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Water Efficiency in the South East of England

Retrofitting existing homes

Reference number/code GEHO0407BMNC-E-E

ea/br/e/std/v1

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Executive summary

We previously commissioned environmental and engineering consultancy Entec to assess the viability of different options for retrofitting water efficiency into existing homes in the South East. Entec was subsequently commissioned by the Environment Agency to undertake a more in-depth exploration of effective ways of increasing water efficiency in existing homes, building on the findings of the earlier study.

The objectives of the study were:

- to review the range of water efficiency measures identified in the previous study, *'Water Efficiency Analysis of South East England Rollout Options* (Entec, September 2005)';
- to review any other similar studies and assess whether to consider other measures;
- using the best options and the most up to date information, to assess the scope for reducing water use in existing homes;
- to consider the most effective ways of implementing the efficiency measures, for instance by linking with other ongoing programmes;
- using up to date information, to fully assess the costs and benefits and identify the pros and cons of these approaches.

Having identified and reviewed all potential demand management measures, five were selected for further analysis. These were:

- ultra low flush toilet replacement scheme
- variable flush retrofit devices
- low flow showers
- metering
- range of low water use fittings.

Potential strategies were identified and average incremental social costs (AISC) in pence per cubic metre and yield benefits in megalitres per day (Ml/d) were calculated. Results were calculated for:

- the total domestic housing population in the Greater London Authority (GLA) and the South East England Regional Assembly (SEERA).

and also as worked examples for three case study areas:

- all Housing Association households in the South East;
- a water resource zone with a tight supply-demand balance;
- typical population and demand of a medium sized water company in the South East.

These worked examples were assessed together with the South East of England as a whole to confirm that the results are realistic on a local scale.

Finally two implementation strategies consisting of combinations of schemes were assessed. This was to examine the savings that could be made by implementing water efficiency measures together as part of an overall strategy. Two combinations were explored:

- metering combined with variable flush retrofit devices and low flush replacement WCs;
- metering combined with low use fittings.

Results and conclusions

In general, the average incremental social costs of retrofitting water efficiency measures compare favourably with the costs of traditional resource development schemes.

The highest water savings come from the combined implementation strategies. Compulsory metering combined with fitting of variable flush retrofit devices and subsidising the end of life replacement of toilets with low flush models returns yields of **77.2 Ml/d (+/-25.3) for 136 p/m^3 (+/-39)**. The same scheme, but with metering on change of occupancy, can save **31.9 Ml/d (+/-10.5) for 115 p/m^3 (+/-30)**.

Savings from compulsory metering, combined with a range of low water use fittings, were just as high but cost more: **77.5 Ml/d (+/-25.8) for 162 p/m^3 (+/-49).** Low use fittings combined with metering on change of occupancy is estimated to save **22.4 Ml/d (+/-6.6) for 150 p/m^3 (+/-42)**.

Probabilistic modelling using a Monte Carlo simulation estimates that there is a 95 per cent chance of achieving savings of approximately **65 Ml/d** from each of the combined schemes when implemented with compulsory metering and a 75 per cent chance of achieving approximately **70 Ml/d**.

The relatively high savings from these schemes are based on the assumption that households switching to a metered supply will be more interested in water efficiency. Metering on change of occupancy may be more likely as compulsory metering currently depends on applying for water scarcity status.

Improving water efficiency in existing homes can offset increased demand in growth areas like Ashford and the Thames Gateway. Increase in demand caused by these growth areas is predicted to be around **50 – 70 Ml/d,** which is less than the potential demand management savings from implementation of combined strategies. The total increase in demand for the entire South East region is estimated to be approximately **160 Ml/d** by 2015. So, introducing the combined strategy measures in existing homes could reduce this increased consumption by almost **50 per cent**.

Individual, wide-scale schemes across the GLA and SEERA regions that could also achieve significant savings are:

- **compulsory metering – 51.6 Ml/d (+/-19.5) for 176 p/m^3 (+/-59)**
- **variable flush retrofit devices – 9.9 Ml/d (+/-2.5) for 102 p/m^3 (+/-19)**
- **low use fittings – 8.4 Ml/d (+/-2.0) for 113 p/m^3 (+/-20)**

The results show that water savings increase significantly with only a small increase in cost if full subsidies and free installation are provided as part of the 'package'. This is because greater incentives encourage more people to take up the schemes, which increases savings. Also, up front costs are discounted over the life of the scheme.

The implementation of individual demand management measures at a local level is likely to achieve limited savings. However, **compulsory metering** is estimated to provide useful savings in water resource zones with limited available resources, particularly if combined with water efficiency measures such as low use fittings or toilet replacement/retrofit. The combined implementation schemes can also achieve significant savings even at resource zone level.

Significant uncertainty remains around many of the inputs used for calculating scheme savings. This uncertainty will reduce as new and ongoing studies are completed creating higher confidence levels for the calculation of updated results.

Recommendations

1. Findings from new studies should be used to reduce the uncertainties associated with the savings from water efficiency measures to give more confidence in the outcomes of large-scale schemes.

2. Housing Associations could be valuable partners in the implementation of water efficiency programmes, because they own and maintain a large number of properties. Water companies should explore further the benefits of working with Housing Associations.

3. The effect retrofitting existing properties has on offsetting future demand from new homes should be explored further.

4. Practical delivery mechanisms and affordability issues should be considered in more detail when assessing specific strategies.

5. Options to manage demand not considered in this study should be taken into account as new information becomes available.

Contents

1. Introduction

1.1 Background

A previous study by Entec[1] assessed the viability of different options for retrofitting water efficiency into existing homes in the South East. This was a high-level study that compared the average incremental social costs and benefits, in terms of volume of water saved, of six water efficiency schemes that targeted all households or just the social housing sector.

The results of this study found that metering on change of occupancy and ultra low flush WC schemes led to the greatest water savings, with savings estimated at 14-29 Ml/d and 9-27 Ml/d respectively. Combining these two schemes was most likely to achieve the greatest savings, as metered households would be more likely to take up the ultra low flush WC scheme because of the financial incentive to save water. You can find further details of the results of this study in Appendix 1 of this report.

We then commissioned Entec to examine in more in-depth effective ways of increasing water efficiency in existing homes, building on the findings of their earlier study.

The South East of England has some of the highest per capita consumption values in the UK, both measured and unmeasured. The Government's Sustainable Communities programme assumes that approximately 550,000 new houses will be built in the South East by 2016[2]. Even if new houses are built to the standards proposed by the Code for Sustainable Homes, the extra demand will increase the pressure on water resources in the South East, where the current population density already means that, per person, there is relatively little water available.

One way of reducing overall demand is to make the existing homes more water efficient. A study[3] we commissioned shows that basic retrofit technology could reduce consumption in an average household by 49.3 litres per day, or approximately 14 per cent of typical domestic consumption. We want to use the information we have available to develop real life scenarios for implementing effective wide-scale water efficiency programmes that can save significant amounts of water in existing homes.

1.2 Objectives

The study set out the following five objectives:

- to review the water efficiency measures identified in the previous study, *'Water Efficiency Analysis of South East England Rollout Options'* (Entec, September 2005);
- to review any other similar studies and assess whether to consider other measures;
- using the best options and the most up to date information, to assess the scope for reducing water use in existing homes;
- to consider the most effective way of implementing efficiency measures, for instance by linking with other ongoing programmes;
- using up to date information, to fully assess the costs and benefits and identify the pros and cons of these approaches.

1.3 Report outline

Section 2 describes how all potential demand management measures were identified, reviewed and selected schemes for further analysis.

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[1] 'Water Efficiency Analysis of South East England Rollout Options, 2005' Entec UK Ltd

[2] Estimated based on work carried out for our reports to SEERA and the GLA 'Response to latest South East plan housing provision and distribution received from SEERA (May 2006)' and 'Housing growth and water supply in London, 2005 to 2026 (November 2005)'

[3] 'Retrofitting sustainability in new homes – The financial and environmental costs and benefits (Draft), 2006' Environment Agency

Section 3 identifies potential strategies and the areas in which these could be targeted.

Section 4 provides an assessment of each strategy, while Section 5 applies each strategy to worked examples.

Section 6 examines the combination of schemes and considers affordability implications. It also considers how retrofit schemes can help to offset increased demand from new development and how they can be implemented.

Sections 7 and 8 present the conclusions and recommendations of this study.

2. Retrofit options

2.1 Review of available information

We have carried out a full review of previous studies to identify different demand management measures, implementation strategies and the savings they could bring. The review has also helped to highlight the limitations of implementing certain measures and where there is a lack of information to work out the costs and potential savings. This is important when selecting options that could bring significant and long-lasting savings.

2.1.1 UKWIR project 'Sustainability of Water Efficiency Measures' (06/WR/25/2)

The UKWIR WR25B website has been produced by WRc as part of the UKWIR project, *Sustainability of Water Efficiency Measures (06/WR/25/2)* to share and develop further information on water efficiency measures. When this report was produced there were over a hundred projects that could be analysed.

2.1.2 Other relevant information

We also reviewed the following reports as part of this project:

- Energy Savings Trust, 2006 (Draft) *Review of Sustainability of Existing Buildings Scoping Study: Improving the Energy Performance of Existing Homes*.
- Environment Agency, 2006 (Draft) *Review of Sustainability of Existing Buildings: Improving Water Efficiency*.
- Environment Agency, 2006 (Draft) *Retrofitting Sustainability in Homes – The Financial and Environmental Costs and Benefits*.
- Environment Agency, 2006 (Final Draft) *Marketing Strategies to Promote Retrofitting Behaviour.*
- Hooper, B, 2006 *Promoting Water Efficiency – The Work of the Water Companies*'
- Sustainable Development Commission, July 2005 *Sustainable Buildings – The Challenge of the Existing Stock*.

2.1.3 Conclusions of literature review

The review provides a comprehensive list of demand management measures, which can be screened and analysed further. However, the limited sample sizes for many of the studies are a particular issue, making it difficult to apply the results on a larger scale. This is reflected in the large uncertainty of some of the options we describe further in this report.

Section 2.2 describes the potential demand management measures and the screening process.

2.2 Identifying potential demand management measures

To make sure that the proposals for retrofitting demand management measures in the South East are sound, we considered a wide range of possible measures. A list of all relevant measures has been identified from the UKWIR *Sustainability of Water Efficiency (06/WR/25B)* project and the literature review. These are as follows:

- cistern displacement devices
- rainwater harvesting
- water butts
- greywater recycling
- water audits
- water efficiency promotion / publicity
- variable flush retrofit devices
- low flush replacement toilets
- low flow showers
- pressure control
- metering
- sophisticated tariffs
- taps
- point of use water heaters
- flow regulation
- water efficient garden irrigation

We have screened this list of measures to produce a shortlist based on three criteria:

- the quality, extent and relevance of data to work out the costs and savings of each measure;
- the feasibility of implementing the measures;
- the potential for each measure to produce long lasting water savings.

Screening the measures involved scoring options according to the availability and quality of studies identified in the literature review, as well as using our own knowledge of how feasible the options are and the potential savings they could bring. Appendix 2 lists the results of the scoring.

Table 2.1 presents the results of this screening, with brief comments on each measure. Section 2.3 presents a more detailed assessment of the reasons for selecting or not selecting the measure.

