.022	186	0.022	186	100%

Output Area splits DMA

DMA	OutputArea	CutArea	CutCensusPop	FullArea	FullCensusPop	Share
Example	X00KFNA0006	0.313	266	0.316	266	100%
Example	X00KFNA0007	0.033	284	0.092	318	89%
Example	X00KFNA0012	0.008	0	0.031	213	0%
Example	X00KFNA0014	0.018	294	0.020	294	100%
Example	X00KFNA0017	0.018	293	0.028	293	100%
Example	X00KFNA0018	0.009	0	0.028	264	0%
Example	X00KFNA0022	0.020	300	0.023	300	100%
Example	X00KFNA0026	0.016	98	0.059	323	30%
Example	X00KFNA0029	0.030	85	0.044	250	34%
Example	X00KFNG0009	0.135	62	0.253	304	20%
Example	X22ULGD0005	0.045	47	0.273	327	14%
Example	X22ULGD0006	0.117	0	0.425	331	0%

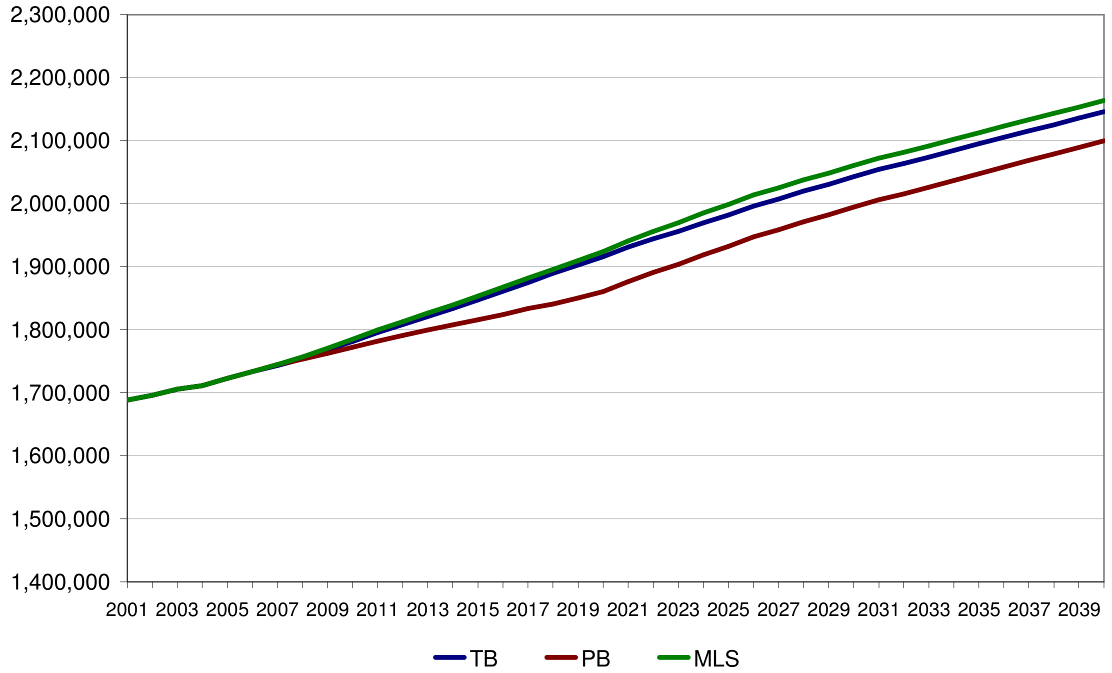
Most likely scenario Methodology
The population and household most likely scenario projections have been calculated initially at a LAUAD level in two steps.

1) Constraining the policy-based household population estimates (generated by applying the trend-based average household size to the RSS household numbers) to the trend based England household population total.

2) Creating a "most likely scenario" estimate which is half-way between the constrained policy-based estimate and the trend-based estimate.

OA most likely scenario household population projections are derived using the OA share of the LAUAD trend based population. WRZ level most likely scenario population projections are then derived using the same OA shares and methodology as used in the trend based projections. Note that for some WRZs across the multi client study the scenario projection is not necessarily in between the trend and policy projection. This is consistent with Experians standard population methodology and our best estimate of where we think population is going given all the available information.

Essex & Suffolk Water Total Population (Essex & Suffolk only)



Appendix A: Data Sources

This note outlines the data sources embedded in the production of Experian Business Strategies' estimates and projections of population and households.

Census of Population, 2001. Release date: 30 March 2004.
http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7534&Pos=3&ColRank=1&Rank=272

ONS Sub-national population estimates, 2001-2006, by gender and quinary age bands. 2006 release date: 22 August 2007.
http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15106

ONS Sub-national population projections, 2006-2031, by gender and quinary age bands. Release date: 12 June 2008.
http://www.statistics.gov.uk/statbase/Product.asp?vlnk=997

ONS National level population projections, 2006-2056, by gender and quinary age bands. Release date: 23 October 2007.
http://www.statistics.gov.uk/statbase/Product.asp?vlnk=8519

Experian Output Area level datasets, (2007 JICPOPs estimates, 2008-2040 projections, 2001-2006 backcasts). OA level household and population estimates are created using a wide variety of small area data sources to estimate and track household and population change over time, including 2001 Census results, Postal Address File (PAF), lifestyle data and Experian's UK Consumer Dynamics Database (UKCDD). The estimates take account of changing postal geography and are also calibrated to Local Authority District/Unitary Authority level (LAUAD) targets based on the most recently available government household and population estimates and projections. They also take account of people and households that were not recorded in the 2001 Census (under-enumeration). They are updated annually to allow for changes in housing stock and population changes due to births, deaths, migration, and the ageing of the population. Household and Population Estimates for all levels agree with the Joint Industry Committee for Population Standards (JICPOPs) Postal Sector and Administrative District (i.e. LAD and Unitary Authority (UA)) estimates;
Property Pipeline information from Emap Glenigan – data as of January 2008.

Anglia University / CLG 2004-based projections of household representative rates, by age and gender, by LAUAD, 2001-2029 (fixed from 2029 to 2040).
Proposed Changes set out the Secretary of State's amendments to the draft Regional Spatial Strategy for the South East of England – also known as the South East Plan, Chapter 7, Table H1b.
http://gose.limehouse.co.uk/portal/rss/pcc/consult?pointId=1201122891581#1201122891581.
Panel Report, December 2007, Draft Regional Spatial Strategy for the South West, Appendix A (ii): Comparison of Housing Market Areas, Unitary Authorities

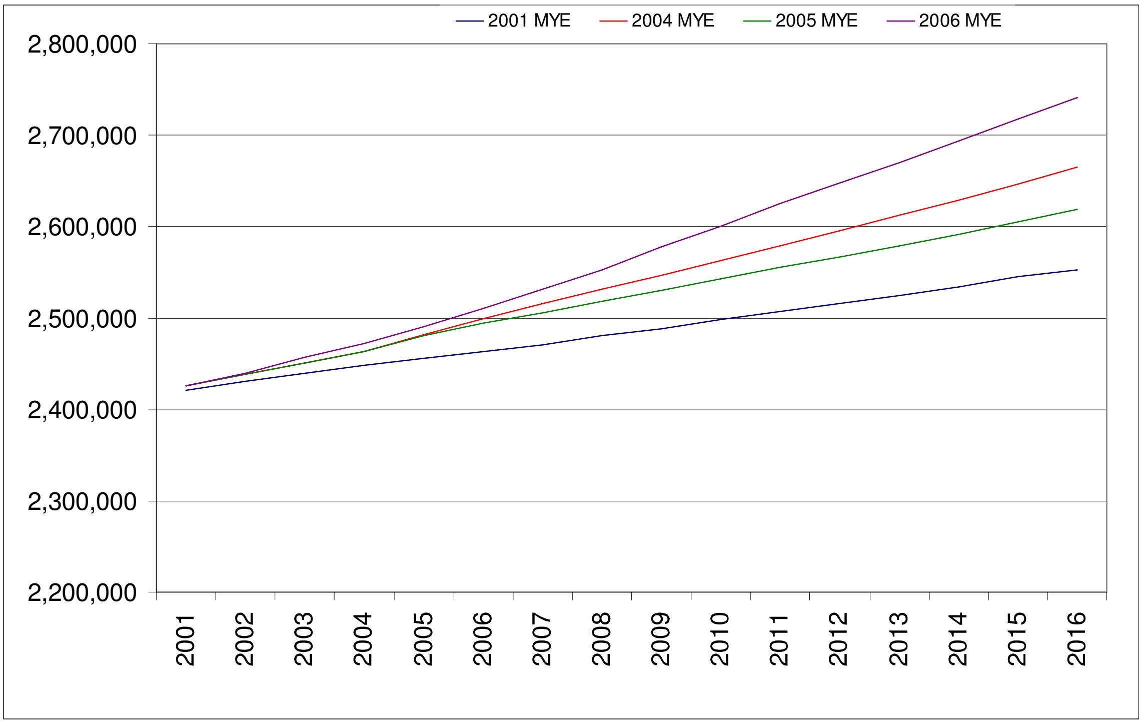
& Districts: Draft RSS Housing Totals, 2003 DCLG Housing Projections & Panel Modifications.
East of England Plan, The Revision to the Regional Spatial Strategy for the East of England, May 2008.
The London Plan, Spatial Development Strategy for London, Housing Provision Targets, Waste and Minerals Alterations, December 2006.
Milton Keynes & South Midlands Sub-Regional Strategy Alterations to Regional Spatial Strategies covering the East of England, East Midlands and South East of England, March 2005.
North East Of England, Regional Spatial Strategy, The Secretary Of State's Further Proposed Changes To The Draft Revision Submitted By The North East Assembly, February 2008.
The Yorkshire and Humber Plan, Regional Spatial Strategy to 2026, May 2008.
The North West Plan, Submitted Draft Regional Spatial Strategy for the North West of England, January 2006.
East Midlands Regional Plan, Report of the Panel, Examination in Public (22 May – 19 July 2007), November 2007.
Regional Planning Guidance for the West Midlands, RPG 11, June 2004.
CLG New Growth Points, Partnership for Growth with Government, South East Growth Points (Basingstoke, Didcot - South Oxfordshire, Maidstone, Oxford, Partnership for Urban South Hampshire, Reading, Reigate and Banstead).
http://www.communities.gov.uk/index.asp?id=1162073

