Section 8

Appraisal of demand options

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Appraisal of demand options

Section 8 outlines the demand management options appraisal process to determine the demand management programmes for assessment towards our preferred plan. The includes the details of:

- The three stages to the demand management options appraisal process, screening, evaluation and optimisation of feasible options. We use these stages to develop a range of deliverable demand management programmes.
- Each of the feasible options, their costs and benefits and the associated delivery constraints.
- The process whereby the feasible options are optimised using our Integrated Demand Management (IDM) model to produce a range of demand management programmes and discusses the implications of the costs, benefits and delivery constraints of the optimisation process.

A. Options appraisal process

8.1 Section 8 details the identification and appraisal of demand management options considered in our plan. The purpose of water demand management is to reduce the volume of demand and thereby reduce the size of the supply demand deficit identified in Section 6: Baseline supply demand position, as part of a best value investment programme. The purpose of demand management options appraisal is to identify and compare demand management interventions and produce demand management programmes that can achieve this reduction. These demand management programmes are then optimised alongside the supply options (Section 7: Appraisal of water resource options) to develop our preferred plan (Section 11: Preferred programme).

Overview

8.2 We have conducted our demand management options appraisal in three stages to produce a range of demand management programmes. These are: the screening, evaluation and optimisation of options.

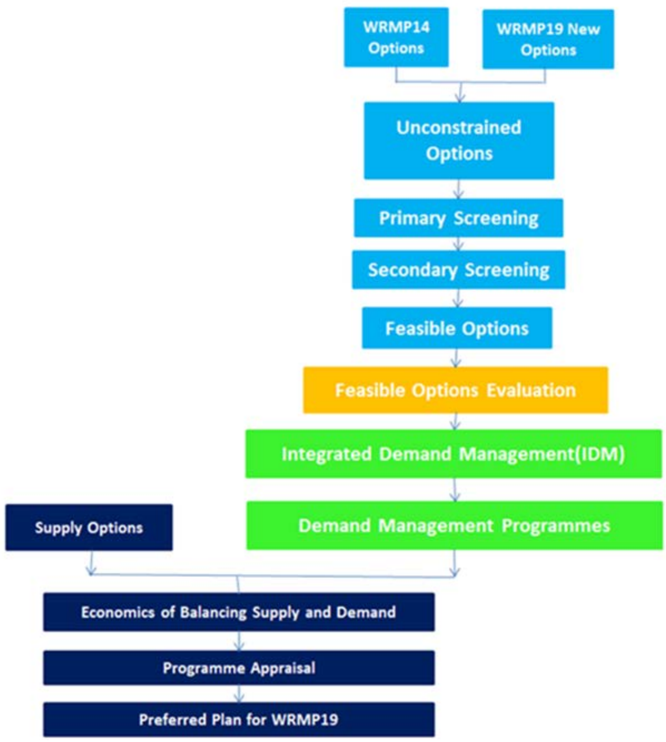
8.3 The **Screening** of options involves the identification of a list of generic demand management options. These options undergo primary and secondary screening based on technological, financial, environmental, risk and resilience and legal constraints. The output of this process is a list of feasible demand management options that are then evaluated in the next stage of options appraisal. Section 8.B sets out the principles and approach we have used to screen 135 generic demand management options to produce 47 feasible options.

8.4 The **Evaluation** of the 47 feasible options categorises the demand interventions by whether they can reduce either leakage or usage (includes usage and wastage) or both. To quantify the value of these options, we assess the cost and reduction in demand that could be achieved by implementing these options individually. Section 8.C provides an overview of the evaluation process, Section 8.D describes the optimisation process itself and Sections 8.E to 8.8.179 outline the detail for each demand management intervention.

8.5 The **Optimisation** of options involves the comparative assessment of feasible options using the IDM model. The purpose of optimisation is to develop a range of deliverable, cost efficient demand management programmes. This means we look at the overlapping costs and benefits of options that can be promoted in combination in addition to assessing each option individually. It also means we look at the optimised combination of options for each District Metered Area (DMA) and consider the deliverability constraints.

8.6 Figure 8-1 illustrates the demand management options appraisal process and its connection with the next stage of the preparation of the plan, Economics of Balancing Supply and Demand (EBSD) and Programme Appraisal (Section 10: Programme appraisal).

Figure 8-1: Demand management options appraisal overview



8.7 Section 8.D outlines the procedure for conducting this optimisation. Sections 8.E to 8.G detail the information we used to determine the costs and benefits of each feasible option, the reason for any significant changes since our Water Resources Management Plan 2014 (WRMP14), the delivery constraints of each option and the impact these have on demand management optimisation.

8.8 The output of the demand management options appraisal process is a range of demand management programmes. A demand management programme consists of an optimised mix of demand management interventions to achieve a certain level of demand reduction in each Asset Management Planning (AMP) period. Section 8.H summarises the demand management programmes and the relative usage and leakage savings achieved by each programme.

8.9 The demand management programmes are used in the next stage of preparation of our plan. This is where the demand programmes are assessed with the water resource options in the EBSD model, through our Programme Appraisal process which establishes our preferred or 'best value' plan.

B. Screening

8.10 The purpose of options screening is to develop a list of feasible demand management options. Feasible demand management options are those options considered to have a reasonable prospect of implementation and of achieving a water demand saving. The number of feasible options must be both sufficient and manageable to allow real choices to be made when undertaking their optimisation (Section 8.D).

8.11 There are two predominant stages in the Demand Options Screening Process; first, create an unconstrained list of options; second, undertake primary and secondary screening to create a list of feasible options.

8.12 The full Demand Management Options Screening process is presented in the report, 'Thames Water WRMP19 Demand Management Options Screening Report', March 2017[1]. This report was reviewed by external stakeholders at our technical stakeholder forum on 19th June 2017.

Unconstrained options list

8.13 The purpose of this stage is to create a list of all possible options that may be technically feasible but not necessarily free of environmental or planning issues. The Unconstrained Options list is developed from the Generic List of Options outlined by United Kingdom Water Industry Research (UKWIR) in its Water Resources Planning Tools 2012 Report[2]. All water companies are encouraged to use this generic list as the starting point in identifying potential water Supply and Demand Options in their areas.

8.14 The generic water Demand Management Options identified by UKWIR are grouped into five categories: Leakage, Metering, Water Efficiency, Tariffs and Non-Potable (termed 'Water Recycling' in the UKWIR document). Using these five categories as a base, we developed each Generic Option to include multiple potential sub-options and specific options.

[1] Thames Water (2017), 'Thames Water WRMP19 Demand Management Options Screening Report', March 2017
[2] UKWIR (2012), Water Resources Planning Tools 2012, Economics of Balancing Supply and Demand Report

8.15 In drawing-up the list of sub-options and specific options, we utilised two sources of WRMP14 Demand Management Options to evaluate or re-evaluate, and identified new options for our draft Water Resources Management Plan 2019 (the draft WRMP19):

- WRMP14 Accepted Options: these options passed the screening process in WRMP14 to make the Feasible Options list
- WRMP14 Rejected Options: these options did not pass the screening process in WRMP14 and were recorded on the Rejection Register. The question giving rise to non-compliance is noted in the table in the Rejection Register
- Draft WRMP19 New Options: these options were not considered in WRMP14

8.16 The sub-options and specific options identified under each Generic Option category forms the Unconstrained Options List (Appendix P: Options List Tables).

8.17 For the draft WRMP19, we have developed an unconstrained list of 135 Demand Management Options under the Generic Option categories; Leakage, Metering, Water Efficiency, Incentives and Non-Potable Water Supply. Of the 135 options, 26 have been sourced from WRMP14 Accepted Options, 65 from the WRMP14 Rejected Options and 44 are new options for the draft WRMP19.

Primary and secondary screening

8.18 Each option in the unconstrained options list is then subjected to Primary Screening and Secondary Screening.

Primary screening

8.19 Primary Screening assesses option feasibility at a high level for acceptance within technological, financial, environmental, risk and resilience and legal constraints.

8.20 In Primary Screening, each option in the Unconstrained Options List is assessed against the following criteria:

- Technical: Is the option currently technically feasible?[3]
- Cost: Does the option avoid excessive cost, using available outline cost information?
- Environmental: From an initial environmental assessment, are the likely significant effects of the option on the environment considered acceptable?
- Risk: Does the option give rise to an acceptable risk of it being implemented? Is there an acceptable risk that the option will not provide a net water resource benefit or not provide sufficient future resilience?
- Legal: Does the option comply with current legal requirements?[4]

8.21 This assessment is conducted at a high level by our own economists, engineers and environmental experts who specialise in each of these areas.

[3] This screening question is new to the draft WRMP19
[4] This screening question is new to the draft WRMP19

8.22 To pass through the Primary Screening exercise each Demand Management Option must score 'yes' to all five questions. If an option is rejected it will not continue to Secondary Screening and will be listed on the WRMP19 Rejection Register (Appendix Q: Scheme rejection register). Options that pass Primary Screening continue to Secondary Screening.