Table 2.1 Summary results of list screening

Measure	Considered further?	Comments
Cistern displacement devices	No	Excluded because many people already have them and so there is limited potential for further savings.
Rainwater harvesting	No	Excluded because potential savings are uncertain.
Water butts	No	Excluded because many people already have them and so there is limited potential for further savings.
Greywater recycling	No	Excluded because potential savings are very uncertain.
Water audits	No	Excluded because of a lack of quality information.
Water efficiency promotion / publicity	No	Excluded because of a lack of quality information.
Variable flush retrofit devices	Yes	Selected because of quality information available, it could be successfully implemented and there is potential for significant savings.
Low flush replacement toilets	Yes	Selected because of quality information available, it could be successfully implemented and there is potential for significant savings.
Low flow showers	Yes	Selected because of quality information available and it could be successfully implemented.
Pressure control	No	Excluded because of lack of quality information.
Metering	Yes	Selected because of the potential for significant savings, it could be successfully implemented and bring benefits combined with other measures.
Sophisticated tariffs	No	Excluded because of lack of quality information.
Taps	Yes	Excluded as a stand alone option but selected as part of a ‘low use fittings’ suite because of quality information available and it could be successfully implemented.
Point of use water heaters	No	Excluded because of lack of quality information.
Flow regulation	No	Excluded because of lack of quality information.
Water efficient garden irrigation	No	Excluded because of lack of quality information.

2.3 Review of measures

2.3.1 Cistern displacement devices

We decided to exclude fitting of cistern displacement devices from the shortlist of measures because a large number of households in the South East already have them fitted and further benefits would be limited.

2.3.2 Rainwater harvesting

Rainwater harvesting is becoming more of a 'mainstream' option in new build schools, community centres and other similar buildings. It is less well advanced as part of domestic new builds, largely because the payback periods are long and there are maintenance issues. For retrofit systems, the installation costs are much greater, reducing the overall benefits. We have therefore not included rainwater harvesting in a shortlist of options.

2.3.3 Water butts

Water butts are effectively simple ways of collecting rainwater that provide non-drinking water for use outside. Evidence varies on how effective water butts are in reducing demand. The main factor that limits how effective they can be is that they only store a relatively small amount of water, which tends to be used quickly once rain stops before a prolonged dry period. Therefore the annual variation in rainfall patterns will significantly affect how effective water butts are in managing demand.

Water butts reduce peak demand, but are likely to have a limited effect. Large scale programmes would also have a limited effect because many people already have water butts, partly due to water companies in the area selling them at discounted rates. So, we have decided not to include water butts in a shortlist of options.

2.3.4 Greywater recycling

Greywater recycling remains a relatively little used method of managing demand, even in new builds. There are many issues associated with retrofitting greywater systems – the main ones are high costs and high maintenance. Our report[4] on recycling domestic greywater concluded that if greywater systems are to appeal to the general public, reliable systems that operate more or less on a 'fit and forget' basis are required to reduce the need for ongoing maintenance. Technology has improved since this report was published, although it is still questionable if current designs can be considered a reliable, cost effective and publicly acceptable solution.

We have not included greywater recycling for these reasons.

2.3.5 Water audits

Several water companies have carried out studies of the savings from water audits (either professional or domestic self-audits). These studies, including the 'Household Water Audits' project completed by Essex and Suffolk Water in 2002 that carried out audits in over 1,400 houses, do not provide convincing evidence that this type of scheme can achieve reliable savings on a long-term basis. We have not included water audits because on their own they do not generate enough savings.

2.3.6 Water efficiency promotion / publicity

We have not included promoting and publicising water efficiency as an option because there is a lack of evidence that it can result in reliable savings. Because of a lack of quality studies into the savings that this option could bring, the uncertainty levels would be unacceptably high.

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[4] *'A study of domestic greywater recycling, 2005'* Environment Agency

2.3.7 Variable flush retrofit devices

The variable flush retrofit involves fitting a small device to an existing, single flush toilet that allows it to flush with different amounts of water. Evidence from large-scale studies[5] suggests that implementing this scheme can bring noticeable savings. We have therefore chosen to consider this option further.

2.3.8 Low flush replacement toilets

We selected the low flush replacement toilet scheme as an option because there is strong evidence of the potential savings this technology could generate. As with the variable flush option, studies have shown the potential savings could be relatively large and cost effective.

2.3.9 Low flow showers

We believe the savings from the low flow shower option are relatively small. Despite this, we have chosen to consider the scheme further as previous studies suggest that the small amount of potential savings are reliable and could be achieved at low cost.

2.3.10 Pressure control

We have excluded the pressure control option because there has been a lack of quality studies carried out to date on its potential savings.

2.3.11 Metering

We have chosen to consider the metering option further. It has the potential to generate significant reductions in the demand for water, by providing customers with a price signal against which to compare consumption. It is important to note that the size of these savings is relatively uncertain. Metering also provides useful benefits, as it can encourage more people to take up other water efficiency measures offered at the same time.

2.3.12 Sophisticated tariffs

We have not included the sophisticated tariffs option because of a lack of quality studies into savings carried out to date. This could be significant, although further investigations are needed into how a tariff system can be designed before savings can be reliably estimated.

2.3.13 Taps

We have not included low flow taps as a stand-alone scheme because of the relatively low savings in homes. However, we have chosen to consider this option further as part of a 'low use fittings' suite.

2.3.14 Point of use water heaters

We have not included the point of use water heaters option because there has been a lack of quality studies carried out to date on its potential savings.

2.3.15 Flow regulation

We have not included the flow regulation option because there has been a lack of quality studies carried out to date on its potential savings.

2.3.16 Water efficient garden irrigation

Garden irrigation can account for a large proportion of the total amount of water used by households. However, we have not included reducing the amount of water used in gardens as an

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[5] 'Retrofitting variable flush mechanisms to existing toilets, 2005' Environment Agency, and 'The water efficiency of retrofit dual flush toilets, 2000' Southern Water

option because this could only generate savings during the summer months and so it is only relevant to demand at peak times.

2.4 Methodology

This section summarises the analytical process we used to compare the costs and savings from the schemes we chose to analyse further.

2.4.1 Overview

The savings and costs associated with implementing a water efficiency scheme fall into the following categories[6]:

- capex (£/annum) – capital expenditure during setting the scheme up;
- opex (£/annum) – operational costs when implementing the scheme;
- opex saving (£/annum) – the amount saved by not having to produce the water saved by the scheme;
- social cost (£/annum) – a measure of the costs associated with any disruption or damage caused by implementing the scheme;
- water saved (Ml/annum) - water saved due to scheme.

We calculated the annual cost/saving profile for each of these elements and used this to calculate the scheme average incremental social cost (AISC) in pence per cubic metre. We used the AISC and the water saving profiles in megalitres per day (Ml/d) to analyse and compare the scheme options.

Section 2.4.2 describes the method for calculating the AISC.

2.4.2 Calculating the average incremental social cost

To directly compare the scheme options, we calculated an AISC in p/m^3 for each scheme. AISCs have been developed as part of the water resource planning and are widely accepted by the water industry and regulators as the main method of comparing the costs and benefits of various schemes.

The AISC is calculated using the following formula:

$$AISC(p/m^3) = \frac{C + O + S - OS}{W * 10}$$

Where:

C = net present value of the capital expenditure (Capex) (£)

O = net present value of the operating cost (Opex), that is the cost of achieving or maintaining the water saving (£)

OS = net present value of the opex saving, that is the money saved by not producing the water saved by the scheme (£)

S = net present value of the social cost of the scheme (£)

W = net present value of the total water saved in megalitres (Ml)[7]

The net present value (NPV) of each element is defined as the sum of the annual costs/savings over 60 years, with future costs/ savings discounted at a rate of 5.5 per cent per year[8]. Although the nature of these schemes means that water savings spanning 60 years are unlikely, these figures are in line with our Water Resources Planning Guidelines. They allow us to make direct

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[6] We do not consider environmental costs in this study

[7] 1 megalitre = 1,000,000 litres = 1,000 m^3

[8] Discount factor for a given year = $1/(1+a^b)$
Where a = discount rate (0.055) and b = implementation year (1 to 60)

comparisons with demand management schemes that were investigated by water companies as part of the ‘AMP4’ water resource planning submission in June 2004.

For each scheme, an annual saving/spend ‘profile’ over the 60 year period was developed for each cost element as well as the potential water saving. This was carried out using MS Excel spreadsheet models developed by Entec UK.

It is very difficult to estimate the potential savings from water efficiency schemes, mainly because of uncertainties in the way people behave. We have used previous studies where possible, to be clearer about potential savings. We have also used the experience and knowledge of Entec and our own staff to reduce uncertainties, where possible.

2.4.3 Main assumptions

We did not make any allowance for population growth or new developments, as the aim of these schemes is to tackle water efficiency in existing homes.

We used a standard ‘current cost of water production’ of 10 p/m^3 when we estimated opex saving costs. This represents water costs in the South East.

We have not made any attempt to calculate the environmental benefits of these schemes, in terms of extra water made available for the environment. Although these schemes would undoubtedly generate these kind of benefits, this could only be assessed on a site-specific basis and this would not be a direct factor affecting our choice of water efficiency scheme.

For each of the selected schemes, implementing them with a full subsidy increases water savings with just a marginal increase in costs. This is because more people are likely to take up the schemes if they are subsidised. Whereas the cost is important, as long as it compares favourably with other alternatives, it is the volume of water saved that determines whether a scheme is recommended or not.

2.4.4 Example cost and savings calculation

This section provides a worked example for the variable flush retrofit device scheme. The example covers the steps carried out to calculate costs and savings for the scheme for total housing in the South East region under a selected implementation method.

Table 2.2 lists the data that has been used to calculate the costs and savings, and the range of uncertainty that has been added to certain data. This data relates to an implementation method that assumes the device is fully subsidised and includes free installation. The complete scheme results are provided in section 4.2 and the assumptions and variables that lie behind the data are listed in Appendix D.

Table 2.2 Input data

Description	Input	Uncertainty
Average water saving with scheme	24.7 litres per household per day	+/- 15 per cent
Number of unmeasured households	3,969,200	
Number of measured households	1,384,200	
Expected uptake (unmeasured)	20 per cent	+/- 10 per cent
Expected uptake (measured)	30 per cent	+/- 10 per cent
Saving decay rate	15 per cent	
Social cost associated with house calls	£3 per household	
Net present value discount rate	5.5 per cent	
Equipment and installation costs	£50 per household	
Customer recruitment costs	£2 per household	
Opex cost of water	£10 p/m^3	
Scheme implementation year	2007	
Number of years to complete	8 years	

Table 2.3 lists the costs and savings calculations based on the data in Table 2.2. These results are based on the lower range of uncertainty. For the final results presented in section 4.2, we made a second calculation to take account of the upper range of uncertainty, with the best estimate being the average of the two.