Appendix B: Mid Year Estimate comparison

The ONS prepares annual MYE of population for LAUAD areas in England and Wales.
Mid-2006 population estimates at LAUA level by five-year age groups and gender have been used in this project. The mid-year point relates to the estimated resident population as of 30 June each year. The 2006 MYE of population were released in the autumn of 2007.
The ONS also produce LAUAD level population projections for England and Wales. These projections are available by gender and single-year age groups. The latest long-term (25-year) sub-national projections are the 2006 based projections, which were published in June 2008. The 2006 projections vary from the previous 2004 based projections for three reasons.
The latest projections include mid-year estimates for 2004, 2005 and 2006, which have themselves been revised.
Official national level population projections have been revised upwards to account for additional international in-migration.
The change in methodology to allocate international in-migrants in the MYE's has been incorporated into the methodology for producing sub-national projections. In very general terms, this means that the migration element of population change outside of London is likely to be higher than under previous projections.
After the first cut of bespoke population projections were produced there was a concern from some water companies that the projections were lower than estimates produced for PR04.
This exercise compares the LAUAD level projections used in this project with those available for PR04 (using 2001 mid year estimates which would have been the latest available in the Spring of 2003). We have also compared the current vintage of estimates and projections with the vintage produced in the Spring of 2006.
Totals shown for each water company are the combined population for all LAUADs that cover the client supplied water resource zones boundaries. No adjustments have been made where the resource zone bisects the LAUAD boundary. Where this occurs, the full LAUA population has been used and as a consequence the population presented in this appendix will be greater than the population produced in the main part of this project for most water companies.
Folkestone and Dover, Mid Kent Water, Sutton and East Surrey, Thames Water, Veolia Water, Essex & Suffolk Water and Southern Water all experience an upward revision in their projections in the latest 2006 based estimates / projections.
Now only Bournemouth & West Hampshire Water and South East Water have a 2006 based projection that is lower than the vintage that would have been available for PR04.

Source: ONS, Experian Ltd

Essex & Suffolk Water Population (Essex & Suffolk only)



Source: ONS, Experian Ltd

Appendix C: Average Household Size

The labour force survey (LFS) was considered as a possible alternative source for average household size. The theory being that if the official population estimates have underestimated international migration in recent years then this may have fed through to smaller average household size projections.

However we have not used any LFS data in the final projections. As the trend and policy based projections use CLG projections of household representative rates to derive households from household population, it was thought that using an alternative source of average household size to derive household population from households was incompatible with the baseline methodology. Additionally, the data is only considered robust at a regional level, data at a LAUAD is available and was obtained from ONS but it has not been used.

The LFS average household size data at a regional level does however provide a useful comparison to the average household size implied from CLGs household representative rates. Table 1 shows the indices for the regions relevant to this study. The LFS data has been derived from the TOTNUM variable which is the total number of eligible people in households.

Table 1: LFS and CLG average household size indices.

LFS	2001	2002	2003	2004	2005	2006
East Midlands	100.0	100.3	99.2	99.6	99.3	97.4
Eastern	100.0	100.5	101.1	101.0	99.8	99.7
London	100.0	100.2	100.5	101.3	101.6	102.9
South East	100.0	98.4	97.2	98.9	97.6	98.0
South West	100.0	99.0	99.1	99.5	99.4	99.6

CLG	2001	2002	2003	2004	2005	2006
East Midlands	100.0	99.4	99.0	98.5	98.0	97.5
Eastern	100.0	99.5	99.1	98.7	98.3	97.8
London	100.0	99.6	99.2	99.1	98.9	98.6
South East	100.0	99.5	99.2	98.9	98.5	98.0
South West	100.0	99.5	99.1	98.7	98.3	97.8

Source: Experian derived from LFS & CLG

Appendix D: How property pipeline level data is built into the demographic forecasts

The methodology that we use to build residential property pipeline information into our demographic forecasts utilizes site level planning application and contract progress data that is sourced from Emap Glenigan. The approach adopted by Emap Glenigan involves weekly visits to the local planning authorities to gather information regarding new planning applications. In addition to this Emap Glenigan's information gathering approach features regular phone calls to "plan applicants" (undertaken by a dedicated team of around 40 people) in order to establish the planning application/contract progress stage that each site has reached. Accordingly, through Emap Glenigan we are able to access real time information regarding the country's residential property pipeline.

To utilize Emap Glenigan's site level planning application and contract progress data in our demographic forecasts we first need to establish the likelihood that each site in the property pipeline has of being "built-out". To do this we use a procedure (developed in consultation) with Emap that assigns "build out" probabilities according to the stage that each site has reached in the planning /contracting process and the insight (based on experience) that this information provides regarding the likelihood that the associated scheme will be completed. In particular the "build out" probability that is assigned to each site reflects the maximum of the probabilities that are shown in Table 2 regarding site planning and contract stages.

Table 2: Emap Glenigan Probabilities

Planning Stage	Probability
Planning Not Required	0.98
Plans Appr on Appeal	0.95
Detail Plans Granted	0.90
Reserved Matters Granted	0.85
Detailed Plans Submitted	0.80
Detail Plans Withdrawn	0.60
Detail Plans Refused	0.55
Outline Plans Granted	0.54
Circular 18/84	0.53
Outline Plans Submitted	0.52
Appr Reserved Matters	0.55
Listed Building Consent	0.48
Pre-Planning	0.45
Public Enquiry	0.40
Outline Plans Refused	0.30
Outline Plans Withdrawn	0.20

Contract stage	Probability
Start on Site	1.00
Contract Awarded	0.75
Preferred Bidder Appt	0.50
Bills Called	0.45
Tenders Returned	0.40
Tender Currently Invited	0.30
Applications to Tender	0.25
Pre-Tender	0.20

To calculate the population that is associated with each site in the residential property pipeline the "build out" probability is simply multiplied by the number of units that are planned for each site and then multiplied again by our estimate of the average occupancy rate in the relevant Output Area.

The final stage in the methodology that we use to build residential property pipeline information into our demographic forecasts requires us to estimate when each “potential“ new development is likely to be completed. If start and completion dates are not available for a given site we take a conservative view that the site will be completed 4 years after the date at which we are making our forecasts (if the number of units in the project is less than one thousand). If the number of units exceeds one thousand, the project is given a completion date 12 years after the start date. Finally simple linear interpolation techniques are used to determine the speed at which each site is “built out” (and hence population accumulated) over the construction period.

Reproduced Demographic Decisions Report on :- Illegal Immigrant and short term migrant population estimates.

Executive Summary and Recommendations

Northumbrian Water Limited, like the other water companies in England and Wales, is currently preparing its Business Plan for the 2009 price review "PR09" which includes as an essential element its supply demand balance for the next 25 years. As part of this process a draft Water Resource Management Plan has to be produced for consultation by April 2008, with the final version by August 2008.

The Water Resources Management Plan is of critical importance to regulators, as it forecasts the current and future demands for water and drives investment in supply and demand schemes. In this context accurate population figures are essential to assess the amount of water supplied, the amount estimated to have been consumed, and the volume that is assumed to have been lost through leakage.

Ofwat's starting point for population statistics is the government's official estimate of the resident population. It will however, consider alternatives to the ONS estimates if they are based on sound evidence. Two such populations lie outside the definition of "residents": Short-Term Migrants, who are in the country for less than 12 months (these include many of the East Europeans who have so conspicuously moved to this country in the last three years); and Illegal Immigrants, who have sought refuge over a much longer period. Northumbrian Water Limited has therefore commissioned this independent review of both these populations for the three separate water company areas of Essex, Suffolk, and also Northumbria.

The report provides evidence that the following figures should also be added to the current population estimates:

Short-Term Migrant Population:-
Using National Insurance registration statistics as proxies, the estimates for 2006 are:

Essex Water	9,200
Suffolk Water	1,200
Northumbrian Water	9,800

Illegal Immigrant Population:-
Using Asylum Seeker and Visitor Switcher statistics as proxies for Greater London as a whole, the estimate for that part of the Essex Water company area in London for 2006 is:

Essex Water	10,300

It is advised that it is not currently possible to make plausible projections of these populations for future years, or to realistically allocate the national estimate of the Illegal Immigrant population down to local areas such as Suffolk or Northumbria.

The report concludes by highlighting that it is universally accepted that current official estimates need to be improved – there are many "known unknowns" – and recommends that Northumbrian Water Limited (NWL) should seek common cause with other water companies and with local authorities, to press for improved government statistics and the resources necessary to produce them, and to share local intelligence.

Introduction

The business-planning context

Every water company in England and Wales is required to have a 5-year funding plan agreed by the industry regulator, Ofwat. Each is now preparing its Business Plan for the 2009 price review "PR09", which will include a Water Resources Management Plan. This is of critical importance to regulators, as it forecasts the current and future demands for water and drives investment in supply and demand schemes. In this context accurate population figures are essential to assess the amount of water supplied, the amount estimated to have been consumed, and the volume that is assumed to have been lost through leakage. A draft plan for consultation has to be produced by April 2008, with the final version completed by August 2008.