8.23 For the draft WRMP19, 44 of the 135 Demand Management Options in the Unconstrained Options list have been screened out by Primary Screening, leaving 91 potential options.

Secondary screening

8.24 Secondary Screening further refines the 91 options in the list that has emerged from the primary screening exercise by reference to qualitative criteria. Each option that passed through the Primary Screening process is assessed against the following criteria applied for the purposes of Secondary Screening, to develop the final feasible water demand management options list.

- Does the option avoid excessive cost?
- Is the option likely to be acceptable in terms of planning and environmental constraints?
- Is the option likely to help meet Water Framework Directive objectives and prevent deterioration of water body status?
- Does the option have an acceptable risk of social impact or inequality?
- Does the option align with company policy objectives?
- Does the option provide flexibility/adaptability to climate change uncertainty?
- Does the option provide conjunctive use benefits or other benefits to water resource management?
- Is the option practical and efficient to implement and maintain? (new to the draft WRMP19)
- Is the option lead time sufficiently flexible to planning or other uncertainties to ensure security of supply is maintained?
- Are all other risks and uncertainties acceptable?
- Can costs and benefits of the demand option be modelled for comparison with alternatives at DMA level?

8.25 This assessment is carried out by internal Thames Water economists, engineers and environmental experts who specialise in each of the Generic Demand Management Options areas. To pass Secondary Screening each option must score 'yes' to all eleven questions. If an option is rejected it will be listed on the draft WRMP19 Rejection Register (Appendix Q: Scheme rejection register).

8.26 Options that pass through the Secondary Screening exercise make up the List of Demand Management Feasible Options. For the draft WRMP19, of the 91 Demand Management Options remaining after Primary Screening, a further 44 options were screened out by Secondary Screening, leaving 47 feasible options.

Feasible demand management options

8.27 The Feasible List of Demand Management Options must provide a sufficient but manageable number of options to allow real choices to be made between options when undertaking optimisation in IDM.

8.28 The outcome of Primary and Secondary screening is the drawing up of the Feasible Demand Management Options list. There are 47 Feasible Demand Management Options for the draft WRMP19. These are amalgamated by type and summarised in Figure 8-2 (i.e. the feasible option mains rehabilitation is made up of four individual options:

1) replace 25% of mains in a DMA
2) replace 50% of mains in a DMA
3) replace 75% of mains in a DMA
4) replace 100% of mains in a DMA)

8.29 The list of options broken down individually is provided in the report, 'Thames Water WRMP19 Demand Management Options Screening Report', March 2017[5].

Figure 8-2: Feasible demand management options

Leakage and Usage Benefit	Leakage Benefit	Usage Benefit		
Metering	**Leakage**	**Water Efficiency**	**Incentives and Tariffs**	**Non-Potable Water**
Metering houses only	Mains Replacement	Smarter Home Visit	Incentives Programme	Rainwater harvesting
Metering blocks of flats (bulks) only		Smarter Business Visit	Innovative Tariffs	Stormwater harvesting
Metering houses and bulks	Pressure Management	Wastage Fix ('leaky loos')		Greywater harvesting
Metering houses, bulks and individual flats	DMA Enhancement	Housing Association Fix		
Customer Side Leakage (CSL) repair		Intensive area based promotional campaigns		
Metering houses, bulks and individual flats + CSL repair + Smarter Home Visit				
Metering houses, bulks and individual flats + CSL repair + Housing Association Fix				
Metering houses + CSL repair + Smarter Home Visit				

Note: green indicates new options for the draft WRMP19

8.30 The feasible options list was presented to external stakeholders at the Technical Stakeholder Forum on 19th June 2017 and published in the Thames Water WRMP19 Demand Management Options Screening Report and the Feasibility Paper[6].

[5] Thames Water (2017), 'Thames Water WRMP19 Demand Management Options Screening Report', March 2017
[6] Thames Water (2017), 'Thames Water WRMP19 Demand Management Options Feasibility Paper', June 2017

C. Evaluation

8.31 In Section 8.B we explained the screening process to derive the feasible demand management options. Section 8.C details the approach we employed to individually evaluate these feasible options and explains the reasoning behind demand management programmes.

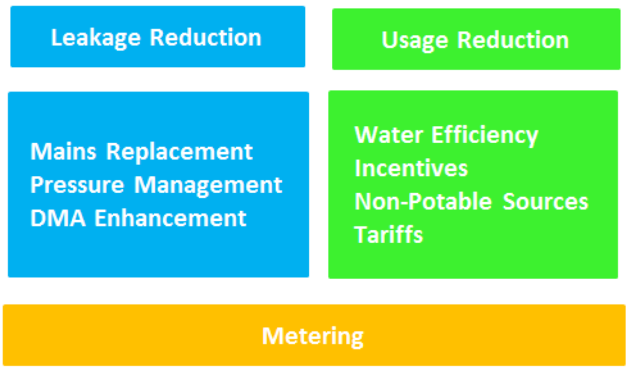
Leakage and usage benefits

8.32 The screening process identified eight overarching demand management feasible options:

1) Metering
2) Mains Rehabilitation
3) Pressure Management
4) DMA Enhancement
5) Water Efficiency
6) Incentives Programme
7) Non-Potable Sources
8) Tariffs

8.33 These options can be grouped as targeting either a reduction in leakage or a reduction in customer usage. As the exception, metering can achieve both a reduction in leakage (customer side leakage (CSL)) and customer usage to reduce overall demand (Figure 8-3).

Figure 8-3: Demand management options categorised by leakage and usage reduction



8.34 To quantify the value of these options, we assessed the cost and reduction in demand that could be achieved by implementing these measures. For example, to achieve a reduction in customer usage and leakage from metering, there is a cost to install the meter, maintain meter reading infrastructure, fix any CSL and replace the meter when it reaches the end of its operational life. This information gives us a total cost benefit to undertake metering as an independent demand management intervention.

Figure 8-4: Overview of demand management option costs, benefits and constraints

Feasible Option	Direct Benefits		Indirect benefits	Work Required	Constraints	Relative Cost Benefit*
	Leakage Reduction	Usage Reduction				
Metering	Increased ability to find customer supply leakage (csl)	Reduced customer usage Reduced customer wastage	Enhanced detection of network leaks with sufficient meter coverage (DMA Enhancement)	Household meter installation and replacement Bulk meter installation and replacement Meter reading costs Csl repair costs	Ability to fit a meter on a property Physical maximum meter installs per year	**Medium**
Mains Replacement	Direct Leakage Reduction Reduced mains deterioration Increased ability to find leaks Reduced number of mains bursts	n/a	Aligned to customer preference Minimise customer supply interruptions from emergency bursts	Streetworks permits Size and length of main to rehabilitate Number of network monitoring meters, chambers and customer conections to	Efficient number of kilometres that can be replaced in one year Access to congested roads	**High**
Pressure Management	Direct Leakage Reduction Reduced burst frequency	n/a	Aligned to customer preference Reduced customer supply interruptions Increased mains asset life	Number and size of pressure reducing valves and chambers Number of tall building boosters Number of critical pressure points (ongoing maintenace)	Accurate level of pressure management reduction and therefore pressure management schemes available	**Medium**
DMA Enhancement	Increased ability to find leaks Direct Leakage Reduction	n/a	Detection of illegal customer usage Increase accuracy of DMA Water Balances Accurate allocation of customer use	Number of network monitoring meters and chambers Number and cost of leak detection hours Leak repair costs and streetworks	Maximum number of DMA Enhancement/Plus schemes identified	**Medium**
Water Efficiency	n/a	Reduced usage Reduced wastage Reduced business usage	Aligned to customer preference Wider awareness through media Long term behaviour change	Free water saving devices Plumber assisted audit	Customer uptake rate Smarter Home Visit to newly metered customers dependent on the number of new meters	**Low**
Non-Potable Supplies	n/a	Reduced customer usage from the potable network	Increased customer awareness Promotion of innovative solutions for the future	Construction and implementation of non-potable supplies on new developments	Maximum number of schemes currently available	**Very High**
Incentives	n/a	Reduced usage Reduced wastage	Increased customer awareness	Media campaign to advertise incentives Administrative costs	Uptake rate of the incentives programme	**Very Low**
Financial Tariffs	n/a	Reduced usage Reduced wastage	Increased customer awareness	Administrative costs to implement and track the programme	Minimum meter penetration required	**Very Low**

Note: High = high cost to benefit received in comparison with other options

8.35 Figure 8-4 provides an overview of the work required that incurs a financial cost, direct and indirect benefits and constraints associated with each demand management feasible option. It also shows the average cost benefit of each option relative to the other options to highlight the most cost efficient options. This relative value estimate does not consider cost benefit over time or take into account constraints on availability and deliverability.

8.36 The data lying behind this overview is presented in Sections 8.E to 8.G. These sections outline the source of data for our costs and benefits, the reason for any significant changes since WRMP14, the delivery constraints of each intervention and the impact this has on demand management optimisation. Since this detail underpins the discussion of the optimisation phase of demand management programme appraisal it has been presented at this stage.