Table 2.3 Cost and savings calculations

Description	Calculation	Result
Number of devices fitted in total	Total households x uptake %	1,088,186 devices
Water available for use (WAFU) saving per year	Number of devices fitted x average water saving with scheme x 365.25	8328 Ml/a
Opex saving per year	WAFU saving x opex cost of water	£832,778
Capex cost of device / installation per year	Number of devices fitted per year x cost of device / installation	£6,801,150
Capex cost of customer recruitment per year	Number of customer contacts per year x customer recruitment costs	£1,338,350
Total capex	Cost of device / installation + cost of customer recruitment per year	£8,139,500

Table 2.3 (continued) Cost and savings calculations

Description	Calculation	Result
Capex cost of customer recruitment per year	Number of customer contacts per year x customer recruitment costs	£1,338,350
Total capex	Cost of device / installation + cost of customer recruitment per year	£8,139,500
Social cost per year	Number of devices fitted per year x social cost associated with house calls	£469,279
Number of installations needed per year to retain savings	Number of devices fitted in total x saving decay rate / number of years to complete scheme	20,403 installations
Opex cost of device / installation per year	Number of installations needed per year to retain savings x cost of device / installation	£1,020,174
Opex cost of customer recruitment per year	Number of customer contacts needed per year to retain savings x customer recruitment costs	£401,504
Total opex	Opex cost of device / installation + opex cost of customer recruitment	£1,421,678

The NPV of the cost and savings were calculated in an MS Excel spreadsheet as described in Section 2.4.2. These are as follows:

NPV of capex = £M 48.87

NPV of opex = £M 5.06

NPV of social costs = £M 2.52

NPV of opex savings = £M 4.35

NPV of WAFU = 43453.6 Ml

We then used these NPVs to calculate the AISC as described in section 2.4.2. The following calculation is based on the lower range of uncertainty:

$$AISC(p/m^3) = \frac{£M\,48.87 + £M\,5.06 + £M\,2.52 - £M\,4.35}{43453.6Ml * 100000}$$

AISC (p/m3) = 119.9

3. Identifying possible retrofit strategies

We identified strategies for implementing each of the chosen measures to manage demand regionally. We assessed these and compared them using the analysis method described in section 2.4. We also identified uncertainties over the costs and savings for each scheme and included these when calculating the results. Results have been presented as a range of costs in p/m^3 and savings in Ml/d. This allows us to compare different schemes and ways of implementing them, both with other measures to manage demand and with possible options to develop water resources in the future. The different ways of implementing each of the selected demand management measures were based on numbers of existing measured and unmeasured households in the total SEERA and GLA regions. Uptake rates by measured and unmeasured properties are expected to differ – metered customers have more incentive to save water. Assumptions on metered and unmetered uptake rates for each of the schemes are shown in the appendices. The final results have however, been presented as a sum of both measured and unmeasured households, as all implementation methods aim to target all households. This is because:

- it is likely to be uneconomic and impractical to target metered and unmetered households in the same area separately;
- schemes targeted at one or the other of these groups could be seen as unfair.

As well as calculating costs and savings for the total number of households in the South East of England, we also modelled the recommended implementation methods in three specific groups of housing as worked examples. This was to explore the impact that the best water efficiency measures could have on a local scale.

Finally, we modelled combination measures to look at how benefits could be maximised by combining different measures.

Sections 4, 5 and 6 provide a description and results of each of the steps described above.

4. Assessing regional strategies

This section provides details of the identified retrofit strategies and the potential implementation methods. Previous studies were used extensively to characterise and quantify the costs and water savings associated with each scheme, which have been applied to the Entec spreadsheet models used for calculating the scheme AISC. Appendices 3 to 7 list the data used for each scheme and the reference source upon which they are based.

We used the populations of the Greater London Authority (GLA) and the South East England Regional Assembly (SEERA) to calculate the costs and savings listed in sections 4.1 to 4.5 for each of the selected schemes. Data on household numbers and breakdowns were taken from water companies' 'PR04' final water resource plans (2004). Factors such as occupancy rates, appliance ownership rates and social housing numbers used to calculate scheme costs and water savings are therefore calculated from regionally specific data, which does not necessarily apply to other areas of England and Wales.

For each of the schemes, implementation with a full subsidy increases water savings with a marginal increase in costs because more people are assumed to take up schemes that are subsidised. Another general assumption made for all schemes is that saving water, and the effect this will have on their water bill (if measured), is a major incentive for customers to participate in the schemes.

Sections 4.1 to 4.5 list the main uncertainties associated with the assumed costs and savings of each scheme. As well as the uncertainties associated with the specific scheme, there is a number of general uncertainties, such as the costs of setting up the scheme and the cost of customer recruitment that surround each of the options.

AISC calculations can be used to compare the costs of different demand management and water supply schemes. Water supply option AISCs have not been compared in this report. It is difficult to do this generically, as AISCs may vary considerably even for similar types of developments depending on the size of the development and the local conditions. However, as a rough guide the following ranges of AISCs for types of water supply schemes have been estimated[9].

- new reservoir: 300 – 1000 p/m^3
- desalination plant: 400 – 800 p/m^3
- groundwater development: 100 – 500 p/m^3
- Surface water development: 100 – 500 p/m^3

Acceptance of responsibility' plans could be needed for each scheme to clarify who takes responsibility for customer complaints, maintenance and replacement if problems occur with the individual fittings.

4.1 Ultra low flush toilet subsidy

4.1.1 Implementation methods

The ultra low flush WC replacement scheme aims to reduce the amount of water used for flushing domestic toilets by subsidising the replacement of existing toilets (when they are due to be replaced) with an ultra low volume flush alternative. The modelled schemes were voluntary. The costs associated with the scheme do not include the cost of fitting the toilet, which the customer would be expected to cover anyway. The subsidy, the potential for saving water (and money in metered households) provide the incentive for the customer to choose this type of toilet over a regular flush design. We have calculated costs and savings for three subsidy options; no subsidy, £50 subsidy and full subsidy (£140 based on the cost of the WRAS approved Tribune CC suite. See Appendix 3 for details). On average, toilets are replaced every 16.5 years. Therefore, we have assumed that the scheme will run for 16.5 years.

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[9] Based on information submitted by water companies in their 2004 Final Water Resources Plans

4.1.2 Costs and savings

The costs and savings of the scheme are most strongly influenced by the level of subsidy modelled, which in turn influences the uptake rate. We have considered three levels of subsidy, each with a range of uncertainty. These levels, the savings and AISCs associated with them are as follows:

a) no subsidy = 1.0 Ml/d (+/-0.2) for 6 p/m^3 (+/-3)
b) £50 subsidy = 3.9 Ml/d (+/-0.6) for 20 p/m^3 (+/-2)
c) full subsidy = 6.3 Ml/d (+/-0.9) for 65 p/m^3 (+/-4)

These results show that including a subsidy means significant savings, with costs that are low when compared to other demand management schemes such as variable flush retrofit devices and metering. Appendix C shows the assumed uptake rates at each level of subsidy, and the summary of the data used to create these results.

4.1.3 Uncertainties

The main uncertainties associated with this option concern the uptake rates and savings resulting from implementing the scheme.

Uncertainty over the assumed savings for the ultra low flush toilet replacement scheme is not as high as for the other selected schemes. This is largely due to the fairly high confidence associated with the low flush technology. Once installed, these toilets are likely to work satisfactorily. The assumed number of flushes, the current estimated average toilet use and the assumed life of the device will, however, have an influence on calculating the savings the scheme could provide. We have therefore included an uncertainty of +/-five per cent around savings.

There is a great deal of uncertainty over uptake rates, as there is little information about actual subsidised low flush toilet replacement programmes. Uptake rates have a direct influence on savings and this needs to be considered further when assessing the potential impact of the scheme on the supply demand balance. We have estimated an uncertainty of +/-10 per cent for uptake rates.

4.1.4 Summary

Unlike retrofit schemes discussed elsewhere in this report, the low flush WC replacement scheme has the potential to provide long-term sustained savings as it replaces an asset already at the end of its life. It is also relatively effort free for those providing the scheme as the householders, who would have replaced the existing toilet anyway, take care of the fitting. No access is needed to the property and customer liaison is limited to publicising and administering the subsidy. Savings should therefore be guaranteed provided the new technology performs. (WRAS or similar certification of performance should guarantee this).

4.2 Variable flush retrofit devices

4.2.1 Implementation methods

The variable flush retrofit device scheme aims to reduce the amount of water used for flushing toilets in households with the older 9 and 7.5 litre siphonic cisterns where replacement of the whole toilet is not planned. These devices modify the existing single flush cisterns without having to replace the cistern or toilet itself. Once installed, the devices allow the option of two or more flush volumes.

It is estimated that 70 per cent of toilets would be suitable for fitting a variable flush device[10]. Two schemes were modelled: 1) providing and delivering free a fully subsidised variable flush device where the customer is responsible for installation, and 2) providing a fully subsidised variable flush device with free installation. The scheme life has been assumed as 10 years.

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[10] 'Water Efficiency Analysis of South East England Rollout Options, 2005' Entec UK Ltd

4.2.2 Costs and savings

Variations in the calculated costs and savings of the scheme are closely related to whether the scheme is implemented with or without free professional installation of the variable flush retrofit device. This is because free installation would affect how many people took up the scheme, which, in turn, would affect the costs and savings. The yields and AISCs of the two methods are as follows:

a) fully subsidised device without installation = 1.2 Ml/d (+/-0.3) for 157 p/m^3 (+/-39)
b) fully subsidised device including installation = 9.9 Ml/d (+/-2.5) for 102 p/m^3 (+/-19)

The analysis shows that it is more cost effective to implement the fully subsidised scheme, including free professional installation. The higher savings generated by increased uptake rates outweigh the extra installation costs. The result is a lower AISC than in the scheme without installation included.

Appendix 4 gives a summary of the data used to create these results.

4.2.3 Uncertainties

The main uncertainties associated with this option are associated with the uptake rates and savings generated by the scheme.

The uncertainties surrounding the savings have a large impact on the final results. A number of studies have been carried out on variable flush retrofit devices, although these have produced a range of different savings, which depend on factors such as occupancy, installation, quality of device and toilet usage patterns. Ongoing studies carried out on a large scale should reduce the uncertainties as these results become available. For the purpose of this report, we applied an uncertainty based on previous studies of +/-15 per cent to savings.

There is a great deal of uncertainty over uptake rates as there is little information about actual variable flush retrofit programmes. Uptake rates have a direct influence on savings and the assumed levels of uptake are therefore important when considering the scheme's potential impact on the supply demand balance. We have estimated an uncertainty of +/-10 per cent for uptake rates.

There is also uncertainty over other elements of the final cost benefit calculation for this scheme such as social costs, customer recruitment costs and the saving decay rate. However, the final results are not significantly sensitive to these elements.

4.2.4 Summary

A fully subsidised device, including free professional installation gives the best results. Uptake rates are likely to be much higher when free installation is included in the package. This significantly increases savings and reduces the AISC. Increased savings are therefore achieved at a lower cost per cubic metre.

Free fitting also overcomes the potential issue of incorrect installation, which is more likely to occur with DIY fitting. Professional fitting, together with an in situ demonstration of how to use the device, would avoid potential future problems and make sure the devices are used correctly. However, free installation is unlikely to prevent all future problems and there may be other issues to consider in terms of liability when devices malfunction.

4.3 Low flow showerheads

4.3.1 Implementation methods

This scheme consists of installing a low flow showerhead fitted to suitable existing showers to reduce the volume of flow per minute. Two implementation methods have been modelled; fully subsidised showerhead, including delivery without installation, and fully subsidised showerhead, including delivery and installation. An additional incentive apart from lower water bills is that, as 22 per cent of domestic energy is used for heating water, using less hot water will also reduce energy bills. The scheme life has been assumed as eight years.

4.3.2 Costs and savings

The yields and AISCs of the two methods are as follows:

a) fully subsidised device including delivery without installation = 0.4 Ml/d (+/-0.1) for 4 p/m^3 (+/-2);
b) fully subsidised device including installation = 0.8 Ml/d (+/-0.2) for 17 p/m^3 (+/-3).