This report is concerned with three separate water company areas: Essex, Suffolk, and also Northumbria. Maps of the areas – which are not coterminous with County boundaries – are reproduced in Appendix 1. It is important to appreciate that these areas are very different. Looking at their constituent local authorities, the Office for National Statistics classification "http://www.statistics.gov.uk/about/methodology_by_theme/area_classification/la/default.asp" the predominant area types are:

- Essex – Prospering UK (on the margins of the Greater London conurbation)
- Suffolk – Coastal & Countryside (a rural area by national standards)
- Northumbria – Mining & Manufacturing (reflecting the North East's history)

Forecasting the future demand for water – the importance of population

Research by the water industry has established that demand can be increased by several factors which include: growing population or households (which are generally becoming smaller), rising affluence (especially a suburban lifestyle), and weather (and potentially climate change). Conversely, demand can be reduced by providing more efficient appliances and better-designed new homes, the installation of meters, increasing price, and perhaps by encouraging behavioural change in customers.
The industry has particularly focused on analysing micro-components – the ownership and frequency of use of water consuming appliances – when estimating demand. These current measures and recent past trends need to be allied with the projected demographic changes in local areas in order to produce demand forecasts for the next 25 years. NWL also includes an assessment of the water that would be required in a dry year, and an element of uncertainty, to determine "target headroom" for each of its areas.

Of the three areas under consideration, Essex is exceptional even by national standards, being the focus for the extensive Thames Gateway development plans and the general increase in housing within the South East.

<u>The resident population – current estimates, and forecasts</u>

Ofwat's requirement for estimates and forecasts of the population is formally stated in Section 2 below. It is worth observing at this stage that demographers prefer to talk about projections (based on stated assumptions) rather than forecasts (which suggest an element of belief, if not certainty).

The starting point is the Office for National Statistics' (ONS) official estimate of the resident population. These are also the basis for Experian's accompanying figures which provide figures for smaller areas, project years further ahead, and give alternatives based on varied assumptions about the future. Details of the methods used are given in Section 3.

<u>Additional short-term and illegal populations</u>

Ofwat will however, consider alternatives to the ONS estimates if they are based on sound evidence. Two populations lying beyond the definition of the resident population are short-term migrants who are in the country for less than 12 months, and illegal immigrants.

Ideally, the ONS would produce official statistics of each of these populations to accompany those of the resident population – providing current estimates, and also projections for the next 25 years for local areas. However, this is not the case, due to the difficulty of creating even current counts or estimates, let alone plausible projections.

The approach used in this report draws on recent experience of working with Thames Water. Given the limited data available for the current situation, it is not possible to produce conventional demographic projections for future years – the most defensible thing to do in the circumstances is to assume that the current situation continues. Turning to the creation of estimates of the current situation, we have:

- Short-term Migrants (STM). ONS has just produced its first estimates of these at national level, and for Greater London, but they are widely regarded as implausibly low. There is, however, other government data available at local authority level, which can be used as a proxy, and estimates are provided here for Essex, Suffolk, and Northumbria (see Sections 4 & 5).
- Illegal immigrants. Official estimates are, as might be expected, very sketchy even at national level, but it is believed that the majority gravitates to Greater London, and that the three London Boroughs within the Essex Water area must therefore have a small proportion of the London total (Section 6). The idea of seeking to apportion a very approximate national estimate to other specific local areas – the remainder of Essex, to Suffolk, and to Northumbria – which have much smaller overseas-born populations, is not thought to be tenable.

As with the work for Thames, the approach here is to freely acknowledge that ideal data doesn't exist, but that by using those pointers that are available, it is possible to make a plausible case for some estimates. This is a matter of presenting a convincing argument, rather than using sophisticated demographic models to produce detailed but doubtful outputs.

The author would like to express his thanks Martin Lunn and Liz Wright for all their input, and to the range of other external specialists listed at the end of this report who have also made time to provide information and opinions.

Water Resources Management Plan requirements

Ofwat provides the following guidelines for its regular June Return:
"Population figures should be consistent with the Registrar General's current estimates of mid-year resident population, which are based on the latest available census returns. Population figures should only differ from those implied by the Registrar General's estimates where such differences are based on sound evidence. Where there is such evidence, it should be stated in the commentary."
Source: June Return reporting requirements and definitions manual 2007. Issue 1.0 – Dec 2006:
"http://www2.watervoice.org.uk/aptrix/ofwat/publish.nsf/Content/jr07_reporting_requirements"

This report assumes that the Registrar General's (now ONS's) most recent mid year estimates will be used as the basis for the resident population. The focus here is on marshalling convincing evidence that Ofwat should also include estimates of short-term migrant and illegal populations too.

Resident population – ONS's estimates

This section provides the key background, defining the "resident population", and summarising how the ONS produces its Mid Year Estimates (MYEs). These are also used by ONS as the starting point for its projections, and by Experian for both its estimates and projections, which provide numbers for smaller areas, project further ahead, and give alternatives based on varied assumptions about the future.

It should be noted that the department of Communities and Local Government converts ONS's estimates and projections of the population into numbers of households, as does Experian with its own population figures.

Mid Year Estimated Population – definition

ONS defines the population as:
"The estimated resident population of an area includes all people who usually live there, whatever their nationality. Members of UK and non-UK armed forces stationed in the UK are included in their respective Countries and UK forces stationed outside the UK are excluded. Students are taken to be resident at their term time address."

And then comments:
"The methodology used to update mid-year estimates includes an estimate of the population change due to flows of International migrants. These flows are based on estimates of long-term International migrants (where stays of over twelve months only are counted) therefore this does not include flows of short-term International migrants."
Source: http://www.statistics.gov.uk/statbase/Product.asp?vlnk=601&More=Y

<u>ONS's Mid Year Estimates – method and inputs</u>

ONS's methodology is described in detail in several reference documents (see Appendix 2), which include news of the revisions made in Summer 2007 (see below).

ONS uses the well-established cohort component method. The general procedure for updating for both national and local estimates is, starting with the resident population on 30 June the previous year, to add one year to ages of resident population, add births, and subtract deaths.

The remaining components, in- and out-migrants, are much the most difficult to measure, and this difficulty increases when estimating for local (subnational) areas. The "12-month" definition for migrants is crucial.

For the National estimates there are three types of migration:

- Migration within the United Kingdom. This is estimated using the NHS Central Register, and tracks flows between England & Wales, Scotland and Northern Ireland.
- Migration to and from the Republic of Ireland. Estimates are made using data from the Irish Central Statistical Office and survey data.
- Migration beyond the UK and Republic of Ireland. This uses the International Passenger Survey (IPS), a continuous sample survey of passengers conducted by the ONS. It covers the channel tunnel and principal air and sea routes between the UK and overseas. The main use of the IPS is to collect information on tourism and the contribution of travel expenditure to the balance of payments, but ONS uses some of the grossed-up results to estimate international migration.

In addition, allowance needs to be made for:

- Visitor switchers, who extend their stay. ONS estimates these using the IPS.
- Asylum seekers. The Home Office provides data.

Subnational estimates are made for about 400 "building bricks" within England and Wales. In London, these are the boroughs; outside they are based on local or unitary authorities.

- Migration. Migration within the United Kingdom is estimated using the NHS Central Register. Migration beyond the UK and the Republic of Ireland is estimated using IPS, but estimating the local distribution of these migrants has to rely partly on 2001 Census data.

Migration to and from the Republic of Ireland is estimated using data provided by the Irish government; numbers are again distributed locally on the basis of the 2001 Census counts of people born in Ireland.

- Visitor switchers. These are split down to LA level using a 2001 Census distribution.
- Asylum seekers. The Home Office data is apportioned to LA level using information from the National Asylum Support Service.

In July 2007 ONS announced its "Improved methods for estimating the international migration component of population estimates", which implements new methods for the distribution of international in-migrants and out-migrants, and intentions on length of stay ("switchers"). These are based primarily on the International Passenger Survey, and the Labour Force Survey. Links to details of the methodology are given in Appendix 2.

Of the components of change, there is good data on births and deaths, but that on migration is far from perfect. Its reliability decreases along with the size of the area, making the population estimates for small areas less robust. ONS has also recently produced experimental estimates down to Middle Layer Super Output Area level, employing a ratio change method, and using data from administrative sources.
"http://neighbourhood.statistics.gov.uk/dissemination/datasetList.do?JSAllowed=true&Function=&%24ph=60&CurrentPageId=60&step=1&CurrentTreeIndex=-1&searchString=&datasetFamilyId=1307&Next.x=9&Next.y=7"

<u>Short-Term Migrants – current research and published data</u>

Short-Term Migrants – the case for recognition as part of the resident population

During the last three years, there has been increased public and political awareness about migration to the UK. In particular, on 1 May 2004, ten countries – Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia – joined the European Union (EU). From that date, nationals of Malta and Cyprus have had free rights of movement and work. The UK put in place transitional measures to regulate access to the labour market by the other "Accession 8" (A8). Most recently, separate arrangements have been put in place for Bulgaria and Romania, which joined the EU on 1 January 2007. Whilst young Eastern European workers are much the most conspicuous recent migrants, there are also many workers from other countries others (as is illustrated in the discussion of National Insurance records below) and in some cases there may also be accompanying family members (including children) who do not register to work.