Geographical scale

8.37 Demand Management options can be implemented anywhere; on any property or any pipe in the network. This is in contrast to water resource options which have fixed geographical locations and can be categorised at Water Resource Zone (WRZ) level.

8.38 To accurately assess demand management options, we must examine them at a smaller scale than WRZ level. The basic geographical unit for which costs and benefits are calculated and compared for each demand management intervention is the DMA.

DMA

8.39 A DMA is a discrete area of the water distribution network that can be isolated by closing valves so that the quantities of water entering and leaving the area can be metered. The volume of water into and out of the DMA is measured by a district meter. The purpose of a DMA is to divide each WRZ into manageable sections to detect and determine the location of burst mains, calculate the level of leakage in each DMA and compare DMAs so that activities can be targeted to where they will have the greatest impact in reducing leakage.

8.40 There are 1,640 DMAs in our supply area, typically covering approximately 2,500 properties each.

Demand management programmes

8.41 The purpose of evaluating the feasible demand management options (Figure 8-4) is to provide cost and benefit data to appraise them with the supply options and develop our preferred water resources management plan. However, if we attempt to evaluate each demand management option against the supply options individually, we cannot deliver a cost effective solution. Although the cost benefit of demand management interventions is lower than the supply options, the ability of each demand option to deliver a saving that either meets or significantly contributes towards the AMP7 supply demand deficit is either restricted (i.e. pressure management) or extremely costly (i.e. mains rehabilitation).

8.42 To ensure therefore, that we present a cost effective demand management solution, we create demand management programmes. A demand management programme consists of a mix of demand management interventions to achieve a certain level of demand reduction in each AMP period. There is a wide range of demand management interventions that could be put together in a large variety of potential programmes. For example, if we wanted to create the most cost effective demand management programme, it follows that we would predominantly make this up of the lower cost to benefit achieved options (i.e. water efficiency and pressure management) rather than pursuing more expensive cost benefit options (i.e. mains rehabilitation).

8.43 However, such an assessment alone does not take adequate account of the limitations to deliverability, availability, the additional benefits of combined options, the changing cost of schemes as they become more difficult to implement or the geographical scale of demand management. Consequently, not only must we develop demand management programmes but we must develop *optimised* demand management programmes (Section 8.D).

D. Optimisation

8.44 In Sections 8.B and 8.C we explained the screening and evaluation process used to determine the feasible demand management options. This section describes the final step in the demand management options appraisal process. It details our approach to optimising the feasible options to produce a range of demand management programmes.

Integrated demand management model

8.45 IDM is the optimisation modelling process we use to develop cost efficient demand management programmes. We do this using an optimisation tool called the IDM model. This involves appraising the overlapping costs and benefits of options that can be promoted in combination, in addition to evaluating each option individually. It also involves looking at the optimised combination of interventions for each DMA and assessing the deliverability constraints.

8.46 For example, considered independently, there is a fixed cost to install and read a meter at a customers' property. The benefit achieved is a reduction in consumption and CSL. However, when metering is promoted in conjunction with a Water Efficiency Smarter Home Visit (SHV), whereby the customer receives free water efficiency devices and a plumber assisted audit, the benefit achieved is greater, for a minimal additional cost.

8.47 Furthermore, traditionally it has been the case that only one demand management activity could be allocated to each DMA. However, using IDM, more than one demand management option can be allocated to a DMA to provide an optimal water saving solution. In this way, the IDM model can produce a range of optimised demand management interventions in as many DMAs as is required.

8.48 The IDM model process encompasses three phases: data input, optimisation and programme outputs (Figure 8-5).

Data input

8.49 All data inputs are made at the beginning of the process represented by the IDM model computer screen in Figure 8-5.

- **DMA inputs:** The IDM model is based on a GIS representation of our water network. This information is derived from our below ground asset register. This provides a list of DMAs and the physical attributes of the network within those DMAs. Background data relating to the number and distribution of properties, plus leakage, water usage and wastage in the DMA, forms the base data in the model. This information is sourced from our company asset register, Netbase, used in the daily running of the business
- **Feasible options:** The costs, benefits, availability and delivery constraints of the feasible demand management options are inputs into the model. Section 8.C provides an overview of these parameters and Sections 8.E to 8.8.179 provide specific details of the data used in the model and the source of this data
- **Scenarios:** The IDM model produces an optimised set of demand management interventions to achieve a specified target. By specifying a range of different demand management requirements, a range of different demand management interventions can be generated for comparison with water resource options as potential solutions to remove the supply demand deficit

8.50 The specific scenarios input into IDM to derive our range of demand management programmes are detailed in Table 8-4 in Section 8.H.

Optimisation

8.51 Once all the data have been input to IDM and the constraints set, the scenario can be set to optimise. IDM will search for a minimum whole life cost solution over the scenario planning period specified, at DMA level. This process is illustrated in Figure 8-5. The optimisation is conducted by reference to multiple parameters including cost, demand benefits and programme delivery constraints to produce demand management programme outputs.

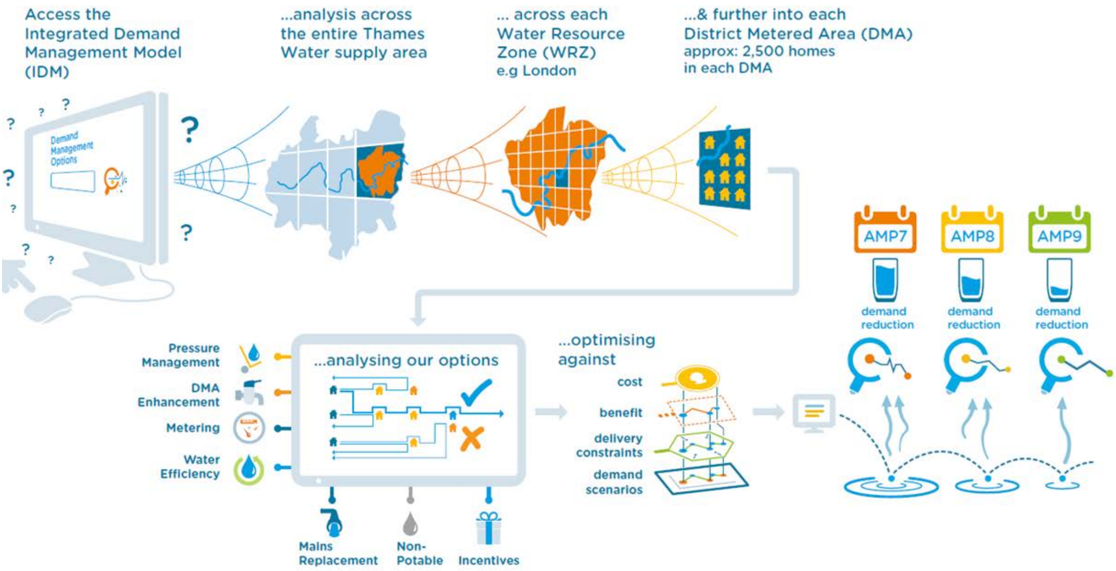
8.52 Appendix N: Metering includes the detailed behind this optimisation in IDM.

Programme outputs

8.53 The output of IDM is a range of optimised demand management programmes. Each programme represents the most cost efficient combination of demand management interventions for the demand scenario specified. The demand management programme can be broken down into the demand reduction it delivers per AMP.

8.54 Section 8.H summarises the demand management programmes that have been produced for the draft WRMP19.

Figure 8-5: IDM process



Accounting for mains deterioration

8.55 The IDM model addresses both leakage deterioration (part of capital maintenance) and enhancement (part of the draft WRMP19). This means IDM identifies the level of mains rehabilitation required to offset mains deterioration, and, if required, models the level of mains rehabilitation required to reduce leakage further.

8.56 There is a separate model known as the Distribution Mains Model that determines the level of mains rehabilitation required to manage leakage deterioration and to stop base leakage (Asset Health). Both IDM and the distribution mains model utilise the same leakage cost and benefits. However, the distribution mains model has pipes instead of DMAs as the relevant assets in its base data and it also optimises for further benefits including reducing bursts, interruptions to supply, low pressure and the level of unwanted calls. This allows the distribution mains model to provide for mains rehabilitation on individual pipes, groups of connected pipes or at a whole DMA level to achieve these benefits.

8.57 In principle, we could use the IDM model to only model the level of mains rehabilitation required to reduce leakage and not include deterioration. However, if deterioration was not included in the IDM model, and the distribution mains model only addressed deterioration, the most cost beneficial mains infrastructure would be targeted in both models, underestimating the total cost and length required. This would happen because the two models could potentially select the same pipes or DMAs to replace (i.e. the most cost/beneficial).

8.58 To prevent this occurring, we include the leakage deterioration requirement in the IDM model, and, at the demand management programme output stage (Section 8.H), we remove the mains rehabilitation required to manage leakage deterioration so only the enhanced programme is presented (note: the mains rehabilitation to manage leakage deterioration will be held within the Asset Health section of the overall price review).