Free installation increases costs more than savings. This is because, unlike retrofit variable flush devices, showerheads are easy to fit and the cost of providing free installation is considerable compared to the limited extra savings it generates. Appendix 5 gives a summary of the data used to create these results.

4.3.3 Uncertainties

The main uncertainties associated with this option are over the savings, uptake rates and cost of showerheads. There is a great deal of uncertainty over whether the savings can be sustained - the low flow showerhead can easily be replaced with a device that has higher flow rates. It is very important that the low flow showerheads chosen for retrofitting are well designed to prevent this from happening.

Showerheads can only be replaced on certain types of showers. Electric showers, power showers and low-pressure gravity fed showers are all unsuitable for installing a low flow showerhead, which restricts the potential uptake of the scheme (see Appendix 5 for further details). There is also inevitably some uncertainty over shower specific inputs that go in to calculating the average water saving. These include the average duration of a shower, number of showers taken per day and how much water the showerhead that is replaced uses. Although these figures on their own have little impact on the final results, together they can have a significant effect on the savings and costs of the scheme. We have therefore applied an uncertainty of +/-10 per cent to the average household savings of the scheme.

As with other schemes, there is significant uncertainty over uptake rates as there is little information about actual low flow shower retrofit programmes. Uptake rates have a direct influence on savings. We have therefore estimated an uncertainty of +/-10 per cent for uptake rates.

The cost of the device and installation (where included) has a significant influence on the AISC calculation for the scheme. Whereas the uncertainty surrounding this element is lower than for the assumed savings or uptake rates, (the cost of the device and the services of a plumber can be accurately estimated) future changes to these costs could have an influence. We have estimated an uncertainty of +/-2.5 per cent for this.

There is more uncertainly over other elements of the final cost benefit calculation for this scheme, such as costs associated with setting up the scheme and customer recruitment costs. However, the final results are not considered to be significantly sensitive to these elements.

4.3.4 Summary

The low flow shower scheme is expected to provide limited savings, but at very low cost. However, the scheme is worth considering in combination with other water efficiency measures such as low flow taps and variable flush retrofit devices (see section 4.5). Implementation without installation is more cost effective, but this may change if the showerhead is provided as part of a package of measures. Installing a low flow showerhead has the potential to generate modest savings that will continue as long as the device stays in place. Showerheads are easy to fit and to remove, and one that does not perform satisfactorily is likely to be changed, so the initial choice of a reliable device is important.

4.4 Metering

4.4.1 Implementation methods

Studies show that metering reduces consumption by raising awareness of water used in the home and providing a financial incentive to use less. However, it is recognised that this financial signal will often be relatively weak, as the unit cost and total cost of water services is generally very low compared to other household bills.

To assess the costs and savings associated with increased levels of metering, we have modelled two methods; metering on change of occupancy, and compulsory metering. The change of occupancy metering can be carried out by using water companies' billing systems. It has been estimated that approximately five per cent of unmeasured homes change occupancy every year. Compulsory metering would require, under current legislation, the relevant water companies to apply for water scarcity status. If granted, it is anticipated that up to 90 per cent of households could be metered over a period of ten years (based on Folkestone and Dover Water's successful application for water scarcity status).

The scheme life for metering on change of occupancy has been assumed as five years. The compulsory metering scheme is assumed to run for 10 years, as this is the length of time estimated to install meters in 90 per cent of households.

4.4.2 Costs and savings

There is a significant difference in the number of meters that could be installed using the two implementation methods (compulsory and on change of occupancy) and therefore the costs and savings of the two approaches are quite different. The benefits and AISCs are as follows:

a) metering on change of occupancy = 18.0 Ml/d (+/-7.4) for 163 p/m^3 (+/-55);
b) compulsory metering = 51.6 Ml/d (+/-19.5) for 176 p/m^3 (+/-59).

Compulsory metering has been estimated to increase savings by over 30 Ml/d compared with metering on change occupancy, with little difference to AISC. Considerably higher levels of metering can be reached within a ten year period under compulsory metering than under the five year scheme life assumed for change of occupancy metering. In practical terms, it is more costly to meter on change of occupancy, as the water company has little control over the metering programme. In contrast, compulsory metering would allow a water company to install meters *en masse*, and on an area by area basis, which would provide economies of scale. Appendix 6 gives a summary of the data used to create these results.

4.4.3 Uncertainties

The main uncertainties over the costs and savings of the two metering methods are associated with the expected water savings and, to a lesser extent, the annual meter installation rates.

Estimates of water savings from metering on change of occupancy have a large impact on the benefits of the scheme and consequently the AISC. There is uncertainty over this element, although these will be reduced as metering increases and the results of ongoing studies become available. For this study, we have based the assumed saving from metering on an average of the figures quoted in the 2004 water resource plans submitted by the companies in the South East. We have applied an uncertainty of +/-2.5 per cent to the average.

Meter installation rate depends on the type of implementation and may vary from area to area as well as over time, although the final AISC of the scheme is not significantly affected by this. We have applied an uncertainty of +/-10 per cent to installation rates of five per cent per year for the change of occupancy and +/-five per cent to installation rates of 8.5 per cent per year for compulsory metering.

4.4.4 Summary

It is estimated that metering can provide large, cost effective savings, although the range of uncertainty is significant. Both methods achieve significant, cost effective savings, with compulsory metering able to provide greater benefits. Both these options are more efficient ways of metering households than optant metering. However, change of occupancy metering can become expensive in areas where households are spread over wide areas, whereas for compulsory metering the water company has to secure water scarcity status.

4.5 Low use fittings

4.5.1 Implementation methods

The low use fittings option aims to reduce the amount of domestic water usage by providing householders with a range of water saving devices that are fitted professionally. Implementation would involve an installer calling at the house to assess the existing fittings and offering to install water efficient devices, where possible. There are several different options for reducing the amount of water usage. We have chosen the following options as a representative sample:

- flow restrictor for taps
- low flow showerhead
- variable flush retrofit device

We have modelled two implementation methods. Under the first the customer has to contribute towards the cost of the water efficiency devices and installation. The second is a fully subsidised scheme with no cost to the customer. Installation has been included for each of the implementation methods.

4.5.2 Costs and savings

The costs and savings for the low use fittings scheme are calculated by combining the potential savings from the three low use components and a cost estimate for the one off installation. The different implementation methods have a direct impact upon the costs and an indirect effect on the savings through the assumed uptake rates. The benefits and AISCs of the two implementation methods for all households in the SEERA and GLA regions are as follows:

a) low use fittings and installation with partial subsidy = 3.5 Ml/d (+/-0.8) for 89 p/m^3 (+/-18);
b) low use fittings and installation with full subsidy = 8.4 Ml/d (+/-2.0) for 113 p/m^3 (+/-20).

Including a full subsidy has been estimated to increase the uptake rate of the scheme, which results in considerably higher savings. The increased savings with this method outweigh the extra installation costs, resulting in a lower AISC than in the first implementation method, which achieves much lower savings.

Appendix 7 gives a summary of the data used to create these results.

4.5.3 Uncertainties

There is a great deal of uncertainty over this scheme because of the combination of three different water efficiency measures, for which cost and savings assumptions must be made.

For each of the fittings, we have included uncertainty over the potential savings. The final results are most sensitive to the uncertainty of savings from the variable flush retrofit device scheme because of the comparatively large savings this element contributes to the scheme as a whole (for details see section 4.2).

As with assessing the individual measures, we have included uncertainty surrounding uptake rates as +/-10 per cent.

4.5.4 Summary

The low use fittings scheme is worth pursuing especially when provided and fitted free of charge. This increases the uptake rate and consequently the water savings. The fittings themselves are inexpensive and the impact of the main cost of the scheme, installation, is reduced as all fittings can be installed during a single visit by a plumber.

5. Worked examples

The costs and savings results presented in section 4 assess the selected strategies on a regional level that covers all households in the South East of England. To check that these results are realistic on a local scale, we have applied the measures we discussed previously to three case study examples from the South East:

- a single water resource zone with a tight supply-demand balance;
- a typical population and demand of a medium sized water company;
- the households owned by Housing Associations.

We applied the selected water efficiency measures to the numbers of existing homes in each of the groups.

The single water resources zone is located in a part of the South East where the supply-demand balance is stretched due to increasing demand and lack of acceptable options to increase supply. We chose the medium sized water company to examine the impact water efficiency measures can have on a company-wide scale in the region. Finally, we chose the Housing Association households as Housing Associations can potentially help implement water efficiency schemes because they are responsible for large numbers of affordable housing.

It is important to note that in the worked examples the results may not be representative of specific local cost and savings, since we used the same assumptions as for modelling the regional results. In reality, these can differ depending on local circumstances.

5.1 Water resource zone example

The example resource zone we looked at has an average daily total demand of approximately 65 – 75 Ml/d, with a total of around 100,000 existing houses, approximately 30 per cent of which are metered. The rest of the assumptions and uncertainties are the same as those we applied to the South East region as outlined in Section 4. Figure 5.1 and Table 5.1 present the findings.

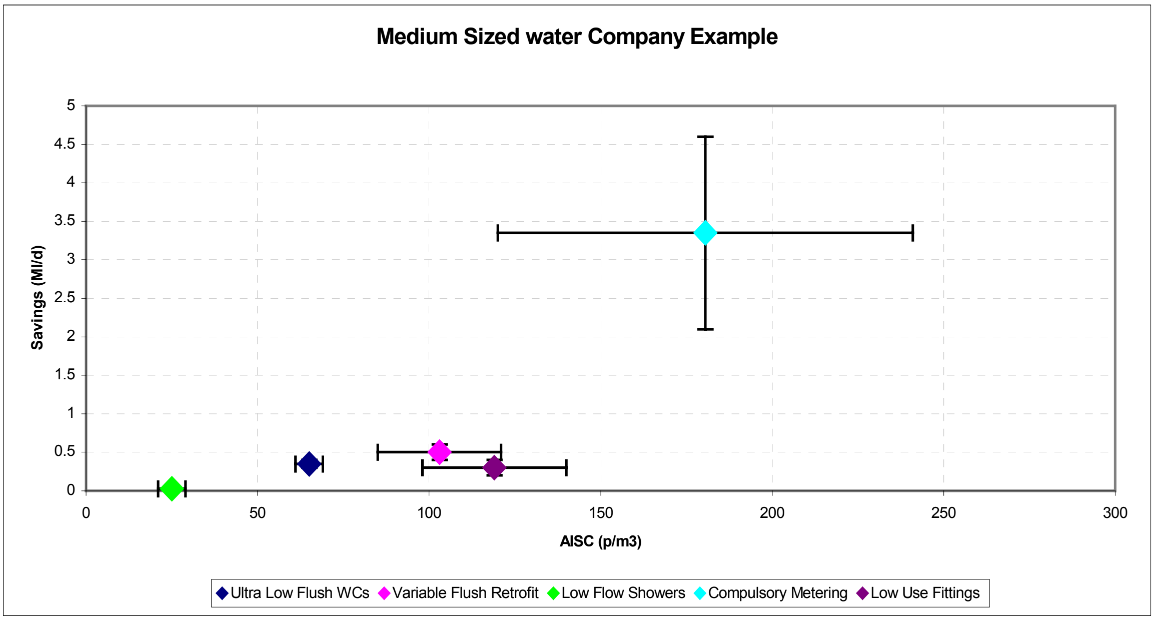
Table 5.1 Yields and AISCs for the selected water efficiency measures in the water resource zone example

Demand Management Measure	Implementation method	Benefit and AISC calculation
Ultra low flush WC replacement	Full subsidy	0.2 Ml/d (+/-0.1) for 66 p/m^3 (+/-5)
Variable flush retrofit device	Fully subsidised device including installation	0.2 Ml/d (+/-0.1) for 101 p/m^3 (+/18)
Low flow showerheads	Fully subsidised showerhead including installation	0.02 Ml/d (+/-0.01) for 32 p/m^3 (+/-6)

Table 5.2 Yields and AISCs for the selected water efficiency measures in the water resource zone example

Demand Management Measure	Implementation method	Yield and AISC calculation
Metering	Compulsory metering	0.9 Ml/d (+/-0.4) for 195 p/m^3 (+/-66)
Low use fittings	Low use fittings with full subsidy and installation	0.2 Ml/d (+/-0.1) for 114 p/m^3 (+/-21)

Figure 5.1



The results suggest that, at resource zone level, the savings from selected single demand management measures that are unlikely to have a major impact on the zone's supply-demand balance. Apart from possibly metering, AISCs for each option are low. However, when measures are introduced together, such as metering combined with low use fittings, schemes could have a notable effect on the supply-demand balance. Section 6 of this report examines these combinations of measures in more detail.