In recognition of these rapid changes, the government set up the Inter-departmental Task Force on Migration Statistics, which reported in December 2006:
"http://www.statistics.gov.uk/statbase/Product.asp?vlnk=14731"

It identified “increasing demand for estimates of short-term migration, that is people moving for less than 12 months. Such migrants use some local services, contribute to the economy, impact on labour supply, and are part of the consumer base”. Even the Governor of the Bank of England highlighted the problem in October 2006 year: “We do not know how big the population of the UK is…the statistics may not be that accurate”. “http://www.publications.parliament.uk/pa/ld200607/ldselect/ldeconaf/14/1403.htm”

Many local authorities are very aware of the recent influx of migrant workers in particular residential neighbourhoods, and have been making the case that their numbers need to be recognised when central government allocates its grants. Westminster and Slough Councils have been particularly active. The Audit Commission’s “Crossing Borders” report confirms the importance of migration, and the need for local intelligence to plan for population change. There can be no doubt that local population changes also have consequences for the water industry, in both water consumed and sewerage produced.

Current research and future plans

The ONS was already concerned about the quality of its Mid Year Estimates, and especially the measurement of migration, following the publication of statistics from the 2001 Census, which showed some marked discrepancies for particular age groups and in particular areas of the country. This, together, with the recent conspicuous in-migration from Eastern Europe, had led ONS to devote considerable research effort to improve more estimates, centred on the Improving Migration and Population Statistics Project (IMPS): “http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/default.asp”

The Greater London Authority also regards the issue as important, and has commissioned its own research: Estimating London’s new migrant population – review of methodology:
“http://www.london.gov.uk/gla/publications/refugees.jsp”

Short-Term Migrants – definition and measurement

ONS published a Short-Term Migration Feasibility Report in January 2007: “http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/Short-termMigrationFeasibilityReport.pdf”

ONS identified two particular issues: how short-term migration should be defined, and whether estimates are needed of migration moves or numbers of migrants.

The starting point for estimating short-term migration is the identification of a suitable definition. Central to this is the need to distinguish between a visitor and a migrant. While a stay of one day might be assumed to be a visit, and one of twelve months indicative of migration, lengths of stay between these points may be more difficult to categorise. Related to this, it is also unclear which reasons for visit should be defined as migration. A short-term migration definition should therefore include criteria that take account of both length of stay and reason for visit.

The UN Definition of a Short-term Migrant is: “A person who moves to a country other than that of his or her usual residence for a period of at least 3 months but less than 12 months except in cases where the movement to that country is for purposes of recreation, holiday, visits to friends and relatives, business, medical treatment or religious pilgrimage”.

A distinction is made by ONS between measuring ‘migrant moves’ and ‘migrants’. Migration estimates may refer to either the number of moves made by all individuals (migrant moves) or the number of people who move in a specified time period (migrants). The distinction is particularly important when estimating short-term migration annually. An individual can only be a long-term migrant by definition once in a 12-month period. In contrast a person could be a short-term migrant more than once over the same period, for example moving twice for 3 months on each occasion. The ONS paper focuses on migrant moves rather than migrants, as it is difficult to link successive moves in cross-sectional surveys.

Measurement of migration can be made either in terms of flows (migrant moves) or stocks (migrants present at a given time). In order for stock estimates to be made from information on flows, estimates of both arrival and departure dates are required. It is not possible to produce stock estimates of long-term migration using flow data, as there is often no defined end-point to the move, the change of residence being permanent. In contrast, short-term moves all have defined end-points, which, by definition, are less than twelve months after arrival. As with any stock estimate, the point at which the estimate is made is very important.

In practical terms, this review suggests that NWL is interested in the numbers of recent migrants who are:

- Not included in the Mid Year Estimate definition of usually resident (for a year or more)
- Resident for 3 months or more
- Workers, and also their dependents

NWL’s need is for a snapshot estimate of the stock at a chosen point in time, rather than tracking each migrant move.

<u>ONS’s first estimate of the STM population – and an assessment</u>

ONS has very recently (October 2007) produced its first estimates of the short-term migrant population:
“http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/STM_Research_Report.pdf”
The ONS estimate there to have been only 43,000 Short Term Migrants in England and Wales in June 2005, with just 16,000 of these in Greater London.

These estimates are based on the International Passenger Survey (IPS), rather than administrative data such as National Insurance Numbers, and are widely regarded as implausibly low, given that in 2005/6 there were 235,640 NINo registrations of overseas nationals in Greater London alone.
ONS's method

The IPS is a large, multi-purpose port survey that collects information from passengers as they enter or leave the UK. In excess of 250,000 passengers are sampled each year, though only a small fraction of these are STMs (see below). The ONS report estimates both STM flows, and stocks (which are the focus of our interest).

The IPS is not designed to produce estimates for one point in time: the method developed by the ONS measures the total amount of time spent in an area by all STMs, expressed in years so to be equivalent to Long Term Migration estimates. These are supplemented by an average length of stay of STMs who entered in that year.

Assessment

The ONS report itself comments that "Initial comparisons between STM flows and administrative sources suggest that the IPS based estimates may be too low", and this view is shared by several commentators (including the Statistics Commission).

The IPS carried out in 2005 is a far from ideal source for estimating STMs for the following reasons:

- the sample frame omitted many ports of entry, particularly airports used by budget airlines, and coach travellers;
- the sample size of STMs was very small. Whilst 250,000 passengers were sampled in total, to quote the ONS's report, "the number of STMs sampled entering England and Wales was 120. The corresponding figure for outflows was 38". The sampling (standard) errors, which indicate how much the estimates are likely to differ from the true values because of random effects, are large, and the results have had to be scaled up enormously; and
- there are also doubts about response errors – people declining to take part in a voluntary survey, and also those who do, giving inaccurate answers (due to language difficulties, or deliberately).

ONS used "completed flow" IPS data to produce its estimates. Individuals were sampled at the end of their visit – but this would have missed those STMs who had yet to return.

To quote Professor David Rhind, Chair of the Statistics Commission, in his evidence to the Treasury Sub Committee Inquiry into Counting the Population (December 2007): "Sample surveys are not in general a satisfactory basis for measuring the movement of population into, out of, and around the country. National sample sizes cannot be large enough to give reliable local area information."

ONS is also investigating the potential value of supplementary data sources, and in September 2007 published a Review of the Potential Use of Administrative Sources in the Estimation of Population Statistics: "http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/admin.pdf"

This includes the Worker Registration Scheme (WRS) and National Insurance Numbers (NINos) as possible potential sources of local data. These are discussed in the next Section.

Short-Term Migrant Workers – potential sources and new estimates
Worker Registration Scheme (WRS)

Exploring other possible sources of information about migrant workers, one such source is the Worker Registration Scheme (WRS), an administrative system which enables the compilation of real counts of individuals (not estimates based on a sample survey). To quote the Home Office website's advice to applicants:

"From May 1 2004, most nationals of the new member states (except Cyprus and Malta) who wish to work for more than one month for an employer in the UK need to register under the Worker Registration Scheme. Once you have been working legally in the UK for 12 months without a break you will have full rights of free movement and will no longer need to register on the Worker Registration scheme. You can then get a residence permit confirming your right to live and work in the UK."
"http://www.workingintheuk.gov.uk/working_in_the_uk/en/homepage/schemes_and_programmes/worker_registration.html"

Origin	Home Office, Department for Work & Pensions, HM Revenue & Customs, Communities and Local Government
The file – its purpose and derivation	Permission for A8 nationals to work
Definition – the population recorded	Applications from A8 May 2004 to Sept. 2007 Omits self-employed There is no de-registration – some will have returned home
Variables of possible interest	Nationality Age & Sex Dependants Occupation Hours & wages Temporary / Permanent Employment Employer's location Intended length of stay
Coverage: Number of records	2004: 125,880 2005: 204,955 2006: 227,865 Total UK: cumulated (NB) to 558,700 (inc. 360,840 Polish) by end 2006. Numbers for the first 3 quarters of 2007 are broadly similar to 2006.
Geographical level	Location is that of the employer (NB) "Regions" reported are misleading (based on postal areas) – but records are postcoded, and can be aggregated to other geographies such as LAs
Frequency of supply, and timeliness	Quarterly
Background documents / metadata	HO/DWP/HMRC/CLG: Accession Monitoring Report May 2004 – September 2007 "http://www.bia.homeoffice.gov.uk/sitecontent/documents/aboutus/accession_monitoring_report/"

The WRS statistics are of interest in that they are true counts based on administrative records. Professor Tony Champion has pointed to their use by the Centre for Urban and Regional Development Studies (CURDS) for the Department of Communities and Local Government (see Appendix 2). However, the drawbacks include:

- Measurement of registrations (but not de-registrations)
- Only include in-migrants from the 8 Accession countries
- Exclude the self-employed
- Location of employer, rather than residence of worker
- Data from WRS will not be available after 2009

National Insurance Number registrations (NINos)

National Insurance Number registrations (NINos), like WRS, are based on administrative records, but they have some distinct advantages.

Origin	DWP & HMRC
The file – its purpose and derivation	National Insurance Number for in-migrants – for employment and self-employment (and benefits – a small %)
Definition – the population recorded	Applications and also Registrations Some time lags There is no de-registration – some will have returned home
Variables of possible interest	Nationality Age & Sex Home address
Coverage: Number of records (UK)	2002/3: 349,200 2003/4: 370,700 2004/5: 439,700 2005/6: 662,390 2006/7: 713,450
Geographical level	Location is home address (NB) at time of application. Statistics are available for LAs
Frequency of supply, and timeliness	Quarterly
Background documents / metadata	National Insurance Number Allocations to Overseas Nationals entering the UK (previously Migrant Workers Statistics) "http://www.dwp.gov.uk/asd/asd1/niall/nino_allocation.asp"

NINos again only record new registrations (and not de-registrations), but do have several advantages:

- Include almost all A8 workers registered for WRS
- Include in-migrant workers from all countries of origin (who are probably less likely than A8 immigrants to come for only a few weeks)
- Include the self-employed
- Location of residence (at time of application), rather than employer
- Pioneering analysis of NINo statistics was carried out by Professor John Stillwell (University of Leeds) in 2006, and more recently Gill Green in the Audit Commission's "Crossing Borders" report:

"http://www.audit-commission.gov.uk/reports/NATIONAL-REPORT.asp?CategoryID=&ProdID=05CA5CAD-C551-4b66-825E-ABFA8C8E4717"

The NINo statistics list countries of origin in great detail. At UK-level, of the 713,450 registrations in 2006/7, the most frequent origin was Poland with 222,760 (31%), but the next were India (49,330), Slovakia (28,840), Pakistan (25,320) and Australia (24,400), confirming that NINos have much more extensive coverage than the WRS.