E. Options to reduce leakage and usage - metering

8.59 Section 8.E details the costs, benefits, delivery methods and constraints associated with metering. This information is used in the IDM model to calculate the total benefit expected from metering. Metering is the only feasible demand option that delivers both a leakage and usage (usage and wastage) reduction.

Overview

8.60 Metering is widely supported by Government and stakeholders as an essential tool to facilitate the sustainable use of water. After a meter is installed on a customers' property and the customer is billed for the water consumed, their average total water usage is seen to decline. In addition, the ability to track consumption using metered data allows the identification and subsequent repair of wastage and CSL.

8.61 Metering has broad customer support, recognising that it is fair to pay according to how much resources are used. The Water Services Regulation Authority (Ofwat), Department for Environment, Food and Rural Affairs (Defra), the Greater London Authority (GLA) and the Consumer Council for Water (CCWater) have all stated support for metering as the fairest way for customers to pay.

8.62 Our supply area was designated as being in an area of serious water stress[7] and, in 2012, legal powers were granted to us to compulsory meter properties across our area by the Secretary of State. In WRMP14, this led to our Progressive Metering Programme (PMP) being initiated within the London WRZ.

8.63 Since the beginning of AMP6, we have installed over 200,000 progressive smart meters throughout our area (Section 2). The data from these meters is being used to educate customers on their daily water consumption, inform our Water Efficiency SHV programme and build up our database on water consumption, CSL and our two year billing window across our area.

8.64 This section provides an overview of our metering delivery programme use in the IDM model optimisation. It sets out details of the infrastructure used, the types of benefits that can be achieved by metering (usage, wastage and CSL reduction), the costs of metering and the delivery constraints. Appendix N: Metering provides further information and a more detailed analysis of our approach to metering.

Metering delivery models

8.65 The total demand reduction obtained from metering is dependent on the type of metering undertaken and whether it results in a usage reduction, leakage reduction or both.

8.66 In the draft WRMP19, our enhanced metering programme includes three delivery models: household metering, bulk metering and rehabilitation metering.

[7] Environment Agency and Natural Resources Wales, 2013, 'Water stressed areas – final classification', July 2013

Household metering

8.67 Household metering refers to any household property where a meter can be installed. It applies to compulsorily metered properties (referred to as 'progressive metering' in WRMP14) and includes detached, semi-detached or terraced properties as well as metering individual dwellings in small or large blocks of flats.

8.68 Household metering provides both a usage benefit from reduced customer consumption and wastage fixes, and a leakage benefit from the increased ability to detect and repair CSL.

Bulk metering

8.69 Bulk metering refers to the installation of bulk meters on the supply pipes of a block of flats. A small block of flats refers to properties with up to 12 dwellings. These properties are typically converted houses or terraces which have been developed into multiple dwellings. A large block of flats is defined as a property with greater than 12 dwellings, and is typically purpose built rather than converted.

8.70 There is a leakage benefit associated with bulk metering due to the increased ability to detect CSL on the shared supply pipe with smart metering data. There is no additional usage benefit claimed against the options as bulk customers are not billed individually based on their water use.

Replacement metering

8.71 Replacement metering refers to the programme to replace old 'dumb' meters with new 'smart' Automatic Meter Reading (AMR) or Advanced Metering Infrastructure (AMI) meters.

8.72 There is a leakage benefit associated with this due to the increased ability to detect CSLs with smart metering data. That is, with the broader roll out of the 'fixed network' (see Section 8.E, Infrastructure – fixed network) the benefits of replacement meters will now be more easily available. There is no additional usage benefit assigned to the metering intervention as replacement meter customers are already paying on a metered tariff. However, these properties will still be targeted by our Water Efficiency options and therefore will achieve a reduction in usage.

8.73 In comparison, in WRMP14, the rollout of our enhanced metering programme occurred across two delivery models: progressive metering and bulk metering. The benefits from rehabilitation metering were not included in our enhanced programme but were covered under our maintenance work. This was due to the minimal coverage of the fixed network at the time with the result that the CSL benefits associated with rehabilitation metering were not available. In both WRMP14 and the draft WRMP19, the benefits from optant metering have been included in the baseline water demand forecast.

Meter penetration

8.74 To determine the number of meters that can be installed across our area we model the number of meters that can be installed externally and internally and then apply a 'survey to fit ratio' to account for the fact that not all properties can be metered.

External and internal installations

8.75 Meters can be fitted either externally or internally at a property. This means;

- **External**: a meter is fitted in the pavement at the stop tap position. This has the benefit that the meter will record leakage on the customer's supply pipe aiding quicker leakage repair and the meters are easier to install and read.
- **Internal**: a meter is fitted at the first stop tap inside the property. This location is used if the property does not have an individual supply.

8.76 To model the distribution of external and internal meters in a DMA, the internal-external split is input into IDM and applied per property type. The data providing this information is obtained from the number of internal and external installations carried out from our PMP.

8.77 In WRMP14, we planned to install 441,000 smart domestic water meters by the end of AMP6. So far, we have installed 145,505 meters which is below our target. This was due to start-up challenges and the number of internal installations required being above that originally envisaged. In WRMP14, it was assumed that almost all our meter installations would be external. However, due to the property distribution in London, it was found that up to 20% of properties required an internal installation.

8.78 To ensure we can provide a realistic and achievable programme for the draft WRMP19, we have used the internal and external data split from the last two years of our PMP. This data is the most accurate and current information of internal and external meter installations and allows for a higher proportion of internal installations (see Appendix N: Metering for details). We have also updated our survey to fit ratios to more accurately reflect the likelihood of needing to install an internal meter.

Survey to fit ratios

8.79 It is not possible to fit a meter at all properties. This can be for a variety of reasons both technical and economic. Technical reasons include modifications to internal plumbing which prevent fitting a meter (e.g. a fitted kitchen); or there may be more than one supply serving the property, or a single supply serves more than one property. Sometimes fitting a meter would be technically feasible but prohibitively expensive.

8.80 To accurately model the potential number of meters that could be installed in a DMA, a survey to fit ratio is applied to each property type in IDM to identify the number of properties that can have a meter fitted. The survey to fit ratios applicable to the draft WRMP19, are based on access rates achieved during the PMP[8]. Compared with WRMP14, the average survey to fit ratio across all properties has remained consistent but with slight changes in the distribution, due to ratios having been updated in the latest three boroughs to be progressively metered. These are considered to be the most accurate representation of the survey to fit potential into the future and in subsequent AMPs (see Appendix N: Metering for details).

[8] Based on survey to fit ratios and approach of three London boroughs during 2016

Infrastructure – fixed network

8.81 In addition to the type of metering, the type of metering technology influences the total demand reduction achieved from metering. There are three types of meters currently installed on our network:

- **AMI:** using our fixed network meter system, meters are read electronically rather than by a meter reading. Electronic readings are passed from the meter through to utility offices for billing and network management purposes. With these systems it is possible to collect more frequent data on water consumption and alarm conditions (i.e. high CSLs).
- **AMR:** a meter with a short range radio is installed at each property. The meter reader equipped with a meter reading device is required to walk by the meter in order to take a meter reading but does not require physical access to the meter. This process can also be undertaken in certain circumstances by vehicle, known as drive-by reading. The data is captured electronically.
- **Dumb meter:** a conventional meter is installed with a register dial. Meter reading is undertaken by a meter reader gaining physical access to the meter and visually recording the meter reading. The meter reading can either be recorded in a book or keyed into an electronic meter reading data capture device. Some data capture devices have bar-code readers to record/check the meter serial number

8.82 In our plan we refer to both AMR and AMI meters as smart meters with the intention that AMI meters become the predominant smart meter in our network.

8.83 In WRMP14 we made the decision to use AMI smart metering technology and phase out dumb meters. This is because smart metering data supports customer usage and wastage reduction, water efficiency programmes and achieves a greater leakage reduction; smart meters provide real time information which allows continuous flow to be easily and quickly identified. In comparison, dumb meters will only highlight significant changes in overall consumption. Smart meters also provide greater insight into asset performance, improving the speed and effectiveness of decision making and enabling investments to be made more informatively.

8.84 To enable AMI smart metering, we are currently in the process of commissioning a 'fixed network'. This means we are working with existing telecommunication companies to use their masts as part of our smart metering roll out. These masts will communicate with our AMI smart meters and send the real time meter readings to a database. As a result, customers will be able to view their water consumption in real time.

8.85 In AMP6, we have worked with telecommunications partners to commission 106 masts in London with plans for a further 180 London masts and 119 Thames Valley masts to be commissioned in AMP7. As the fixed network is rolled out, our smart meters are installed with Local Communication Equipment. These are initially set up as AMR with the capability to be switched to AMI as the fixed network communication masts become available.