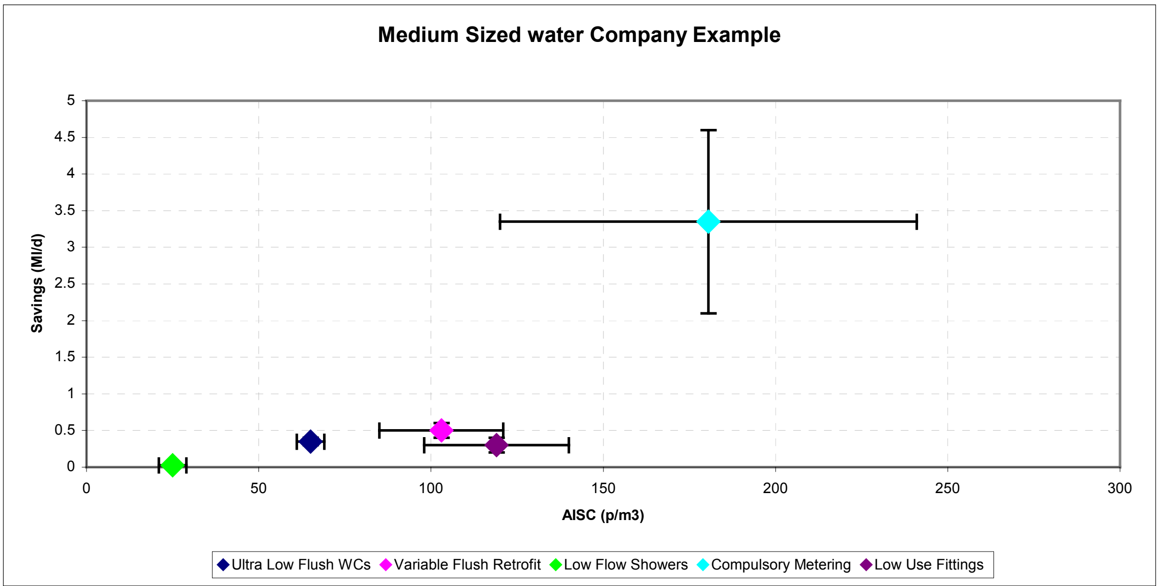
5.2 Medium-sized company example

The average total demand for the example company area is approximately 180 – 200 Ml/d. The calculated costs and savings in this section are based on a total of approximately 280,000 existing homes, with less than 10 per cent of them having meters. The rest of the assumptions and uncertainties are the same as those we applied to the South East region as outlined in Section 4. Figure 5.2 and Table 5.2 present the findings.

Table 5.3 Yields and AISCs for the selected water efficiency measures in the medium-sized company example

Demand management measure	Implementation method	Yield and AISC calculation
Ultra low flush WC replacement	Full subsidy	0.4 Ml/d (+/-0.1) for 65 p/m^3 (+/-4)
Variable flush retrofit device	Fully subsidised device including installation	0.5 Ml/d (+/-0.1) for 103 p/m^3 (+/-19)
Low flow showerheads	Fully subsidised showerhead including installation	0.03 Ml/d (+/-0.01) for 25 p/m^3 (+/-4)
Metering	Compulsory metering	3.4 Ml/d (+/-1.3) for 181 p/m^3 (+/-61)
Low use fittings	Low use fittings with full subsidy and installation	0.3 Ml/d (+/-0.1) for 119 p/m^3 (+/-21)

Figure 5.2



Savings in this example are low, but nevertheless highlight that a small reduction in consumption can be achieved at low cost. Furthermore, combinations of schemes are likely to result in increased savings. Section 6 examines these combinations of schemes in more detail. Calculated savings from the compulsory metering scheme show particular potential. This is largely due to the fact that the water company has currently only a small number of households with meters.

5.3 Housing Associations

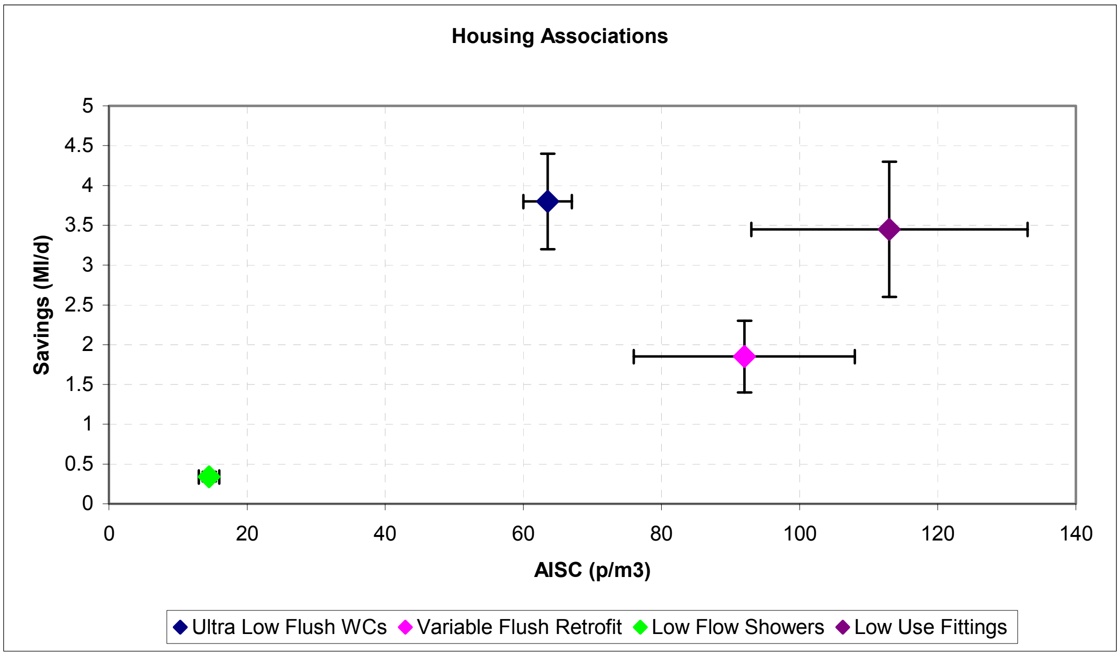
Housing Association households make up around 8.5 per cent of existing housing in the South East of England, a figure based on the average for London, Kent, Sussex and Hampshire. This is equal to approximately 455,000 households throughout the SEERA and GLA regions, with an average total demand of approximately 180 Ml/d. The costs and savings calculated in this section are based on existing houses within the South East and the measures assessed in Section 4 of this report. We have not shown results for the metering option as it would not be practicable or fair to meter just this housing sector. Figure 5.3 and Table 5.3 present the findings.

Housing Associations are responsible for maintaining large numbers of homes and generally have policies that address sustainable housing. Working with Housing Associations could therefore help address water efficiency as the Associations carry out large retrofit and replacement programmes. Water efficiency improvements could be a part of these, either as a one off installation programme, or gradually whenever access to households is required. Working together with local water companies should mean schemes such as variable flush retrofit devices, low flush toilet replacement and low flow fittings can be implemented in Housing Association and other Registered Social Landlord owned social housing fairly easily. Uptake rates are therefore assumed to be higher than in regular measured and unmeasured homes.

Table 5.4 Yields and AISCs for the selected water efficiency measures in Housing Association households

Demand management measure	Implementation method	Yield and AISC calculation
Ultra low flush WC replacement	Full subsidy	3.8 Ml/d (+/-0.6) for 64 p/m^3 (+/-4)
Variable flush retrofit device	Fully subsidised device including installation	1.9 Ml/d (+/-0.5) for 92 p/m^3 (+/-16)
Low flow showerheads	Fully subsidised showerhead including installation	0.3 Ml/d (+/-0.1) for 15 p/m^3 (+/-2)
Metering	Compulsory metering	N/A
Low use fittings	Low use fittings with full subsidy and installation	3.5 Ml/d (+/-0.9) for 113 p/m^3 (+/-20)

Figure 5.3



The results in Table 5.3 show that there is considerable scope to achieve large savings by implementing measures to manage demand within Housing Association households. Savings are likely to be even higher if different schemes were implemented together as Section 6 of this report explores. Water companies and Housing Associations would need to work closely together to maximise water efficiency, as well as the social benefits to tenants that would be important to Housing Associations. There are very few examples in the South East where this has happened. This seems to be due to a lack of communication between Housing Associations and water companies, and unanswered questions over who is responsible for maintenance or equipment failure. Better communication would solve these issues fairly easily. It is likely that, with water companies funding the devices, Housing Associations would be willing to accept responsibility for maintaining and replacing faulty installations.

6. Combined strategies

6.1 Background

This chapter examines the benefits of combining schemes in Section 4. Combinations of measures can be more effective than single measures, particularly if they are combined with metering. Customers who have recently had a meter installed are expected to be more interested in reducing the amount of water they use and therefore more open to offers to help them improve water efficiency. Based on findings described in previous chapters, we examined the following strategies in detail:

- metering combined with low use fittings;
- metering combined with variable flush retrofit devices and low flush toilet replacement.