NINos may have a further advantage in the longer term in presenting the possibility of longitudinal analysis of the start and end dates for payment of National Insurance: this is currently being investigated by ONS, Department of Work and Pensions, and HM Revenue & Customs in the context of the wider Work and Pensions Longitudinal Study (WPLS): "http://www.dwp.gov.uk/asd/longitudinal_study/ic_longitudinal_study_uses.asp"

Unconventional sources – possible pointers and cross-checks

Given the volume and importance of migration, and the difficulties of measurement, there is widespread agreement amongst experts that it is necessary to draw on a variety of partial data sources in order to build up plausible estimates of numbers. The ONS itself mentions the importance of "triangulation", comparing the results of several estimates from different sources.

Traditionally, sample surveys have been important, and administrative files are becoming more so, but intelligence may also be gained from local authorities, and less orthodox sources such as embassies (the Polish ambassador has been as saying there could be as many as 600,000 of his countrymen in the UK), travel volumes (coaches, flights), and church attendees.

Anecdotal evidence of local concentrations of particular migrant communities is widespread, and, whilst difficult to assess in relation to NINo registrations in major conurbations, may be easier to evaluate in smaller towns and cities.
Recommended approach – NINos as a proxy for "Short Term Residents"

Although there is an understandable interest in the flows of Short-Term Migrants, this is a means to an end – for population purposes NWL needs to provide a plausible estimate of the stock of such people resident at any one time (for example 30 June or, ideally for the water industry, 31 October). In the absence of any official short-term migrant or resident statistics for small areas from ONS at the moment, NINos provide the best available basis for an informed estimate. NINos record only registrations, not departures, and do not yet provide the demographer's "holy grail" of recording both stocks and flows – but they do give some good data to work with.

Rather than treating NINos as a precise count, it is recommended that they are used as a proxy, using a chosen percentage which makes judgements about:

Likely length of stay

At the extremes, some will stay less than 3 months, and others more than a year (and should be included in the Mid Year Estimates – but see below). There will also be multiple visits, especially by young Eastern Europeans who arrive, register for NI and work for a few weeks, go home, and then return to work again using their established NINo. It seems reasonable to assume that

at least half the people who register for a NINo in any year are in the United Kingdom for more than 3 months.
NINos only record registered workers – not the whole short-term population. They omit dependents, and no doubt people who don't choose to register and pay National Insurance. Both – especially the latter – are likely to add very significantly to the short-term population present at any one time. This is particularly the case with people from Bulgaria and Romania, who are free to enter the country, but who face limits on the numbers who can work officially. NINos totals should therefore be treated as a proxy for a bigger population (rather than a precise count).

Legitimate concerns that the unprecedented recent flow of in-migrants is not accounted for by ONS in its estimate of Short Term Migrants (here for 3-12 months), nor classified as Residents (>12 months). When asked "How can we measure the transition of NINo registrants who stay in the country more than 12 months, thus becoming residents?" an ONS expert responded, very reasonably, "That's the million-dollar question that we are all interested in."

Local evidence

There is much anecdotal evidence, and this can provide useful insights in some areas.

Estimates of Short-Term Residents for Essex, Suffolk, and Northumbria 2006/7

The tables overleaf show the numbers of people in the Essex, Suffolk and Northumbrian Water areas who registered for NINos in 2006/7 (and includes 2005/6 for comparison).

A great merit of NINos as a source is that they provide statistics down to Local Authority level. Looking at particular cases we can see Barking & Dagenham (3,120), Great Yarmouth (902), and Newcastle upon Tyne (4,530). As a starting point, it would be very reasonable to take just 50% of this total as an estimate of the number of registrants who are here at any one time. This would give figures (rounded to the nearest hundred) of:

Essex Water	6,100
Suffolk Water	800
Northumbrian Water	6,600

However, this would make no allowance for dependents, and those workers who choose not to register. We also need to take into account those who registered in the preceding year (the numbers for 2005/6 were, as we can see, similar) given the doubts that not all those who have stayed are included in the estimate of residents.

It could be plausibly argued that the NINo registrations for 2006/7 provide a reasonable proxy estimate of the total number of Short Term Residents actually present.

Even if we take only 75% of the latest year's count we still have (rounded to the nearest hundred):

Essex Water 9,200
Suffolk Water 1,200
Northumbrian Water 9,800

Given the range of local evidence and pointers from many Local Authorities, these estimates appear reasonable, and very probably on the low side.

Essex Water

Local Authority	**% of 2008 Population in Essex Water Area**	***NINOs 2005/6***	**NINOs 2006/7**	**2006/7 NINos scaled to Essex Water share**	Proxy: Assume 50% of Short Term	**Proxy: Assume 75% of Short Term**
Barking & Dagenham	100.0	*3200*	3,120	**3,120**	1,560	**2,340**
Basildon	100.0	*780*	820	**820**	410	**615**
Braintree	20.0	*730*	820	**164**	82	**123**
Brentwood	86.0	*370*	360	**310**	155	**232**
Castle Point	100.0	*110*	140	**140**	70	**105**
Chelmsford	100.0	*970*	980	**980**	490	**735**
Colchester	0.0	*1560*	1,450	**-**	-	**-**
Havering	100.0	*1100*	1,000	**1,000**	500	**750**
Maldon	100.0	*160*	180	**180**	90	**135**
Redbridge	46.0	*5320*	5,220	**2,401**	1,201	**1,801**
Rochford	100.0	*120*	130	**130**	65	**98**
Southend-on-Sea	100.0	*1370*	1,460	**1,460**	730	**1,095**
Thurrock	100.0	*1160*	1,540	**1,540**	770	**1,155**
Uttlesford	0.0	*520*	520	**-**	-	**-**
TOTAL				**12,245**	6,122	**9,184**

Suffolk Water

Local Authority	**% of 2008 Population in Suffolk Water Area**	***NINOs 2005/6***	**NINOs 2006/7**	**2006/7 NINos scaled to Suffolk Water share**	Proxy: Assume 50% of Short Term	**Proxy: Assume 75% of Short Term**
Great Yarmouth	96.0	*1130*	940	**902**	451	**677**
Mid Suffolk	26.0	*250*	240	**62**	31	**47**
South Norfolk	0.0	*290*	350	**-**	-	**-**
Suffolk Coastal	26.0	*740*	780	**203**	101	**152**
Waveney	100.0	*350*	370	**370**	185	**278**
TOTAL				**1,538**	769	**1,153**

Northumbrian Water

Local Authority	**% of 2008 Population in Northumbria Water Area**	***NINOs 2005/6***	**NINOs 2006/7**	**2006/7 NINos scaled to Northumbria Water share**	Proxy: Assume 50% of Short Term	**Proxy: Assume 75% of Short Term**
Alnwick	96.0	*110*	80	**77**	38	**58**
Berwick-upon-Tweed	92.0	*140*	170	**156**	78	**117**
Blyth Valley	100.0	*120*	150	**150**	75	**113**
Carlisle	0.0	*720*	810	**-**	-	**-**
Castle Morpeth	98.0	*80*	80	**78**	39	**59**
Chester-le-Street	99.0	*80*	70	**69**	35	**52**
Darlington	100.0	*400*	690	**690**	345	**518**
Derwentside	100.0	*290*	430	**430**	215	**323**
Durham	99.0	*470*	570	**564**	282	**423**
Easington	99.0	*110*	130	**129**	64	**97**
Gateshead	99.0	*730*	980	**970**	485	**728**
Hambleton	20.0	*340*	360	**72**	36	**54**
Hartlepool	0.0	*190*	200	**-**	-	**-**
Middlesbrough	100.0	*860*	990	**990**	495	**743**
Newcastle upon Tyne	100.0	*3920*	4,530	**4,530**	2,265	**3,398**
North Tyneside	100.0	*550*	590	**590**	295	**443**
Redcar & Cleveland	98.0	*160*	150	**147**	74	**110**
Richmondshire	3.0	*250*	560	**17**	8	**13**
Scarborough	0.0	*460*	610	**-**	-	**-**
Sedgefield	99.0	*100*	260	**257**	129	**193**
South Tyneside	99.0	*670*	810	**802**	401	**601**
Stockton-on-Tees	98.0	*500*	480	**470**	235	**353**
Sunderland	100.0	*1280*	1,440	**1,440**	720	**1,080**
Teesdale	97.0	*30*	60	**58**	29	**44**
Tynedale	95.0	*130*	200	**190**	95	**143**
Wansbeck	99.0	*70*	80	**79**	40	**59**
Wear Valley	98.0	*120*	150	**147**	74	**110**
TOTAL				**13,104**	6,552	**9,828**

Illegal Immigrants – recent research, published data, & an estimate for Essex
Estimates of Illegal immigrants are, as might be expected, very sketchy even at national level, but the case can be made that the Essex Water has a (smallish) percentage of the national total, which is concentrated in Greater London.