Benefits

8.86 There are three demand reduction benefits associated with metering. They are a reduction in customer usage and in wastage, and repair of CSL. The total demand reduction obtained from metering is dependent on the type of metering undertaken and whether it results in a usage reduction, a leakage reduction or both.

Usage reduction

8.87 The reduction in customer usage as a result of metering is applied to household metering. This means that we have observed customers changing their behaviour in response to being charged specifically for the volume of water they use.

8.88 In the draft WRMP19, we have used the results of the 'Using Household Consumption Models to Estimate the Impact of Metering, February 2017'[9] study to estimate the usage savings achieved through household metering. This study estimated a 17-19% reduction in overall usage if 20% of unmeasured flats and all unmeasured houses were metered. At this stage, we have used the 17% figure to represent the change in customer behaviour resulting from being billed on a metered tariff only. It does not include any savings achieved from a wastage or CSL fix or the customer taking part in any Water Efficiency interventions (Section 8.8.179).

8.89 The average usage reduction of 17% per property is based on models of usages of properties which have been metered (the metered consumption model) and of a statistically robust equivalent set from the unmeasured consumption monitor (Domestic Water Use Study, DWUS) panel. Our DWUS panel consists of approximately 1000 properties whose consumption is metered but they are not charged according to volume, and therefore behave as unmetered customers. The occupancy of these properties is known, the impact of wastage is removed and the dataset is regularly calibrated. The DWUS panel is used in our regulatory reporting to extrapolate to the unmeasured household population.

The metered consumption model

8.90 The metered consumption model used for this study is based on 8,567 properties, across all property types and demographics that had a dumb meter fitted over the 27 years since 1990 and for whom we had occupancy data[10]. The metered properties include:

- **New Domestics:** W have installed a meter on every new house since 1990 and charged customers on a metered tariff. These are considered to most closely represent the likely behaviour of households receiving meters under the PMP
- **Free Meter:** An old initiative where properties received a free meter and customers were charged on a metered tariff
- **Optants:** Households who have opted to have a meter fitted on their properties

[9] Cocks R, February 2017, '*Using Household Consumption Models to Estimate the Impact of Metering'*, Thames Water.
[10] Understanding the number of people living in a property is critical to obtaining an accurate understanding of change in usage. See, '*Using Household Consumption Models to Estimate the Impact of Metering*', February 2017.

8.91 This dataset was considered our most realistic and robust dataset to date because:

- The property occupancy is known. The metered properties all had an SHV in 2015 and therefore their occupancies were accurately recorded. Occupancy is the only information used in the metered consumption model that was obtained during the SHV (i.e. consumption after the SHV was not included in the metered consumption model to ensure it only included data on customer behaviour in response to being charged on a metered tariff)
- A proportion of these customers had been paying on a metered tariff for up to 27 years. This was deemed to be more representative of the long term impact of customers paying on a metered tariff and would also take into account any potential ***decay*** in savings over time. As a result, we have assumed the 17% benefit will be sustained throughout the planning period
- It would provide a conservative estimate of the usage reduction achieved from metering because these customers were on a dumb rather than AMI meter
- The impact of Optants has been removed to ensure these results did not artificially inflate the savings

8.92 The dataset is also considered to provide an underestimate of usage savings. This is due to two factors:

- The properties used in the metered consumption model were customers who had taken up an SHV (because these are the only metered customers for whom we have occupancy information – note that the meter readings after an SHV were **not** included). However, the 'Comparison of Households accepting and not accepting Smarter Home Visits'[11] study showed that customers who chose to have an SHV had a higher usage prior to their visit than customers who chose not to have an SHV. This means that the customers used in the study had not saved as much water by being on a meter as the customers who rejected a smarter home visit. Consequently, we may be potentially slightly underestimating the total usage savings by being on a meter
- As mentioned above, we have taken the lower end of the 95% confidence band around the 19% central estimate of savings. Although the study author recommended the 19% figure as more representative, we have chosen at this stage to apply the 17% figure in our IDM modelling to be conservative in our benefits and this percentage figure is more aligned with savings seen by other water companies, e.g. South East Water who quote figures of 15-18%

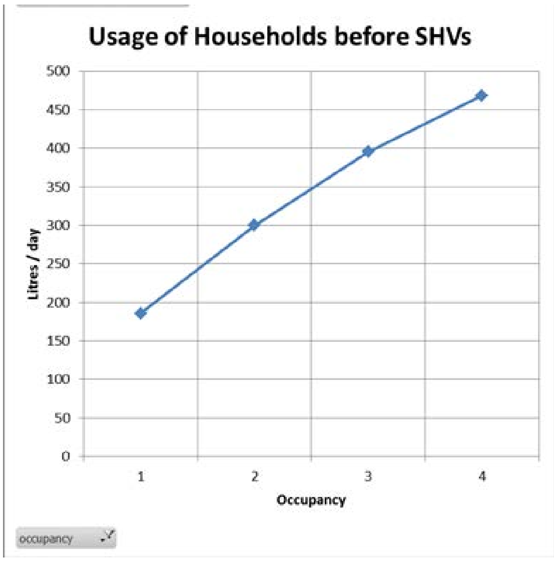
Why do we need to know occupancy?

8.93 Household water usage is determined by two components; personal usage and property usage. Personal usage is related to the number of occupants in a household. That is, personal usage of a household increases with the number of people living in the property. Property usage is unrelated to occupancy (e.g. garden water usage and wastage), or is water used less efficiently when there are fewer people in a household. Together, this means

[11] Cocks R, July 2017, 'Comparison of Households Accepting and not accepting Smarter Home Visits', Thames Water

household water usage is not linearly related to the number of occupants (Figure 8-6), so when modelling usage we need to understand both components.

Figure 8-6: The impact of occupancy on household use[12]



8.94 If we do not include occupancy we do not necessarily have an accurate or reliable comparison. That is, if we use metered properties with a high proportion of high occupancy properties, we are likely to severely underestimate the savings achieved from metering as it would appear that metered properties still use a large volume of water. Conversely, if we use metered properties with a high proportion of single or two people occupancies we are likely to severely overestimate the savings achieved by metering, as in comparison to the DWUS panel single occupancy households would use a much smaller volume of water.

8.95 Therefore, it is critical to know occupancy to ensure it is factored in to the metered consumption model to provide statistically robust results that can realistically be extrapolated to our wider area.

How has our data changed since WRMP14?

8.96 In WRMP14, it was assumed the usage savings achieved through household meter installation was 12% per property. This was based on a similar study to the draft WRMP19, where measured properties from the billing system were compared with data from our unmeasured consumption monitor (DWUS panel). However, in comparison with the measured data used for the draft WRMP19, the measured data for WRMP14 did not include occupancy. This means the risk to either overestimate or underestimate savings was inherent in this dataset.

8.97 For WRMP14, although it was known that occupancy was critical to ensure a robust and accurate assessment, we did not have occupancy data on our metered customers at this time. In transferring to a metered tariff our customers are not obliged to tell us the occupancy

[12] Thames Water (2017), 'R modelling of metered households using SHV data' spreadsheet, October 2017

of their households and we do not keep these records on our billing system. Therefore, although the risk of conducting this study without occupancy was known, the data on our billing system was deemed the most accurate data available and the best we had at the time to estimate the impact of metering. It also aligned with previous studies available at the time which indicated a saving of 10-15% from the national water metering trials conducted in the 1990s.

8.98 In addition, in WRMP14 we did not know whether the customers had opted for a meter or been part of the very early PMP. This means, neither occupancy nor the impact of optants was taken account of in our model in WRMP14. This has resulted in a much lower estimate of usage reduction in comparison with the draft WRMP19 when both occupancy and the impact of optants have been considered.

Verifying our savings

8.99 To benchmark the results of our metered consumption model we have looked at studies by Southern Water, Affinity Water and South East Water. In a report by Southampton University in February 2015, Southern Water have shown a 16.5%[13] reduction in usage studying over 500,000 customers from their universal metering programme. This reduction is also based on the reduction of usage from the impact of paying for the volume of water used. Similarly, studies by Affinity Water have shown a 16%[14] reduction in usage based on a 70,000 meter installation programme in Kent, South East Water has metered 90% of households during AMP6 and quotes savings of 16-18%, and Anglian Water quotes up to 15% savings.

8.100 To continue to verify our metered consumption model, we will be targeting the customers who first entered our smart meter PMP for an SHV. We will be targeting these customers for an SHV to confirm the occupancy of these properties since our billing system does not hold this information. Since 2015/16 (year 1 of AMP6), customers on our PMP have received a smart meter (AMR or AMI) rather than a dumb meter. It is expected these customers will make greater savings in usage because they have real time feedback on their water consumption and its impact on their bill.