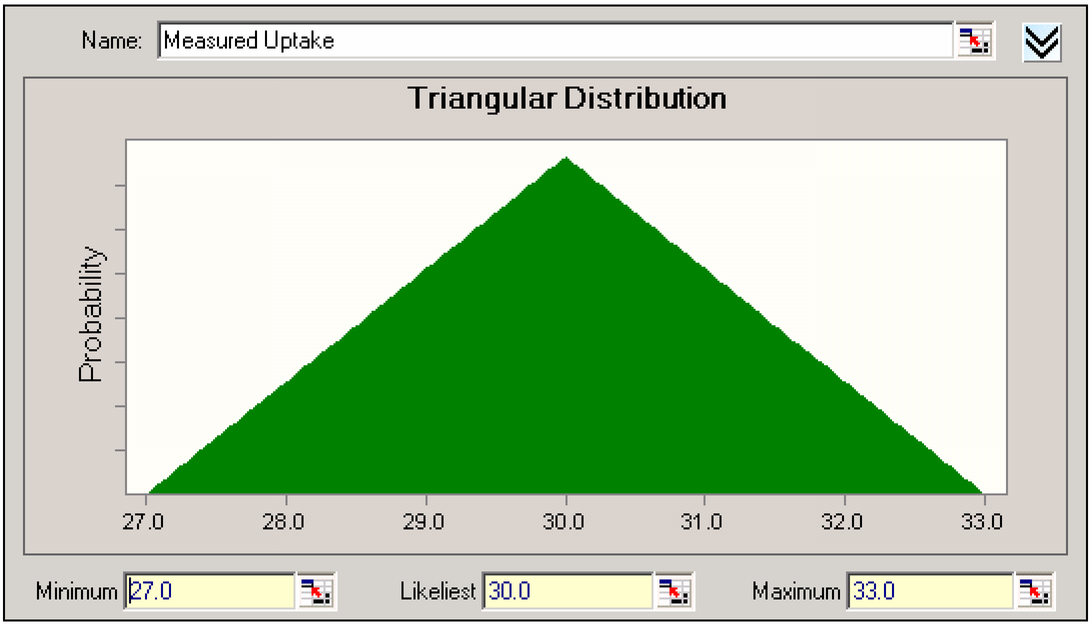
The impact that higher levels of metering have on the schemes is reflected in increased uptake rates which consequently increases savings. We have estimated an increase of 5 – 30 per cent over the unmeasured uptake rates depending on whether increased metering is due to a change of occupancy, or compulsory programme. Measured uptake rates remain the same, which accounts for existing measured housing.

We did not include metering on its own in the Housing Association example in section 5.3 because it would be impractical or unfair just to meter social housing. However, if metering is carried out on a regional or company scale, then working together with Housing Associations to retrofit their properties may provide measurable savings.

6.1.1 Crystal Ball analysis

We have also carried out further analysis on the results from combined strategies using the statistical package Crystal Ball. This software has been used to run a Monte Carlo simulation to assess the probability profile of the AISC and water savings of the combined water efficiency implementation strategies. Parameter inputs have been entered as a triangular distribution representing the uncertainty identified within each demand management measure that makes up the combined strategy. For example, if an input parameter has an associated uncertainty of +/- 10 per cent, the triangular distribution uses the best estimate figure for the most likely entry, with the 10 per cent uncertainty representing the range surrounding this, as shown in figure 6.1.

Figure 6.1



As the most likely value in the triangular profile is an average, the results do not provide more information over and above the possible range of AISCs and water savings calculated using only the MS Excel spreadsheet models. However, it does help identify and illustrate the probability percentiles.

These percentiles provide a probabilistic estimate of what savings and costs can be achieved at different levels of confidence. A 50 per cent confidence level would be expected to be similar to the best estimate of savings for the scheme based on the likeliest entries to the triangular distributions. The 95 percentile would return lower savings and higher costs, because to be 95 per cent, rather than 50 per cent, confident inevitably reduces savings and increases costs due to the uncertainty that surrounds the inputs. For example, it identifies that there is a 95 per cent probability of achieving X Ml/d saving and, for the same scenario, a 50 per cent probability of achieving a Y Ml/d saving. Y will be a larger quantity than X, but there is less confidence in achieving the Y Ml/d saving.

This approach illustrates that the figures published in this report are based on uncertain data. The Crystal Ball analysis results are provided for the 95 and 75 percentiles in tables 6.2 and 6.4.

6.1.2 Metering combined with low use fittings

We have examined the effects of metering combined with providing and installing low water use fittings free of charge. We have modelled both types of metering – compulsory and change of occupancy. Results are presented in Figure 6.2 and Tables 6.1 and 6.2.

Table 6.1 Results for metering combined with low use fitting

Combination of schemes	SEERA / GLA regions	Housing Association households	Resource zone level example	Company level example
Metering on change of occupancy and low use fittings	22.4 Ml/d (+/-6.6) for 150 p/m^3 (+/-42)	2.95 Ml/d (+/-0.9) for 134 p/m^3 (+/-25)	0.4 Ml/d (+/-0.1) for 185 p/m^3 (+/-53)	1.3 Ml/d (+/-0.4) for 162 p/m^3 (+/-47)
Compulsory metering and low use fittings	77.5 Ml/d (+/-25.8) for 136 p/m^3 (+/-42)	6.9 Ml/d (+/-2.3) for 134 p/m^3 (+/-28)	1.4 Ml/d (+/-0.5) for 176 p/m^3 (+/-53)	4.8 Ml/d (+/-1.6) for 167 p/m^3 (+/-51)

Table 6.2 Crystal Ball analysis results for metering combined with low use fitting

Combination of schemes	SEERA / GLA regions		Housing Association households		Resource zone level example		Company level example	
	95%ile	75%ile	95%ile	75%ile	95%ile	75%ile	95%ile	75%ile
Metering on change of occupancy and low use fittings	19.8 Ml/d for 163 p/m^3	21.1 Ml/d for 148 p/m^3	2.6 Ml/d for 141 p/m^3	2.8 Ml/d for 135 p/m^3	0.4 Ml/d for 200 p/m^3	0.4 Ml/d for 182 p/m^3	1.1 Ml/d for 176 p/m^3	1.2 Ml/d for 159 p/m^3
Compulsory metering and low use fittings	65.4 Ml/d for 165 p/m^3	72.0 Ml/d for 148 p/m^3	5.6 Ml/d for 171 p/m^3	6.3 Ml/d for 151 p/m^3	1.1 Ml/d for 182 p/m^3	1.2 Ml/d for 163 p/m^3	3.9 Ml/d for 175 p/m^3	4.4 Ml/d for 155 p/m^3

6.1.3 Metering combined with variable flush retrofit devices and low flush toilet replacement

This combination of schemes examines the impact of metering combined with options to reduce toilet flush volumes. Variable flush retrofit devices convert existing 7.5 and 9 litre cisterns where toilet replacement is not planned. Low flush toilet replacement scheme would target customers that are planning to buy new toilets. Both schemes target different customers and therefore can be implemented at the same time.

We have modelled both compulsory and change of occupancy metering, supported by a full subsidy for low flush toilet and a fully subsidised and fitted variable flush device.

Results are presented in Figure 6.2 and Table 6.2.

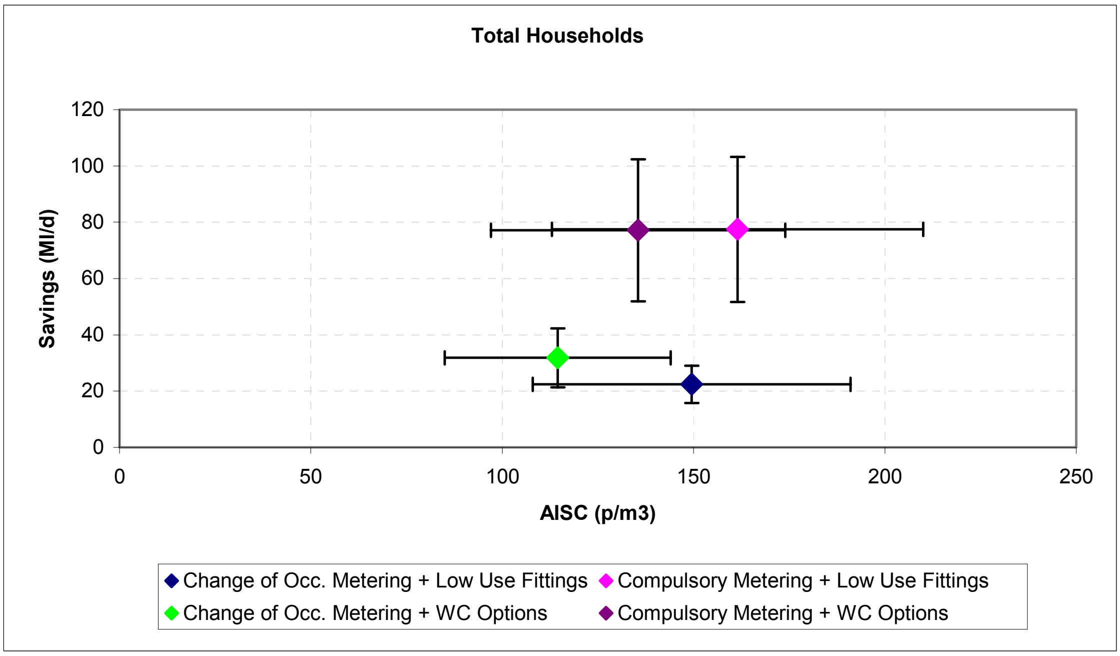
Table 6.3 Results for metering combined with variable flush retrofit devices and low flush toilet replacement

Implementation method	SEERA / GLA regions	Housing Association households	Resource zone level example	Company level example
Metering on change of occupancy and variable flush retrofit devices and low flush toilet replacement	31.9 Ml/d (+/-10.5) for 115 p/m^3 (+/-30)	3.5 Ml/d (+/-1.1) for 105 p/m^3 (+/-27)	0.6 Ml/d (+/-0.2) for 129 p/m^3 (+/-31)	2.1 Ml/d (+/-0.7) for 122 p/m^3 (+/-31)
Compulsory metering and variable flush retrofit devices and low flush toilet replacement	77.2 Ml/d (+/-25.8) for 136 p/m^3 (+/-39)	6.5 Ml/d (+/-2.2) for 141 p/m^3 (+/-42)	1.4 Ml/d (+/-0.5) for 176 p/m^3 (+/-53)	4.8 Ml/d (+/-1.6) for 143 p/m^3 (+/-42)

Table 6.4 Crystal Ball analysis results for metering combined with variable flush retrofit devices and low flush toilet replacement

Combination of schemes	SEERA / GLA regions		Housing Association households		Resource zone level example		Company level example	
	95%ile	75%ile	95%ile	75%ile	95%ile	75%ile	95%ile	75%ile
Metering on change of occupancy and variable flush retrofit devices and low flush toilet replacement	27.0 Ml/d for 126 p/m^3	29.4 Ml/d for 114 p/m^3	3.2 Ml/d for 112 p/m^3	3.4 Ml/d for 105 p/m^3	0.5 Ml/d for 141 p/m^3	0.6 Ml/d for 131 p/m^3	1.8 Ml/d for 135 p/m^3	1.9 Ml/d for 122 p/m^3
Compulsory metering and variable flush retrofit devices and low flush toilet replacement	64.1 Ml/d for 139 p/m^3	70.9 Ml/d for 125 p/m^3	5.4 Ml/d for 145 p/m^3	6.0 Ml/d for 129 p/m^3	1.1 Ml/d for 151 p/m^3	1.2 Ml/d for 137 p/m^3	4.0 Ml/d for 147 p/m^3	4.4 Ml/d for 131 p/m^3

Figure 6.2



6.1.4 Results summary

The results in figures 6.1 and 6.2, and tables 6.1 to 6.4 demonstrate that similar savings are achieved with the two combined strategies. This is particularly the case when the combined schemes include compulsory metering. Low use toilets combined with change of occupancy metering achieve greater savings than change of occupancy metering combined with low use fittings. The Crystal Ball analysis applies a confidence level to the results that takes into account the uncertainties associated with certain scheme inputs.

The results show that combined schemes are likely to achieve higher savings than just implementing individual schemes. Savings achieved for low use fittings combined with change of occupancy metering are estimated to be around 14 Ml/d higher than implementing low use fittings without increased metering when applied to the SEERA and GLA regions. The maximum savings from combined schemes are achieved through compulsory metering combined with low use fittings. The average saving from this scheme of 77.5 Ml/d is considerably higher than the 51.6 Ml/d achieved from the compulsory metering scheme, which generates the largest savings for an individual scheme.