Illegal Immigrant Population – definition
The Home Office definition is:
“The illegally resident migrant population in the UK is made up of quite distinct categories. Broadly, these cover anyone who does not have valid leave to remain in the UK and include:

Illegal entrants (including Clandestine entrants and those using deception on entry by presenting false documents or misleading immigration officials)
Overstayers (those who have not left the UK after valid leave to remain has expired); and

Failed Asylum Seekers who do not comply with instructions to leave the UK, who are not appealing, or who have exhausted their rights of appeal (including those who abscond in the process)”
Source: Sizing the unauthorised (illegal) migrant population in the UK in 2001. Home Office, 2005:
“http://www.homeoffice.gov.uk/rds/pdfs05/rdsolr2905.pdf”
It should be noted that the ONS’s definition of its Mid Year Estimate usually resident population includes Failed Asylum Seekers.

<u>Recent research and estimates</u>

The House of Commons Home Affairs Committee report on Immigration Control (July 2006) confirmed the lack of definitive statistics on immigration:
“http://www.publications.parliament.uk/pa/cm200506/cmselect/cmhaff/775/775i.pdf”

Estimation of the illegal immigrant population faces many difficulties, and there have been very few attempts to do so

(1): Demographic Decisions in 2002 (for 2001) – for Greater London / Thames Water

Source	Demographic Decisions (for WRc & Thames Water)
Publication and date	Water Demand estimation: estimating the population of illegal immigrants (2002)
Inputs	Asylum seekers & Visitor switchers
Method	Cumulated; ratio used as a proxy for Illegals
Year	2001
Subnational	Greater London (GL as 85% of UK total; Thames 75% of GL)
Results	160,000-240,000 for the Greater London part of the Thames Water supply area (215,000-320,000 for Greater London)
Comment	Accepted by Ofwat for June Returns made by Thames Water

(2): Home Office in 2005 (for 2001) – for the UK

Source	Home Office (public report)
Publication and date	Sizing the unauthorised (illegal) migrant population in the UK in 2001 (2005) "http://www.geog.ucl.ac.uk/mru/docs/sizing_illegal_pop.pdf"
Inputs	Administrative records cumulated and compared with 2001 Census counts
Method	Residual Method – as developed in the United States
Year	2001
Subnational?	No
Results	UK (NB): 310,000 / 430,000 / 570,000 No more detail available on either countries of origin, or subregions of UK
Comment	Definition includes failed asylum seekers (part of MYEs).

(3): Migrationwatch's critique of the Home Office estimate
The campaigning organisation Migrationwatch produced a detailed commentary on the Home Office's estimates:
"http://www.migrationwatchuk.org/Briefingpapers/migration_trends/illegal_migrant_pop_in_uk.asp"
This made the case that the range in 2005 was 515,000 – 870,000 for the United Kingdom.

Observations on existing estimates

The estimate produced by Demographic Decisions, used a cumulative method, and was accepted as plausible by Ofwat.

The Home Office estimated a range of 310,000 – 570,000 in 2001 for the UK as a whole. Unfortunately, the Home Office total cannot be broken down to

give an estimate for regions such as Greater London. It's Immigration and Research Statistics Service has also confirmed that the numbers of Failed Asylum Seekers still present in 2001 are not available, so it is not possible to subtract these to conform to the ONS's definition used for the Mid Year Estimates.
However, the fact that the Home Office's estimate for the UK is approximately 50% higher than that of 215,000 – 320,000 for Greater London (which is thought to have the lion's share of illegal immigrants in the UK) produced by Demographic Decisions, supports the latter estimate as being plausible and reasonable.

The Home Office has confirmed that it has not done any further work on estimating the illegal immigrant population since its estimate for 2001. A variety of other experts – including Professor David Coleman at Oxford University (who also advises Migrationwatch) – have confirmed that this is the case.

Updating since 2001, and an estimate for Essex Water

The Home Office's method depended on comparing administrative records with totals from the 2001 Census – so this cannot be repeated until the next Census in 2011. Given that Demographic Decisions' 2001 estimate for Greater London was compatible with that produced by the Home Office, the recommended approach is to roll forward the Demographic Decisions estimate for Greater London from 2001 to 2006 using new data available from ONS, and to then apportion a share to the London Boroughs which are in Essex Water's area.

Taking forward the 2001 estimate we have:

Stage 1 – ONS's estimates for Greater London – net new Asylum Seekers (including Refusals) and Visitor Switchers

Mid Year	Asylum Seekers	Visitor Switchers	Total
Total 1992 – 2001	320,900	112,700	433,600
Since 2001:			
2002	40,640	10,200	50,840
2003	28,750	7,770	36,520
2004	10,900	10,580	21,480
2005	6,580	12,330	18,910
2006	3,160	11,260	14,420
Sub Total	90,030	52,140	142,170
Total	410,930	164,840	575,770

(Source: ONS Estimates Unit – revised figures, November 2007)

Stage 2 – Take ONS's estimates of Asylum Seekers and Visitor Switchers as proxies for Clandestines and Overstayers in Greater London

Taking Asylum Seekers and Visitor Switchers as proxies, we can take a range rather than produce a single estimate of the additional illegal population of Clandestines and Overstayers in 2006:
Higher estimate: Rather than assuming a ratio of one for one, even assuming 75 Clandestines and Overstayers for every 100 Asylum Seekers and Visitor Switchers, we have 432,000.
Lower estimate: Assuming a ratio of only 50:100, we still have 288,000
Mid-point estimate: 360,000. This appears a realistic estimate for Greater London in 2006 when compared with the Home Office's upper estimate of 570,000 for the UK as a whole for the year 2001.

Stage 3 – Estimate Essex Water's share of Greater London
Using the same definition of the Essex Water area in terms of Local Authorities (see Section 5 above), the area includes the London Boroughs of Barking & Dagenham (100%), Havering (100%), and 46% of Redbridge. Expressing this in terms of ONS's latest 2006 Mid Year Estimates, this amounts to 6.8% of Greater London's population.

If this percentage were to be simply applied, we would have the following estimates: Higher estimate: 29,000; Lower estimate: 19,600; Mid-point estimate: 24,000.

However, evidence from the 2001 Census shows that people born overseas are not distributed evenly throughout the London Boroughs. The outer boroughs usually have lower proportions, and the three London Boroughs in the Essex Water area accounted for 2.87% of Greater London's overseas-

2001 Census	**All People**	**People born in other EU Countries**	**People born elsewhere**	**All EU + Elsewhere**
London				
Barking and Dagenham	163,944	1,358	15,267	16,625
Havering	224,248	1,432	8,480	9,912
Redbridge	238,635	3,078	50,742	53,820
Greater London	**7,172,091**	219,763	1,565,856	**1,785,619**
Essex Water shares				
Barking and Dagenham (100%)	163,944	1,358	15,267	16,625
Havering (100%)	224,248	1,432	8,480	9,912
Redbridge (46%)	109,772	1,416	23,341	24,757
Total Essex Water in GL	**497,964**	4,206	47,088	**51,294**
Essex as % GL				**2.87%**

born population

Applying this percentage we have the following estimates:

Higher estimate: 12,400
Lower estimate: 8,300
Mid-point estimate: 10,300

Conclusions and recommended further action

Business planning – the importance of population estimates

Accurate population figures are recognised as essential for business planning. They are of vital importance for NWL's Water Resources Management Plans, statistical returns to Ofwat, and to the Environment Agency. It is essential that they are the best available in order to assess company performance.
Ofwat's guidelines state that population figures should be consistent with the government's current estimates of mid-year resident population, but it will consider alternatives if they are based on sound evidence. Two populations lying beyond the definition of the resident population are short-term migrants who are in the country for between 3 and 12 months, and illegal immigrants.

Short Term Migrant population

This review makes the case that an estimate of Short-Term Migrants should also be added to the resident population for business planning purposes. During the last three years, there has been greatly increased public and political awareness about migration to the UK. Local Authorities in particular are very concerned about the consequences for providing services, and ONS has initiated a major research programme to develop improved information. The ONS's first estimates of the STM population – 43,000 in England and Wales in June 2005, with just 16,000 of these in Greater London – are widely regarded as implausibly low, and highlight doubts about the International Passenger Survey as a source of accurate migration statistics. In particular, they contrast with the total of 235,640 in-migrants who registered for a National Insurance number (NINo) in Greater London alone in 2005/6.
It is recognised that ONS is faced with a very difficult task: neither voluntary sample surveys of migrants, nor files of worker registrations provide a comprehensive picture, and they remain separate views. However, when seeking estimates of the STM population, counts of people who register in local areas have real attractions.

Rather than treating NINos as a precise count, it is recommended that they are used as a proxy, taking a chosen percentage which makes judgements about likely length of stay, and also the fact that they do not record the whole short-term population – they omit dependents, and no doubt people who don't choose to register and pay National Insurance. Both – especially the latter – are likely to add very significantly to the short-term population present at any one time. Taking only 75% of the 2006/7 count as a proxy we have: Essex Water (9,200); Suffolk Water (1,200; and Northumbrian Water (9,800). Given the range of local evidence and pointers from many Local Authorities, these estimates appear reasonable, and very probably on the low side.

Illegal Immigrant population

This report also makes the case that an additional Illegal Immigrant population should be added in the case of ESW.
Estimates of Illegal immigrants are, as might be expected, very sketchy even at national level, but the case can be made that the Essex Water has a (smallish) percentage of the national total, which is concentrated in Greater London.