8.101 Unfortunately, in addition to not knowing the occupancy, due to the extended adjustment period afforded to all customers on our PMP there is not a population far enough through the journey to assess the end impact of the programme. The extended adjustment period we afford our customers is referred to as the ‘two year journey’ and allows for an adjustment of two years between installation of the meter and being charged on a measured tariff. We expect our customers to have a two year depreciation in their use of water toward the final expected level based on:

- 10% of total reduction in the year of meter installation
- 50% of total reduction in a year after meter installation and following their first two comparative bills
- 100% of total reduction two years after the meter installation as the customer is transferred to a measured tariff

[13] The UMP programme: Effects of metering, water efficiency visits and billing University of Southampton, Universits’ di Bolzano in collaboration with Southern Water
[14] https://www.affinitywater.co.uk/water-saving-programme-faq.aspx

8.102 This assumption of water use behaviour behind the two year journey has been entered into the IDM model.

8.103 We expect the first customers of the smart meter PMP to complete their two year journey at the end of 2017 and early 2018. Once they have received an SHV and we can confirm their occupancy, these customers can contribute to the metered consumption model used to verify meter usage reductions.

Customer side leakage and wastage reduction

8.104 When a customer has a meter fitted it will identify if there is a continuous flow of water on the property. Continuous flow is where the flow rate does not drop below a minimum consistently for a number of days. Continuous flow on an external meter indicates the customer either has a CSL on their supply pipe or wastage within their property (i.e. a leaking tap or internal small pipe leak). Continuous flow on an internal meter indicates the customer has wastage within their property.

8.105 When a property is identified as having continuous flow, it is labelled as a point of interest (POI) and our leakage teams will visit the property and prove whether there is a CSL or wastage. For the draft WRMP19, it is assumed that a POI is applicable when a property has continuous flow greater than 15l/hr.

Wastage

8.106 Since wastage has been included in both the DWUS panel and metered consumption model and assumed to remain constant, it has not been included in the 17% usage reduction and must be identified separately in the IDM model.

8.107 To account for wastage we calculate the number of properties where we expect wastage to occur across our area. This is based on the likely number of POIs to be raised for external and internal meters and the percentage of these POIs that can be attributed to a wastage fix. The average saving achieved from a wastage repair is applied to calculate the total wastage benefit (see Appendix N: Metering for details).

8.108 The number of properties with POIs, the percentage of POIs applicable to wastage and the average saving achieved from a wastage repair is based on real data collected from our PMP.

Customer side leakage

8.109 CSL reduction covers the losses within the customer's pipework on their property. It is estimated that over a quarter of our total leakage is due to CSLs. In WRMP14, CSL was considered to be part of the mains rehabilitation intervention. However, due to inefficiencies with detecting and repairing CSLs through the mains rehabilitation process together with the additional detection benefits realised through the installation of smart meters, CSL repair is considered under the metering intervention in the draft WRMP19.

8.110 In the draft WRMP19 we are also targeting smaller CSLs in comparison with our approach in WRMP14. That is, the minimum leakage level we plan to target is 15l/hr, compared with a level of 25l/hr targeted at WRMP14. This will allow us to detect and resolve the smaller leaks that may have been running unnoticed for a long period of time in addition to the larger leaks that are often easier to detect.

8.111 To account for CSL in the IDM model, we calculate the number of properties where we expect CSL to occur throughout our area. This is based on the likely number of POIs to be raised for external and internal meters, the percentage of these POIs that can be attributed to CSL repairs and the average saving achieved from repair of a CSL (see Appendix N: Metering for details).

8.112 This data is based on real data collected from our PMP customers who have had a CSL detected and repaired. The leakage deterioration rate is applied to CSL savings to account for deterioration.

Metering cost

8.113 Meter installation costs are made up of the cost to survey, install and read a meter. The cost to survey and install depends on the size and position of the meter regarding whether it is in the pavement, the soft verge or within the property. The cost of a bulk meter installation includes the cost of the meter and also the meter chamber, an extra cost against the standard rate.

8.114 The cost to install a meter internally is more expensive than an external install due to the additional time and resources required for the customer appointment facilitation. The cost to install an AMI meter both internally and externally is more expensive than for an AMR or a dumb meter due to the additional cost of the AMI meter itself.

8.115 The cost to read an AMR or dumb meter is based on the time and resource required to drive or walk by the meter respectively to collect the reading. The cost to read an AMI meter is not included on a per meter basis. This is because the cost of an AMI meter reading depends on the fixed network infrastructure and therefore does not fluctuate depending on the number of meters, unlike for AMR and dumb meters. The cost of fixed network is discussed below.

8.116 The metering costs used in the draft WRMP19 are based on actual costs from AMP6. These are higher than the costs used in WRMP14, due to substantial underestimates in the WRMP14 figures where overheads (i.e. running depots, travel) were not factored into the total costs. The supplier under WRMP14 also underquoted and then could not deliver the service required. We have rectified this situation by engaging a new supplier early in AMP6 to ensure we could deliver our metering programme. However, as a result there has been an increase in the costs we planned for in WRMP14.

Fixed network

8.117 The cost of the fixed network is included as one fixed cost. This is because there is a certain cost to commission and maintain the further 180 masts in London and 119 masts in Thames Valley. These costs have been based on the costs to commission the existing 106 masts in London in AMP6 and the quotes received to commission the further masts in in AMP7. Table 8-1 summarises the total costs added to our programme to establish the fixed network across our whole area. These costs are presented as the total cost per meter to commission, operate and store data each AMP and each year. The total number of meters includes progressive, optant, replacement and bulk meters. Commissioning refers to the commissioning of the masts in London and Thames Valley. Operation refers to the ongoing maintenance costs of these masts and Head End Services (data storage) refers to the set of the AMI database to manage the real time data.

8.118 The cost of the fixed network per meter installed is much greater in AMP7 than AMP8 and AMP9. This is due to the commissioning costs applied in AMP7 and the greater overhead services to complete a planned upgrade in 2020/21. As more meters are added to the fixed network the cost per meter declines such that the average cost of £1.08 per meter per year is expected to be maintained beyond AMP9.

Table 8-1: Fixed network costs by AMP per meter installed

Fixed network component	AMP7	AMP8	AMP9
Total cost per meter per AMP	£40.50	£7.50	£5.40
Total cost per meter per year	£8.1	£1.5	£1.08

Asset life

8.119 The asset life of a meter has been assumed to be at 15 years. For AMI and AMR meters, this is the point where the manufacturer expects the battery life to cease and therefore stop the transmission of data.

Delivery constraints

8.120 Section 8.E has outlined how we deliver our metering programme, determine meter penetration and calculate the benefits and costs of metering. This information has been entered into our IDM model and optimised to determine three objectives:

- the maximum number of meters possible
- the level of metering in our most cost effective demand management programme
- the deliverable level of metering across our area each AMP

Maximum number of meters

8.121 To determine the number of meters that could be installed across our area, the IDM model was run unconstrained. This means that we did not put any demand constraints on the model, and instead told the model to achieve its maximum meter penetration based on the internal and external split and survey to fit information we had provided.

8.122 The results of the unconstrained IDM run showed that we could install 1,032,691 household meters across our area from AMP7 onwards. This does not mean that every house will be metered but rather this is the level of metering physically achievable at reasonable costs based on the survey to fit information we had provided. It is possible that in future AMPs, as we improve our survey to fit ratio (e.g. find ways to access more customers with shared supplies and make it easier to access customers, especially those resistant to a smart meter, and fit a meter); the maximum number of meters could increase. This is something we will continue to work on over the planning period for review and incorporation into WRMP24.

Cost effective level of metering

8.123 To determine the level of metering in our most cost effective demand management programme, we ran IDM with various constraints on demand but no constraints on metering. This means we asked the model to find a certain level of demand each AMP over the planning period where it could optimise between the interventions to find the most cost effective solution. This allowed the model to choose between metering and all the other interventions.

8.124 The results of this showed that, due to the cost effectiveness of metering, IDM chose to achieve almost full meter penetration by the end of the planning period (i.e. by the end of AMP9 in 2034) for every demand scenario.

8.125 Using London WRZ as an example, the most cost effective programme included between 600,000 and 680,000 meter installations in AMP7 with the remaining meters (up to 190,000) being installed across AMP8 and AMP9. This showed that due to the low cost of metering relative to other options to achieve the expected benefits, it is cost effective to undertake the majority of metering at the beginning of the planning period. This leaves the meters that are more difficult and more costly to install until AMP8 and AMP9. In AMP8 and AMP9, in comparison with the other demand management interventions, they then become more cost effective.

Deliverable level of metering

8.126 Although the cost effective level of metering indicated up to 680,000 meters (out of 790,000) could be installed in AMP7 in London, we consider the level of risk around deliverability of this number of meters to be too high to adopt this programme in our plan.

8.127 The reasons for this are based on our AMP6 performance (Section 2: Water resources programme 2016-2020). We do not believe our teams can increase the rate of successful meter installations and remain cost effective by the beginning of AMP7. That is, there is an optimal level of metering which is the most cost effective. Too little metering and the cost of per meter increases due to significant overheads. However, a significantly larger programme can also reduce in cost effectiveness due to inherent inefficiencies in delivery. Therefore, we need to plan for the most cost efficient delivery of meters in AMP7.