The average saving of the low use fittings combined with compulsory metering scheme is also higher than the sum of the savings from the low use fittings and compulsory metering schemes when implemented individually. The sum of the individual schemes achieves a saving of 60.0 Ml/d (8.4 Ml/d for the low use fittings scheme and 51.6 Ml/d for the compulsory metering scheme) when applied to all households in the South East. This is lower than the 77.5 Ml/d estimated for the combined strategy because of the impact increased metering has on the uptake rates of the low use fittings measures.

6.2 Other issues to consider

6.2.1 Affordability

There are concerns over the possible inequality caused by charging for water by volume (metered charges) and the impact this will have on households on different incomes. On the whole, charging for water based on the amount used is likely to account for a larger proportion of income for low income families than for those that are better off. This is likely to be an issue particularly for compulsory metering. Supporting metering with water efficiency schemes can help reduce the amount of water used and so reduce water bills. In schemes where showerheads are replaced, there will be an extra benefit of saving on energy bills. However, we have not addressed affordability and effects on customer bills further in this report.

6.2.2 Offsetting sustainable communities demand

Some areas in the South East of England have been designated as growth areas by the Government's **Sustainable Communities** programme. High levels of housing growth and increased pressure on water resources are expected there. These areas in particular are expected to have an impact upon water resources in the South East:

- The Thames Gateway
- Ashford

The combined housing growth from these sustainable communities is planned to be around 180,000 new homes by 2016. Even if the new homes are built to higher water efficiency standards, the extra demand for water is expected to be around 50 – 60 Ml/d[11].

The results of this study suggest that reducing the amount of water used in existing homes can play a large role in offsetting this increase in demand. Ongoing studies such as the **'Thames Gateway Water Neutrality'** project, which we are leading, will analyse these opportunities in more detail.

6.2.3 Implementation methods

There is a number of ways of implementing the strategies identified in this report. Opportunities include working with Housing Associations, metering supported by water efficiency measures and possible partnerships with the Energy Savings Trust, although this last option may raise concerns over diluting two separate messages.

We have considered Housing Associations here because they are responsible for maintaining large numbers of households. The Associations are ideally placed to carry out large retrofit and replacement programmes, either as a one off installation scheme, or gradually when they carry out routine maintenance or when properties are refurbished.

It is clear from this study that implementing a combination of measures is the most cost effective way of reducing demand in existing houses. Combining schemes reduces implementation costs. Metering can encourage people to take up other water efficiency measures, giving higher water savings, while water efficiency schemes provide a 'cushion' to wide-scale metering by helping consumers to reduce their bills. It is estimated that 22 per cent of domestic energy is used to heat water, so reducing the amount of hot water used (using showers instead of baths for instance) will also reduce the amount of energy used. Partnerships with the Energy Savings Trust could promote these combined benefits. Combining water efficiency and energy saving advice can help increase uptake rates and reduce implementation costs.

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[11] Based on an average regional occupancy rate of 2.4 and per capita consumption of between 120 – 140 litres per head per day ('PR04' Final Water Resource Plans submitted by the water companies of the South East)

7. Conclusions

In general, the average incremental social costs (AISCs) of retrofitting water efficiency measures examined in this report compare favourably with the costs of traditional resource development schemes.

The costs and benefits calculated in this report should only be used as a guide and to compare the various strategies. We have not considered local environmental costs, but these could be a significant part of the cost of the scheme in some areas. We have made many of the cost assumptions on a regional scale and these could vary at a local level. This particularly applies to the worked examples where a great deal of extra work would be needed working together with the relevant water company or Housing Associations to calculate realistic results for these particular groups of housing.

The Crystal Ball analysis highlights the significant uncertainty that surrounds the assumptions used to calculate savings and costs. Based on this probabilistic analysis, the average savings listed in this report are achievable with around a 50 per cent confidence level. If a higher confidence level is needed, the estimated savings will be less and the costs higher.

1. The combined strategies that are made up of metering supported by water efficiency measures provide the highest savings. This is understandable as metering is assumed to encourage uptake of water efficiency measures. Of the two strategies examined, **metering combined with variable flush retrofit devices and low flush replacement WCs** generates the largest savings at **77.2.6 Ml/d (+/-25.2) for 136 p/m^3 (+/-39)** (when metering is compulsory) and **31.9 Ml/d (+/-10.5) for 115 p/m^3 (+/-30)** (when metering on change of occupancy).

2. **Metering combined with low use fittings** also achieves high savings **77.5 Ml/d (+/-25.8) for 162 p/m^3 (+/-49)** (when metering is compulsory) and **22.4 Ml/d (+/-6.6) for 150 p/m^3 (+/-42)** (when metering on change of occupancy).

3. Probabilistic modelling using a Monte Carlo simulation estimates that savings of approximately **65 Ml/d** can be achieved through each of the combined strategies at a 95 per cent level of confidence. These savings increase to approximately **70 Ml/d** at a 75 per cent level of confidence.

4. Of the individual measures considered, the largest savings are from the **compulsory metering** scheme. This scheme is estimated to achieve savings of **51.6 Ml/d (+/-19.5) for 176 p/m^3 (+/-59)** when applied across the whole region. It must be noted that, at present, a water company needs to secure water scarcity status to carry out compulsory metering. The result of consultations on metering in areas of serious water stress (in progress at the time of writing) may change the future requirements and make compulsory metering easier.

5. The **low use fittings** scheme demonstrates that significant savings can be achieved with limited costs by implementing together a number of different measures. This approach assumes that fitting a variable flush retrofit device, low flow showerhead and low flow taps is carried out during one visit by a plumber, which keeps installation costs to a minimum. Savings were estimated at **8.4 Ml/d (+/-2.0) for 113 p/m^3 (+/-20)** for fully subsidised fittings and installation.

6. The results for individual demand management measures generally show that methods that provide the largest incentive for the customer, such as full subsidy and free installation, achieve higher savings with marginal increases in costs. This is due to the higher uptake rates such incentives are likely to achieve.

7. **Housing Associations** are potentially in a strong position to help implement water efficiency schemes because they own and maintain large numbers of properties. The ultra low flush toilet replacement scheme achieves savings of **3.8 Ml/d (+/-0.6) for 64 p/m^3 (+/-4)** when implemented with full subsidy.

8. Individual demand management measures implemented at a local level are likely to achieve limited savings. However, **compulsory metering** could provide savings of **3.6 Ml/d (+/-1.3) for 181 p/m^3 (+/-58)** on a medium company scale. Combining schemes can achieve notable

savings even at resource zone level. **Metering combined with variable flush retrofit devices and low flush replacement WCs** achieves potential savings of **1.4 Ml/d (+/-0.5) for 145 p/m^3 (+/-41)** in the water resource zone example.

9. Improving water efficiency in existing homes can offset increased demand in growth areas like Ashford and the Thames Gateway. Increase in demand caused by these growth areas is predicted to be around **50 – 70 Ml/d,** which is less than the potential savings that could result by implementing combined strategies. Total increase in demand for the entire South East region is estimated to be approximately **160 Ml/d** by 2015. Therefore, implementing the combined strategy measures in existing homes could reduce this increased consumption by almost **50 per cent**.

8. Recommendations

Comparing the cost of demand management implementation strategies with more traditional water supply schemes shows that the measures could produce more cost effective savings. The cost of savings for many of the measures we examined in this report is likely to compare with most resource development options such as new reservoirs, boreholes and desalination plants (see chapter 4). However, it is difficult to make a direct comparison because of the lack of generic AISCs for different types of water supply options. The following points list the recommendations for taking forward the conclusions of this analysis:

- there is significant **uncertainty** about much of the data used to calculate scheme savings. As new and ongoing studies are completed, we recommend that findings are used to reduce these uncertainties and create higher confidence in the effects of these schemes;
- significant savings can be achieved within **Housing Association** households. Water companies should explore further the benefits of working with Housing Associations;
- The impact of retrofitting existing properties on offsetting future demand from new homes should be explored further. Ongoing studies such as the **'Thames Gateway Water Neutrality'**
- project and updates to the UKWIR WR25B website will provide more information;
- **Affordability issues** and practical **implementation methods** should be considered in more detail when assessing specific implementation strategies;
- Demand management options not included in this study should be reconsidered when new, reliable data becomes available.

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Appendix 1
Results from the 'Water Efficiency Analysis of South East England Rollout Options' (2005) study

In 2005 we commissioned a brief study of the potential water efficiency savings within existing homes in South East England.

The study considered the costs and benefits of six water efficiency schemes, most likely to bring about significant savings. These were:

- cistern displacement devices;
- variable flush toilet retrofit;
- ultra low flush volume toilet (end of life replacement of existing unit);
- white goods subsidy;
- low use fittings retrofit (combination of basin and shower flow regulators, low use shower heads and variable flush retrofit devices);
- metering on change of occupancy.

Analysis methods
Scheme costs were compared using average incremental social costs (AISCs), which are widely accepted as the water industry's and regulators' preferred approach for comparing schemes. Benefits were measured in terms of water saved in megalitres per day (Ml/d). Separate assessments were carried out for Housing Association and privately owned houses to account for likely differences in uptake rates within these sectors. How effective schemes are depends on uptake, which, in turn, is influenced by the effort put into promoting and rolling them out. Results were therefore presented for both maximum and minimum effort implementation. The populations of Greater London Authority and the South East England Regional Assembly were used in this study, corresponding to 5.7 million households.

Results
Table 2.2 shows a summary of the AISCs (in pence per cubic metre) and water savings for each scheme.

Table A.1 Summary of scheme best estimate AISCs and water savings

Scheme	Total households AISC (p/m^3)	Total households Saving (Ml/d)	Housing Association households AISC (p/m^3)	Housing Association households Saving (Ml/d)
Maximum effort				
Displacement device	20.3	5.1	10.6	1.2
Variable flush retrofit	95.8	20.5	88.2	3.9
Ultra low flush WC	33.9	16.7	31.9	10.3
White goods subsidy	434.4	6.6	-	-
Low use fittings	86.0	23.7	78.6	4.6
Metering on change of occupancy*	175.5	28.4	-	-
Minimum effort				
Displacement device	-	-	-	-
Variable flush retrofit	250.0	2.2	75.0	1.4
Ultra low flush WC	20.7	4.1	11.6	5.1
White goods subsidy	725.9	1.2	-	-
Low use fittings	183.3	3.2	61.4	1.8
Metering on change of occupancy*	347.6	14.2	-	-

* Target households are unmeasured only

The best returns in terms of water savings were associated with the **metering on change of occupancy** scheme, corresponding to approximately 14-29 Ml/d.

The most cost effective toilet flushing savings came from a scheme subsidising end of life toilet replacement with **ultra low flush WCs**. Savings were estimated at approximately 9 to 27Ml/d (4.1+5.1 to 16.7+10.3 Ml/d) based on installing the WRAS approved ES4 low flush WC (4.5 litre flush volume), which has been assumed to be available for all households with a subsidy of £40 - £80. It was recommended that particular emphasis be placed on gaining Housing Associations' support for this scheme to encourage fittings during refurbishment to maximise potential savings.

The maximum estimated savings from the cistern displacement device scheme were 5Ml/d, but this was a comparatively low cost option and it was considered that this option could be used to boost the effectiveness of other schemes if implemented at the same time.