Research by the Home Office estimated a range of 310,000 – 570,000 illegal immigrants in the UK in 2001. This was compatible with an estimate of 215,000 – 320,000 for Greater London (which is thought to have the lion's share of illegal immigrants in the UK) produced by Demographic Decisions. Updating the latter to 2006 gives an estimate of 360,000 for Greater London as a whole, which, if apportioned according to the distribution of London's overseas-born population at the 2001 Census, gives an estimate for ESW of 10,300.

Recommended further action

It is widely recognised that information about both the illegal immigrant and the short-term populations needs to be improved, and it is recommended that NWL has an active approach in continuously seeking both more robust new data sources, and also wider qualitative intelligence based on local observations.

The need for better information is of great importance to many organisations, and it is strongly recommended that NWL seek common cause with them. Such joint working needs to be active, setting up meetings, and potentially sharing data.

Other water companies are also interested in such generic matters as population definitions and possible sources of data, whilst Local Authorities are also seeking better information, and are in a position to draw on local data and intelligence. Contact with individual authorities should be pursued. There is also potential for funding collaborative projects, such as the Greater London Authority's proposal for a New Migrant Databank. Such joint initiatives, perhaps in alliance with the Local Government Association, are more likely to win general acceptance than solo research ventures.

The key sources:-
Mid Year Estimates – ONS
ONS’s website provides a variety of information about its population estimates at:
“http://www.statistics.gov.uk/StatBase/Product.asp?vlnk=601”
Definition:
“http://www.statistics.gov.uk/statbase/Product.asp?vlnk=601&More=Y”
Population estimates methodology is available at:
“http://www.statistics.gov.uk/about/data/methodology/specific/population/PEMethodology/”
A full account of ONS’s methodology for making a population estimate is given in:
“http://www.statistics.gov.uk/downloads/theme_population/Making_PopulationEstimate.pdf”
A shorter guide is provided by:
“http://www.statistics.gov.uk/downloads/theme_population/Short_Guide_revision_Nov_04_final.pdf”
Poster diagram:
“http://www.statistics.gov.uk/downloads/theme_population/PopEstimatesposter_28.09.06.pdf”
The Inter-departmental Migration Task Force Report:
“http://www.statistics.gov.uk/statbase/Product.asp?vlnk=14731”
Improving Migration and Population Statistics Project (IMPS):
“http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/default.asp”
(see especially the Revisions to estimates, July 2007)
Other estimates and projections – GLA, Experian
GLA 2006 Round Demographic Projections (December 2006):
“http://www.london.gov.uk/gla/publications/factsandfigures/dmag-briefing-2006-32.pdf”
Environment Agency / Experian. Methods of Estimating Population and Household Projections: Final Report (February 2007):
“http://publications.environment-agency.gov.uk/pdf/SCHO0207BLXO-e-e.pdf”

Short-Term migrants – ONS
Short-Term Migration Feasibility Report (January 2007):
"http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/Short-termMigrationFeasibilityReport.pdf"
Review of the Potential Use of Administrative Sources in the Estimation of Population Statistics (September 2007):
"http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/admin.pdf"
Research Report on Short Term Migration (October 2007):
"http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/STM_Research_Report.pdf"
Illegal immigrants and Short-Term migrants – other sources
Interest in both illegal immigrants and short-term migrants has developed rapidly over the last five years, and it can be helpful to list publications chronologically.

Date	Author	Title
2002 April	Demographic Decisions	Water demand estimation: estimating the population of illegal immigrants (for WRc / Thames Water)
2004 Nov	Home Office / Univ. College London	Sizing the illegally resident population in the UK "http://www.geog.ucl.ac.uk/mru/docs/sizing_illegal_pop.pdf"
2005 June	Home Office	Sizing the unauthorised (illegal) migrant population in the UK in 2001 "http://www.homeoffice.gov.uk/rds/pdfs05/rdsolr2905.pdf"
2005 July	Migration Watch	Illegal Migrant population in the UK "http://www.migrationwatchuk.org/Briefingpapers/migration_trends/illegal_migrant_pop_in_uk.asp"
2006 April	Institute for Public Policy Research	Irregular migration in the UK: "http://www.ippr.org.uk/publicationsandreports/publication.asp?id=446"
2006 June	Centre for Urban & Regional Development Studies (CURDS)	Assessing the Local and Regional Impacts of International Migration. (A research project for the department of Communities and Local Government) "http://www.ncl.ac.uk/curds/research/projects/project/1285"
2006 July	House of Commons Home Affairs Committee	Immigration Control. "http://www.publications.parliament.uk/pa/cm200506/cmselect/cmhaff/775/775i.pdf"
2006 September	Greater London Authority	Estimating London's new migrant population. Stage 1 – review of methodology "http://www.london.gov.uk/gla/publications/refugees.jsp"
2006 November	Slough Council	Migration works seminar "http://www.slough.gov.uk/mycouncil/articles/11421.asp"
2007 January	Audit Commission	Crossing Borders – responding to the challenges of migrant workers

		"http://www.audit-commission.gov.uk/reports/NATIONAL-REPORT.asp?CategoryID=&ProdID=05CA5CAD-C551-4b66-825E-ABFA8C8E4717"
2007 February	London School of Economics	Population mobility and service provision – a report for London Councils "http://www.londoncouncils.gov.uk/upload/public/attachments/997/LSE%20Population%20Mobility%20report%20-%20Feb%202007.pdf"
2007 July	Department for Work and Pensions	National Insurance Number Allocations to Overseas Nationals entering the UK (previously Migrant Workers Statistics) 2007 "http://www.dwp.gov.uk/asd/asd1/niall/nino_allocation.asp"
2007 October	Home Office / Dept for Work & Pensions / HM Revenue & Customs / Communities and Local Government	Accession Monitoring Report May 2004 – September 2007 "http://www.bia.homeoffice.gov.uk/sitecontent/documents/aboutus/accession_monitoring_report/" Details of the Worker Registration Scheme: "http://www.workingintheuk.gov.uk/working_in_the_uk/en/homepage/schemes_and_programmes/worker_registration.html"
2007 December	David Rhind, Chair, the Statistics Commission	Evidence to the Treasury Sub Committee Inquiry into Counting the Population: "http://www.statscom.org.uk/C_1233.aspx"

Sources – people & organisations

The following have been very helpful sources of information and advice for this report:

Organisation	Person	Telephone	Email / Website
Central Government			
Office for National Statistics	Jonathan Swan Kerry Cleave Peter Goldblatt	01329 813262 01329 813386 020 7533 5265	Jonathan.Swan@ons.gsi.gov.uk Kerry.Cleave@ons.gsi.gov.uk Peter.Goldblatt@ons.gov.uk
Home Office	Jo Woodbridge Tina Heath	020 8760 8112 020 8760 8323	Jo.Woodbridge@homeoffice.gsi.gov.uk Tina.Heath@homeoffice.gsi.gov.uk
Department for Work and Pensions	Martin McGill	0191 225 7661	Martin.McGill@dwp.gsi.gov.uk
Local Government			
Greater London Council	John Hollis	020 7983 4604	John.Hollis@london.gov.uk

Westminster Council	Damian Highwood	020 7641 3283	dhighwood@westminster.gov.uk
Audit Commission	Gill Green	020 7166 2782	g-green@audit-commission.gov.uk
Local Govt. Association	Richard Stokoe	020 7664 3225	richard.stokoe@lga.gov.uk
Academics			
Leeds University	Prof. Phil Rees Prof. John Stillwell	0113 343 3341 0113 343 3315	p.h.rees@leeds.ac.uk j.c.h.stillwell@leeds.ac.uk
Manchester University	Dr. Ludi Simpson	0161 275 4975	ludi.simpson@manchester.ac.uk
Newcastle University	Prof. Tony Champion	0191 222 6437	tony.champion@ncl.ac.uk
Oxford University	Prof. David Coleman	01865 270345	david.coleman@socres.ox.ac.uk
University College London	Prof. John Salt	020 7679 5525	jsalt@geog.ucl.ac.uk
Research & Lobbying organisations			
Institute for Public Policy Research			http://www.ippr.org.uk/
Migration Watch			http://www.migrationwatchuk.org/
Electronic Immigration Network			http://www.ein.org.uk/
Joint Council for the Welfare of Immigrants			http://www.jcwi.org.uk/
Refugee Council			http://www.refugeecouncil.org.uk/

[END]

APPENDIX B

WATER EFFICIENCY TARGET WATER SAVING AND COST INFORMATION

Activity 1

2007/8 activity plus self audit leaflet, hoseguns and timers distributed through meter surveys and by water quality samplers - 15500 visits to homes pa

Total water saved **0.24** Ml/day

Total costs of all activities **£150,429.00**

Cistern displacement devices (Save-a-flush)					
	devices fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
13100	devices requested by customer	0.1146	Ml/day saving achieved	£80,434.00	total cost
	devices mailed	0.0000	Ml/day saving achieved	£0.00	total cost
1000	devices distributed at events	0.0025	Ml/day saving achieved	£630.00	total cost
Waterbutts					
	units fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
500	units delivered through billing	0.0016	Ml/day saving achieved	£2,870.00	total cost
Retrofit WC devices (ecoBETA)					
	properties with devices fitted	0.0000	Ml/day saving achieved	£0.00	total cost
Taps					
	properties with tap aerators installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with Miracle tap adaptors installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with dripping taps repaired	0.0000	Ml/day saving achieved	£0.00	total cost
Aerated showerheads (Challis)					
	properties with showerheads installed	0.0000	Ml/day saving achieved	£0.00	total cost
Shower timers					
	properties requested timer specifically	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by post	0.0000	Ml/day saving achieved	£0.00	total cost
15500	shower timers distributed by event	0.0178	Ml/day saving achieved	£20,150.00	total cost
Gardens					
	properties requesting water storing crystals	0.0000	Ml/day saving achieved	£0.00	total cost
15500	properties water storing crystals mailed to	0.0004	Ml/day saving achieved	£7,750.00	total cost
	properties requesting hose guns	0.0000	Ml/day saving achieved	£0.00	total cost
15500	properties hose guns mailed to	0.0078	Ml/day saving achieved	£25,420.00	total cost
Self audits					
	packs distributed upon request	0.0000	Ml/day saving achieved	£0.00	total cost
15500	leaflet hand delivered	0.1085		£3,000.00	
Project Management				£10,000.00	