8.128 Also, for each demand scenario we set a limit on the level of demand the model needs to find. Since metering is cheaper than other solutions, the model will choose to do a majority of metering in one AMP at the expense of more costly but lower risk solutions (i.e. mains rehabilitation). This means we would be reliant on reducing our leakage level through finding and fixing a large volume of CSLs rather than a more balanced mixture of CSL fixes and mains rehabilitation. If we do not achieve the required CSL reduction, there is a risk we will not deliver the total demand savings required to meet the supply demand deficit in AMP7. In addition, metering becomes more difficult with time as we are required to do more internal installs and the external installs that remain unmetered are more difficult (i.e. not previously VMR areas or require permits to access the pavement). We have therefore spread our delivery risk across a number of demand solutions and over three AMPs.

8.129 Our teams can increase their performance to achieve a higher level of successful meter installations. Consequently, we have determined that an ambitious but realistic metering programme includes the installation of 400,000 meters across our area (i.e. 320,000 in London and 80,000 in Thames Valley) in an AMP. This level of metering allows for a significant increase in our current metering programme but allows for a balanced mix between metering and other demand management solutions to achieve an acceptable delivery risk score for the overall demand management programme.

8.130 For the model runs passed to the EBSD model (Section 8.H), we have constrained metering to deliver 400,000 meters across our area in each AMP. This aligns with our total meter installation programme to deliver just over 1 million meters by the end of AMP9.

F. Options to reduce leakage

8.131 Leakage management consists of two predominant components:

1) the level of activity required to manage our existing level of leakage. This includes activity that either repairs or offsets (e.g. through maintenance of our pressure management schemes) the leakage resulting from the deterioration of our water mains. It also includes activity required to repair burst water mains and ongoing active leaks. We manage this activity in the Water Infrastructure or maintenance part of our business
2) the level of activity required to go beyond this and reduce leakage further. Further reductions in leakage arise from our enhanced leakage programme which is covered by the activities in the draft WRMP19

8.132 Customers and stakeholders have clearly indicated they wish to see leakage reduced (Appendix T: our customer priorities and preferences). Our ambition is to strike the right balance between our desire to reduce leakage further and the financial impact of leakage reduction on customers' bills. We also need to consider the need to maintain a robust and efficient water distribution network and the need to manage traffic congestion and household disruption that occur as a result of leakage reduction activity on our network.

8.133 Section 8.F details the costs, benefits, and constraints associated with options that reduce leakage: mains rehabilitation, Pressure Management and DMA Enhancement. This information is used in our IDM model to calculate the total benefit expected from these interventions. Trunk mains leakage control has not been included in this section as it is an activity that contributes to the maintenance of our current leakage position. However, trunk mains leakage and the full details of our leakage interventions are contained in Appendix M: Leakage.

Mains rehabilitation

Benefits

8.134 Mains rehabilitation is a long term sustainable option that involves the rehabilitation of water mains and communication pipes. The direct leakage benefit of mains rehabilitation includes:

- Fewer bursts and visible leaks on our network
- Fewer active leaks on our network
- Less deterioration of our network
- A reduction in Operating Expenditure (Opex) required for leakage detection and repair work to manage a deteriorating network

8.135 Additional benefits of mains rehabilitation include fewer interruptions to supply, fewer complaints of low pressure and fewer interruptions to traffic and local amenities due to emergency and planned repairs.

8.136 In the IDM model, we have considered mains rehabilitation across four interventions:

1) rehabilitate 25% of mains in a DMA
2) rehabilitate 50% of mains in a DMA
3) rehabilitate 75% of mains in a DMA
4) rehabilitate 100% of mains in a DMA

8.137 This allows IDM to optimise the level of mains rehabilitation required in individual DMAs. This is an improvement on WRMP14 where we only considered 100% mains rehabilitation for each DMA. For example, one DMA may provide a cost beneficial solution with 25% of mains rehabilitation and the remainder of the DMA is managed with other demand management interventions. An adjacent DMA may have limited demand management interventions available (i.e. pressure management and DMA enhancement are not available and the DMA is already fully metered) and therefore the most cost beneficial solution would be to conduct 75% or 100% mains rehabilitation in that DMA.

8.138 The reduction in leakage that can be obtained from mains rehabilitation is based on the output of our Asset Investment Manager Distribution Mains model.

8.139 This information is modelled in our distribution mains model at pipe level. The distribution mains model looks at pipe condition as well as performance to ensure mains rehabilitation is targeted to deliver sustainable benefits. This means mains rehabilitation targeting is being done at street and 'superstring' level. Superstrings are pipes connected to each other of the same age, material and diameter. By analysing the performance of each pipe, those pipes within a DMA that are performing poorly can be targeted.

8.140 The benefit of mains rehabilitation, an output from the distribution mains model, is input to the IDM model to capture the benefit for each of the four mains rehabilitation interventions.

Cost

8.141 The cost of mains rehabilitation is derived at DMA level and based on:

- The size and length of main to be replaced
- The techniques required to replace the main (i.e. open cut, slip lining)
- For London, the costs are based on costed schemes by borough/cost zone models.
- For Thames Valley, costs are based on inner city and outer city cost models.

8.142 Data from our Engineering Estimating System (EES) is used to develop the cost models for mains rehabilitation. The output of the EES cost model is input into the IDM model. The mains rehabilitation costs are made up of two predominant components, unit costs and uplifts.

Unit cost

8.143 The unit cost data of replacing a pipe is provided by EES. Unit costs are broken down by borough and zone and according to the techniques required to replace the main. That is, there is a different unit cost for the following in each borough or zone:

- Open cut installation
- Insertion
- Directional drilling
- Pipe bursting
- Communications pipe to customers
- Communications pipe to businesses

8.144 In doing this we have assumed the proportion of open cut installation in each borough is based on the density of communication pipes. That is, a high density of communication pipes means open cut must be used based on previous experience.

8.145 The rates per meter applied by zone are £400 to £800. The rate applied depends on whether the work will be undertaken in north London, south London, the Thames Valley city centre or the Thames Valley rural area. Both north and south London are made up of a mix of inner and outer London.

Shorter lengths

8.146 The complete cost to us (for both WRMP and Asset Health) includes going into some DMAs to rehabilitate short lengths of main. However, the cost per metre of replacing these shorter lengths is comparatively more expensive than replacing many streets of pipe in the one project. This is due to several fixed costs associated with mains rehabilitation such as setting up the site, organising traffic management, conducting health and safety assessments and establishing on site facilities (i.e. comfort facilities). To ensure we accurately model the costs and benefits of replacing different lengths of pipe we have included the costs to replace shorter lengths of pipe. This has a minimal impact on the WRMP programme as our interventions are designed to rehabilitate a certain percentage of the DMA and consequently avoid the shorter lengths of mains rehabilitation (these shorter lengths more heavily influence our Asset Health programme).

8.147 In comparison with our estimates in WRMP14, the cost per meter of mains rehabilitation has increased. This is due to three factors:

- availability of cheaper areas for rehabilitation has reduced as we have targeting these cheaper areas in previous AMPs and therefore the costs are greater to work in the remaining areas
- the costs applied from councils for access and traffic management have increased

- a review of communications pipe density and short length uplift used in WRMP14 based on work completed in AMP6 resulted in updated cost models being used in the draft WRMP19

8.148 In addition, we have undertaken some improvement work in the draft WRMP19 to update our cost models so they more accurately reflect the zoning profiles in London and include actual costs of work over the previous AMP. These have been updated to revise the cost profile differentials between inner and outer London and cross check these profiles with our work to ensure they are realistic. Although this work has significantly improved the accuracy of our data it does reflect an increase in average cost from WRMP14 to the draft WRMP19.

Mains rehabilitation costs over time in the IDM model

8.149 To understand the relationship of mains rehabilitation costs over time we optimised the IDM model for mains rehabilitation only. This showed that in the early part of the plan (AMP7), mains rehabilitation costs were cheapest as the model selected areas that were located in cheaper zones and had lower levels of communication pipes (i.e. to reduce the level of open cut activity required). As time progressed and we had undertaken the more cost effective rehabilitations, IDM selected areas with slightly more expensive mains rehabilitation costs (e.g. inner South London areas with slightly higher communication pipes numbers). Then, as that cost band of mains rehabilitation was completed, IDM was left to select the much more expensive mains rehabilitation.

8.150 The relationship of mains rehabilitation costs over time is also reflected in the Thames Water, Mains Replacement Programme Independent Review[15]. This states that in the period to 2010, we achieved an average leakage saving of 1Ml/d for each 12km of mains rehabilitated. Based on the projections in our final WRMP for 2009, amended and submitted to Defra in March 2012, the leakage savings associated with mains rehabilitation were projected to reduce to 1 Ml/d for approximately 13km of mains replaced for the period 2010-2015 and 1 Ml/d for approximately 33km of mains rehabilitated for the period 2015-2020.