Introducing the **metering on change of occupancy and ultra low flush WC subsidy** schemes together were most likely to bring about significant savings. Depending on implementation effort, it was estimated that between 23 and 56 Ml/d could be saved at a cost of between 179 and 246 p/m^3. In addition, implementing these schemes together would also maximise potential savings as metered households would be more likely to take up the ultra low flush WC scheme because of a financial incentive to save water.

Appendix 2
Scoring options

We used a scoring process to screen options based on the quality, extent and relevance of data available to define the costs and savings of each measure. We assessed the effectiveness of studies of relevant water efficiency technologies using the methodology developed for the UKWIR 'Sustainability of Water Efficiency (06/WR/25/2)' project. We gave scores from 1 (low) to 5 (high) under the following headings: project management

- approach
- monitoring period
- sample composition
- sample size
- control group
- data collection
- data analysis
- data audit
- statistical inference
- transferability

To make sure that the technologies we took forward were appropriate and reliable, we also assessed them according to the following categories:

- scalability – Are the study results appropriate for scaling up to regional level (scored 1 – 5)?
- durability – Will implementation produce sustainable savings? Durability may be compromised due to a) life expectancy of technology or b) relevance of technology to future water use scenarios (scored 1 – 3).

The results of the scoring are provided in the following table:

Table A.2 Scoring of technologies

Technology	Number of projects assessed	Score based on UKWIR headings [1]	Score based on scalability (scored 1 – 5)	Score based on durability (scored 1 – 3)	Total
Variable flush WC	21	13.8	3	2	**19**
Taps	16	11.7	4	2	**18**
Low flow showers	14	9.5	5	2	**16**
Low flush WC	13	8.1	5	3	**16**
Cistern displacement devices	18	9.2	3	1	**13**
Water butts	9	6.5	3	3	**12**
Metering	6	2.8	4	3	**10**
Greywater recycling	7	4.9	3	2	**10**
Flow regulation	4	3.1	3	2	**8**
Rainwater harvesting	7	3.8	2	2	**8**
Water heaters	1	0.5	5	2	**8**
Water audits	6	3.3	2	1	**6**
Promoting water efficiency	6	2.9	2	1	**6**
Garden irrigation	3	1.9	2	1	**5**
Tariffs	N/A	N/A	N/A	3	**3**
Pressure control	1	N/A	N/A	N/A	**N/A**

[1] Scores of 1 (low) to 5 (high) given for each UKWIR heading with total divided by 100 to make them compatible with scalability and durability scores

Appendix 3
Ultra low flush WC replacement scheme

Assumptions and variables

Variable	Input range	Notes
Average water saving	50 – 55 l/hhold/d	Average use currently is approx. 50 litres per person per day for toilet flushing (Conserving Water in Buildings 9: Water-efficient WCs and retrofits (Environment Agency leaflet)). If assume 4.5l flush (WRAS approved Tribune CC Suite low flush WC) at 1.5 toilets per household (Customer Survey: Report on appliance ownership and attitudes to water efficiency, Southern Water, 2004) and only 1 is low flush at an average flush rate of 4.1 flushes/person/day (Retrofit options for water efficiency in existing buildings, Environment Agency 2005) at an average household size of 2.38 (S. E. average, Census, 2001) then average saving = 53.1 l/hhold/d.
Cost of subsidy	£0 – 140	As subsidised price of WC (WRAS approved Tribune CC Suite).
Customer recruitment costs	50p/hhold/year	Advertising literature with water bill.
Uptake rate - unmeasured	1 – 10%	1% with no subsidy 6% with partial subsidy 10% with full subsidy
Uptake rate - metered	4 – 15%	4% with no subsidy 10% with partial subsidy 15% with full subsidy
Uptake rate - housing association	40 – 80%	Good uptake assumed if able to get Housing Associations on board.
Implementation time	16.5 years	This is the estimated average life of a WC. As this scheme is aimed to replace WC at the end of their life, the scheme will last the same time.
Scheme life	16.5 years	As above, advancing WC technology may provide lower flush toilets after this time.

Appendix 4
Variable flush retrofit device scheme

Assumptions and variables

Variable	Input range	Notes
Average water saving	21 – 29 l/hhold/d	Best estimate based on the following studies: 'Retrofitting variable flush mechanisms to existing toilets', Environment Agency 2005 'The Water Efficiency of Retrofit Dual Flush Toilets', Southern Water 2000.
Cost of device	£8 – £50	Cost of device £8 plus £42 fitting. Cost of device based on the Ecobeta product tested by Essex & Suffolk Water in its ongoing variable flush retrofit trials. £3 for postal delivery where implementation method does not include installation.
Customer recruitment costs	£2/Hhold/year	Advertising literature with water bill and house call.
Uptake rate - unmeasured	2 – 20%	Uptake limited by unsuitable toilets - approximately 70 per cent of toilets are the correct type.
Uptake rate - metered	5 – 30%	
Uptake rate - housing association	20 – 50%	Good uptake assumed if able to get Housing Associations on board - uptake limited by unsuitable toilets.
Implementation time	8 years	
Scheme life	10 years	After this period most retrofitted toilets are likely to be replaced with new ones.
Saving decay rate	15% per year	Rate at which savings are lost - (toilets are replaced and devices break down or are removed) - Increased decay rate in minimum effort assumed to be due to break down and removing device from incorrect use/fitting by householder.
Social cost associated with house calls	£3/hhold/year	Due to disruption caused by house calls and damage caused by the device not working properly.

Appendix 5
Low flow showerhead scheme

Assumptions and variables

Variable	Input range	Notes
Average water usage without device	10.8 l/min	This value is higher than the average 7 l/min as it represents higher use mains pressure and pumped power showers. 24 per cent of households have showers that are non- electric at average of 9l/min, 19 per cent have power showers at average of 13 l/min = 10.8 l/min average. -"in UK 24 per cent of showers are non- electric showers, with 21 per cent of the remaining market divided between bath tap mixers and integral power showers." Managing Director of Triton (2002) www.trade-mags.co.uk/Triton.htm -Average of 19.4 per cent of customers have power showers in (Southern Region Customer Survey - Report on Appliance ownership and attitudes to water efficiency (Southern Water, Jan 04)).
Water usage with restrictor	9 l/min	The Economics of Water Efficient Products in the Household (Elemental Solutions, June 2003).
Cost of device and fitting	£15 – £50	
Initial cost of setting up scheme	£5,000	
Customer recruitment costs	£0.70	Cost of leaflet distribution and phone call.
Ownership - unmeasured	51.9%	Southern Water Customer Survey: Report on ownership and attitudes to water efficiency (Jan 2004).
Ownership - metered	61.4%	
Uptake rate - unmeasured	2.5 – 7.5%	
Uptake rate - metered	10 – 20%	
Uptake rate - housing association	40 – 60%	Good uptake assumed if able to get Housing Associations to implement scheme in all properties.
Implementation time	5 years	
Scheme life/life of device	8 years	Advances in technology or changes in behaviour may reduce potential saving after this time.
Suitable showers	43%	Restrictor valves / low use shower heads are only effective as far as shower performance is concerned on pumped or mains fed pressure showers (The Economics of Water Efficient Products in the Household (Environment Agency, June 2003)) -"In the UK 24 per cent of showers are non- electric showers, with 21 per cent of the remaining market divided between bath tap mixers and integral power showers." Managing Director of Triton (2002?) www.trade-mags.co.uk/Triton.htm -Average of 19.4 per cent of customers have power showers - (Report on Appliance ownership and attitudes to water efficiency (Southern Water, Jan 04)) From this suitable shower taken as 43 per cent.

Appendix 6
Metering scheme

Assumptions and variables

Variable	Input range	Notes
Average water saving	5 – 10% reduction	Based on average savings assumed by the water companies of the South East in their 2004 AMP4 Water Resources Plans.
Cost of fitting meter - with boundary box present	£71	Pers. Comm. Graham Jones Dwr Cymru – Welsh Water. Cost of meter included.
Cost of fitting meter - with no boundary box present	£250	
Number of properties with boundary box currently present	35%	
Cost of setting up scheme (capex)	£1,500,000	High cost due to necessary changes in the billing infrastructure.
Annual switch rate	5.5 – 8.5%	5.3% based on 4%/yr of total population can be metered on change of occupancy and 28% of the population currently metered. When this figure is adjusted to relate to unmeasured population only = (4/72)x100 = 5.5% 9% included in Folkestone and Dover's 2004 AMP4 Water Resources Plan that includes compulsory metering. 8.5% applied to reflect that a higher proportion of houses may not be suitable for metering in parts of the South East outside of the Folkestone and Dover supply area.
Scheme life	5 / 10 years	5 years for change of occupancy metering and 10 years for compulsory metering.
Replacement of meter	10 years	
Social cost associated with house calls	£20/household	Due to disruption and damage caused by house calls and engineering works involved in fitting meter.

Appendix 7
Low use fittings scheme

Assumptions and variables

Variable	Input range	Notes
Low use taps		
Average water usage without restrictor	6.5 l/s	Average not a maximum as taps will not be used at maximum flow in normal usage.
Water usage with restrictor	5 l/s	Best Practice Volume (Retrofit Options for Water Efficiency in Existing Buildings (Environment Agency, Jul 05)).
Tap uses per day	16.9 hhold/day	Average household in South East = 2.38 (Census, 2001) - hand washing taken from average toilet trips 4.1 per person per day (Retro-fit options for water efficiency in existing buildings (Environment Agency, Water Demand Management, July 2005) - face washing (once per day) - tooth brushing (twice per day) = (4.1 + 1 + 2) x 2.38.
Average length of usage	6 sec	Varied to incorporate uncertainty.
Cost of flow restrictor	£4	For insert only.
Low flow showerhead (for a detailed breakdown of showerhead inputs see Appendix E)		
Average water saving from fitting	12 – 14 l/hhold/day	Based on 1.8 l/min saving with low flow showerhead, 5 min shower, 1.43 showers per household per day.
Cost of device	£15	Hand held aerating head.
Variable flush retrofit device (for a detailed breakdown of showerhead inputs see Appendix D)		
Average water saving from fitting	21 – 29 l/hhold/day	Best estimate based on the following studies: 'Retrofitting variable flush mechanisms to existing toilets', Environment Agency 2005 'The Water Efficiency of Retrofit Dual Flush Toilets', Southern Water 2000.
Cost of device	£8	Cost of device based on the Ecobeta product tested by Essex & Suffolk Water in its ongoing variable flush retrofit trials.
General		
Cost of fittings and installation	£50 – £95	£50, with customer contributing approximately half of fittings and installation costs. £95, with full subsidy and free installation.
Uptake rate - unmeasured	5 – 10%	5%, with customer contributing approximately half of fittings and installation costs. 10%, with full subsidy and free installation.
Uptake rate - metered	10 – 30%	10%, with customer contributing approximately half of fittings and installation costs, 30%, with full subsidy and free installation.

Assumptions and variables (continued)

Variable	Input range	Notes
Uptake Rate - Housing Association	40 – 80%	Good uptake assumed if able to get Housing Associations on board.
Customer recruitment costs	£2/hhold/year	Advertising literature with water bill and house call.
Initial cost of setting up scheme	£10,000	
Implementation time	8 years	
Scheme life	8 – 10 years	10 years for taps and variable flush retrofit device. 8 years for showerheads as advances in technology or changes in behaviour may reduce potential saving after this time.

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