Activity 2

Self audits posted to 20% households pa

Total water saved **0.16** Ml/day

Total costs of all activities **£102,134.81**

Cistern displacement devices (Save-a-flush)

	devices fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
	devices requested by customer	0.0000	Ml/day saving achieved	£0.00	total cost
	devices mailed	0.0000	Ml/day saving achieved	£0.00	total cost
	devices distributed at events	0.0000	Ml/day saving achieved	£0.00	total cost

Waterbutts

	units fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
	units delivered through billing	0.0000	Ml/day saving achieved	£0.00	total cost

Retrofit WC devices (ecoBETA)

	properties with devices fitted	0.0000	Ml/day saving achieved	£0.00	total cost

Taps

	properties with tap aerators installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with Miracle tap adaptors installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with dripping taps repaired	0.0000	Ml/day saving achieved	£0.00	total cost

Aerated showerheads (Challis)

	properties with showerheads installed	0.0000	Ml/day saving achieved	£0.00	total cost

Shower timers

	properties requested timer specifically	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by post	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by event	0.0000	Ml/day saving achieved	£0.00	total cost

Gardens

	properties requesting water storing crystals	0.0000	Ml/day saving achieved	£0.00	total cost
	properties water storing crystals mailed to	0.0000	Ml/day saving achieved	£0.00	total cost
	properties requesting hose guns	0.0000	Ml/day saving achieved	£0.00	total cost
	properties hose guns mailed to	0.0000	Ml/day saving achieved	£0.00	total cost

Self audits

	packs distributed upon request	0.0000	Ml/day saving achieved	£0.00	total cost
		0.0000			
158724	leaflet posted	0.1587		£86,262.41	

Project Management £15,872.40

Measurement of Savings

Activity 3

h2eco Audit/Retrofit Project Completed in 5500 Properties pa

Total water saved **0.25** Ml/day

Total costs of all activities **£871,391.11**

Cistern displacement devices (Save-a-flush)

1734.7	devices fitted by ESW	0.0217	Ml/day saving achieved	£10,651.06	total cost
	devices requested by customer	0.0000	Ml/day saving achieved	£0.00	total cost
	devices mailed	0.0000	Ml/day saving achieved	£0.00	total cost
	devices distributed at events	0.0000	Ml/day saving achieved	£0.00	total cost

Waterbutts

3256	units fitted by ESW	0.0107	Ml/day saving achieved	£249,084.00	total cost
	units delivered through billing	0.0000	Ml/day saving achieved	£0.00	total cost

Retrofit WC devices (ecoBETA)

2101	properties with devices fitted	0.0483	Ml/day saving achieved	£65,215.04	total cost

Taps

1573	properties with tap aerators installed	0.0252	Ml/day saving achieved	£58,122.35	total cost
1323.3	properties with Miracle tap adaptors installe	0.0185	Ml/day saving achieved	£37,092.10	total cost
539	properties with dripping taps repaired	0.0065	Ml/day saving achieved	£17,830.12	total cost

Aerated showerheads (Challis)

777.7	properties with showerheads installed	0.0226	Ml/day saving achieved	£30,353.63	total cost

Shower timers

	properties requested timer specifically	0.0000	Ml/day saving achieved	£0.00	total cost
27500	shower timers distributed by post	0.0316	Ml/day saving achieved	£67,375.00	total cost
	shower timers distributed by event	0.0000	Ml/day saving achieved	£0.00	total cost

Gardens

3256	properties requesting water storing crystals	0.0003	Ml/day saving achieved	£3,711.84	total cost
	properties water storing crystals mailed to	0.0000	Ml/day saving achieved	£0.00	total cost
3256	properties requesting hose guns	0.0065	Ml/day saving achieved	£4,851.44	total cost
	properties hose guns mailed to	0.0000	Ml/day saving achieved	£0.00	total cost

Self audits

5500	packs distributed upon request	0.0550	Ml/day saving achieved	£4,959.53	total cost
		0.0000			

Project Management	£258,450.00
Measurement of Savings	£63,695.00

Activity 4

Subsidised Waterbutts to 5000 customers pa

Total water saved **0.02** Ml/day

Total costs of all activities **£78,700.00**

Cistern displacement devices (Save-a-flush)

	devices fitted by ESW	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	devices requested by customer	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	devices mailed	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	devices distributed at events	**0.0000**	Ml/day saving achieved	**£0.00**	total cost

Waterbutts

	units fitted by ESW	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
5000	units delivered through billing	**0.0164**	Ml/day saving achieved	**£78,700.00**	total cost

Retrofit WC devices (ecoBETA)

	properties with devices fitted	**0.0000**	Ml/day saving achieved	**£0.00**	total cost

Taps

	properties with tap aerators installed	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	properties with Miracle tap adaptors installe	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	properties with dripping taps repaired	**0.0000**	Ml/day saving achieved	**£0.00**	total cost

Aerated showerheads (Challis)

	properties with showerheads installed	**0.0000**	Ml/day saving achieved	**£0.00**	total cost

Shower timers

	properties requested timer specifically	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	shower timers distributed by post	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	shower timers distributed by event	**0.0000**	Ml/day saving achieved	**£0.00**	total cost

Gardens

	properties requesting water storing crystals	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	properties water storing crystals mailed to	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	properties requesting hose guns	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
	properties hose guns mailed to	**0.0000**	Ml/day saving achieved	**£0.00**	total cost

Self audits

	packs distributed upon request	**0.0000**	Ml/day saving achieved	**£0.00**	total cost
		0.0000			

Project Management

Measurement of Savings

Activity 5

Commercial/Institutional audits

Total water saved **0.0403** Ml/day

Total costs of all activities **£152,144.80**

Cistern displacement devices (Save-a-flush)

3000	devices fitted by ESW	0.0375	Ml/day saving achieved	£18,420.00	total cost
	devices requested by customer	0.0000	Ml/day saving achieved	£0.00	total cost
	devices mailed	0.0000	Ml/day saving achieved	£0.00	total cost
	devices distributed at events	0.0000	Ml/day saving achieved	£0.00	total cost

Waterbutts

	units fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
	units delivered through billing	0.0000	Ml/day saving achieved	£0.00	total cost

Retrofit WC devices (ecoBETA)

120	properties with devices fitted	0.0028	Ml/day saving achieved	£3,724.80	total cost

Taps

	properties with tap aerators installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with Miracle tap adaptors installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with dripping taps repaired	0.0000	Ml/day saving achieved	£0.00	total cost

Aerated showerheads (Challis)

	properties with showerheads installed	0.0000	Ml/day saving achieved	£0.00	total cost

Shower timers

	properties requested timer specifically	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by post	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by event	0.0000	Ml/day saving achieved	£0.00	total cost

Gardens

	properties requesting water storing crystals	0.0000	Ml/day saving achieved	£0.00	total cost
	properties water storing crystals mailed to	0.0000	Ml/day saving achieved	£0.00	total cost
	properties requesting hose guns	0.0000	Ml/day saving achieved	£0.00	total cost
	properties hose guns mailed to	0.0000	Ml/day saving achieved	£0.00	total cost

Self audits

	packs distributed upon request	0.0000	Ml/day saving achieved	£0.00	total cost
		0.0000			

Project Management £100,000.00

Measurement of Savings £30,000.00

Activity 6

ecoBETA retrofitting in 2,000 props pa

Total water saved **0.05** Ml/day

Total costs of all activities **£243,903.47**

Cistern displacement devices (Save-a-flush)

	devices fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
	devices requested by customer	0.0000	Ml/day saving achieved	£0.00	total cost
	devices mailed	0.0000	Ml/day saving achieved	£0.00	total cost
	devices distributed at events	0.0000	Ml/day saving achieved	£0.00	total cost

Waterbutts

	units fitted by ESW	0.0000	Ml/day saving achieved	£0.00	total cost
	units delivered through billing	0.0000	Ml/day saving achieved	£0.00	total cost

Retrofit WC devices (ecoBETA)

2000	properties with devices fitted	0.0460	Ml/day saving achieved	£62,080.00	total cost

Taps

	properties with tap aerators installed	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with Miracle tap adaptors installe	0.0000	Ml/day saving achieved	£0.00	total cost
	properties with dripping taps repaired	0.0000	Ml/day saving achieved	£0.00	total cost

Aerated showerheads (Challis)

	properties with showerheads installed	0.0000	Ml/day saving achieved	£0.00	total cost

Shower timers

	properties requested timer specifically	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by post	0.0000	Ml/day saving achieved	£0.00	total cost
	shower timers distributed by event	0.0000	Ml/day saving achieved	£0.00	total cost

Gardens

	properties requesting water storing crystals	0.0000	Ml/day saving achieved	£0.00	total cost
	properties water storing crystals mailed to	0.0000	Ml/day saving achieved	£0.00	total cost
	properties requesting hose guns	0.0000	Ml/day saving achieved	£0.00	total cost
	properties hose guns mailed to	0.0000	Ml/day saving achieved	£0.00	total cost

Self audits

2000	packs distributed upon request	0.0040	Ml/day saving achieved	£1,803.47	total cost
		0.0000			

Project Management	£116,150.00
Measurement of Savings	£63,695.00