8.151 This relationship is particularly significant in our ambition to reduce leakage further. We ran IDM for multiple scenarios to explore the cost and range of activities required to meet specific levels of leakage reduction. In all scenarios, in order to achieve a much higher leakage reduction, IDM optimised for a significant degree of enhanced mains rehabilitation which significantly increased the costs of the demand management programme, sometimes to prohibitive levels. This cost increase is due to the significant increase in cost of mains rehabilitation. These programmes have contributed to our final list of programmes (Section 8.H) that will be optimised against the supply side solutions in EBSD.

Delivery constraints and IDM optimisation

8.152 Mains rehabilitation has one of the highest cost benefit ratios (second only to non-potable interventions) demand management interventions available in IDM. This means that IDM will optimise using other lower cost beneficial ratio interventions when they are available in preference to mains rehabilitation.

[15] Black and Vetch, Chandlers KBS, GL Water, 2012, 'Thames Water Mains Replacement Programme Independent Review, Findings and Recommendations Report', Thames Water Utilities to Ofwat, July 2012

8.153 To ensure the deterioration of our network is managed reliably, we have constrained the model to do a minimum number of kilometres of mains rehabilitation in each AMP. The benefits achieved from this minimum number of kilometres contribute to the Water Infrastructure (maintenance) side of the business rather than the WRMP. If the IDM model optimises to include additional mains rehabilitation above this minimum, then the benefit achieved from the additional kilometres of mains rehabilitation will be part of the enhanced demand management programme for the draft WRMP19. This is done to ensure the cost of mains rehabilitation is not underestimated (Section 8.D).

8.154 The degree to which the IDM model optimises to include an enhanced mains rehabilitation programme depends on the availability and cost comparison of other demand management interventions and the total demand that has been requested in each AMP. For example, in AMP7, when all demand management interventions are available, IDM will optimise to only include enhanced mains rehabilitation where required because it is more expensive than the other interventions. However, in AMP8 and AMP9 as the other demand management interventions decline (i.e. there is no further Pressure Management or DMA Enhancement available and fewer new meter installations) IDM will optimise to include a higher proportion of enhanced mains rehabilitation activity. This is despite the cost of mains rehabilitation becoming increasingly expensive with each AMP.

Pressure management

8.155 Pressure Management refers to the reduction of excess pressure and fewer pressure fluctuations within the water mains network to reduce the overall leakage and usage in a discrete area of the network. It is also believed to have an effect on the overall performance of our network, providing a reduction in burst frequency and an increase in the anticipated remaining asset life of a pressure-managed network. To achieve this, Pressure Reducing Valves (PRVs) are installed and a discrete area set up through the use of new or existing valves to reduce pressure to a targeted level – this is termed a Pressure Managed Area (PMA). We install Critical Pressure Points (CPPs) within our pressure managed DMAs which feed back to the controlling valve or pumps through telemetry systems to cause a change in the outlet pressure at that asset, such that the pressure at the CPP location remains constant.

8.156 We have a long history of implementing pressure management throughout our area. This means that opportunities for further pressure management in the next planning period are limited, but not yet exhausted.

8.157 The total volume of pressure management available was demonstrated by our alliance partners based on their expertise and experience with AMP6 activity. The total number of schemes and benefits that could be obtained from these schemes was used as an input into the IDM model.

Costs and benefits

8.158 In developing the number and cost of schemes that were available for pressure management, the following assumptions were employed:

- Greater than 5% of the DMA must have pressures higher than 35m before a DMA was eligible for pressure management

- The cost of pressure management must factor in the 12% conversion rate from survey to install for Tall Building Boosters. i.e. 12 out of 100 surveys result in a tall building booster installation.
- The size of the PRV required and therefore the cost of the scheme is equal to the size of the largest two metered inlets (i.e. District Meters).
- The number of PRVs required is assumed to be 1 PRV per District Meter.
- The number of CPPs required is one per scheme.

8.159 DMAs with a current pressure below 30m were not considered as there is minimal leakage savings that can be achieved by dropping pressure 1-3m. DMAs are also required to have an average minimum pressure of 25m before they are considered for pressure management. This ensures we can continue to meet our service levels (i.e. 10m pressure and 9l/s flow at the property boundary) without an infeasible number of tall building boosters being installed. Although the legal position of water companies is unclear in this area, we have historically installed tall building boosters in PMAs to maintain supplies to tall buildings (anything above four stories) and avoid customer complaints.

8.160 DMAs with current pressure above 40m were not considered to be reduced to 25m due to:

- high volumes of customer complaints when pressure is reduced by more than 10%. Customers in particularly high pressure areas are used to that pressure and may be required to alter their own internal systems (i.e. pressure to attic bathrooms) to accommodate lower pressures (even if we still comply with the minimum level of service).
- network restrictions - areas with significantly higher pressures usually require that level of service.
- new developments in high pressure DMAs have often been found to have undersized pipes. When developers identify a high pressure area, a smaller bore of pipe is often considered to be a more cost-efficient solution. Although this is the developer issue at construction, many customers in our supply area will be unaware of this and a significant reduction in pressure by us will cause additional costs to these customers

8.161 The volume of leakage reduction that can be achieved from a pressure management scheme has been developed using the data from Water Net. Water Net holds data for existing average pressure reductions in DMAs and the volume of leakage that pressure management areas are holding back. Water Net is our system for forecasting, calculating, reporting and monitoring leakage savings and PMA maintenance.

8.162 The cost to implement a PRV scheme was based on EES Cost Models. This includes the cost of:

- Butterfly Valve – strategic valves only;
- Data Controller - PRV configuration;
- PRVs - configuration 1 (On bypass);
- PRV - configuration 2 (Inline);
- Tall building boosters;
- Ongoing maintenance Opex.

Asset life

8.163 In WRMP14 we assumed a pressure management scheme would provide no further benefit to leakage reduction at the end of its life (i.e. at 20 years). In the draft WRMP19 we have included a cost to maintain the benefits from pressure management beyond 20 years by maintaining the infrastructure.

Delivery constraints

8.164 Due to our long history of pressure management throughout our area the volume of pressure management available for AMP7 is limited. Our analysis found that the total number of schemes available for pressure management in London was 150. In total these schemes could achieve an average leakage saving of 12.5 Ml/d across the AMP. The total volume of schemes available in Thames Valley will achieve a leakage saving of 5Ml/d.

8.165 Given the limited volume of pressure management available we have constrained the IDM model to assume all pressure management schemes are undertaken in AMP7. This means that we will have exhausted all pressure management opportunities by 2024 and will thereafter only include activity to maintain these pressure management schemes.

8.166 In addition, we have assumed that the benefits of pressure management will contribute towards offsetting water network deterioration. That is, 10 Ml/d of the pressure management benefit for London and 5 Ml/d of the benefit for Thames Valley are utilised in the Water Infrastructure (maintenance) side of the business and do not contribute towards the enhanced demand management programme for the draft WRMP19. This meant that our enhanced demand management programme included approximately 2.5 Ml/d of pressure management benefit in London in AMP7 and no enhanced pressure management in the Thames Valley. This is a significant reduction compared with WRMP14 but emphasises the work we have already conducted in this area over previous planning periods.

DMA enhancement

8.167 DMA Enhancement comprises two demand management interventions, DMA Enhancement and DMA Enhancement Plus (Figure 8-7).

8.168 DMA Enhancement replaces the enhanced portion of Active Leakage Control (ALC) that was included in WRMP14. ALC in WRMP14 referred to enhanced levels of 'find and fix' activity over and on top of that already being undertaken to maintain current levels of leakage. We continue to pursue ways to improve our find and fix activity during the rest of AMP6, but due to the condition of our network and volume of work we have undertaken in AMP6 (Section 2.0: Water Resources Programme 2016-2020), further conventional find and fix work is limited for the draft WRMP19. We have assessed that if we are to detect and repair enhanced levels of leakage on our network, we need a more innovative solution. Consequently, DMA Enhancement and DMA Enhancement Plus are included in the draft WRMP19 to replace the traditional 'enhanced ALC' intervention.

DMA enhancement

8.169 DMA Enhancement is defined as improving the accuracy of leakage detection by better accounting for demand and hence leakage and then following up with more intensive leak detection techniques. First all the data defining the DMA is checked. This uncovers anomalies in the network, assets, properties and customer assignments, and property and customer water use. Corrections and improvements are made in respect to each task where it will in turn improve data quality for the three components (water supplied, water consumed and leakage). The interaction between these components will either reduce leakage directly or help narrow the search of leaks in reality.

8.170 Once the DMA has proven to be reporting leakage accurately, a range of leakage detection techniques (traditional and advanced) can be used in the DMA to find the leakage.

DMA enhancement plus

8.171 DMA Enhancement Plus combines DMA Enhancement with network reconfiguration activity. That is, some DMAs are particularly large (> 5,000 properties or > 6 District Meters), making traditional 'find and fix' activity more difficult to yield leakage control results. In comparison, a small DMA has <=2,500 properties or <= 4 District Meters.

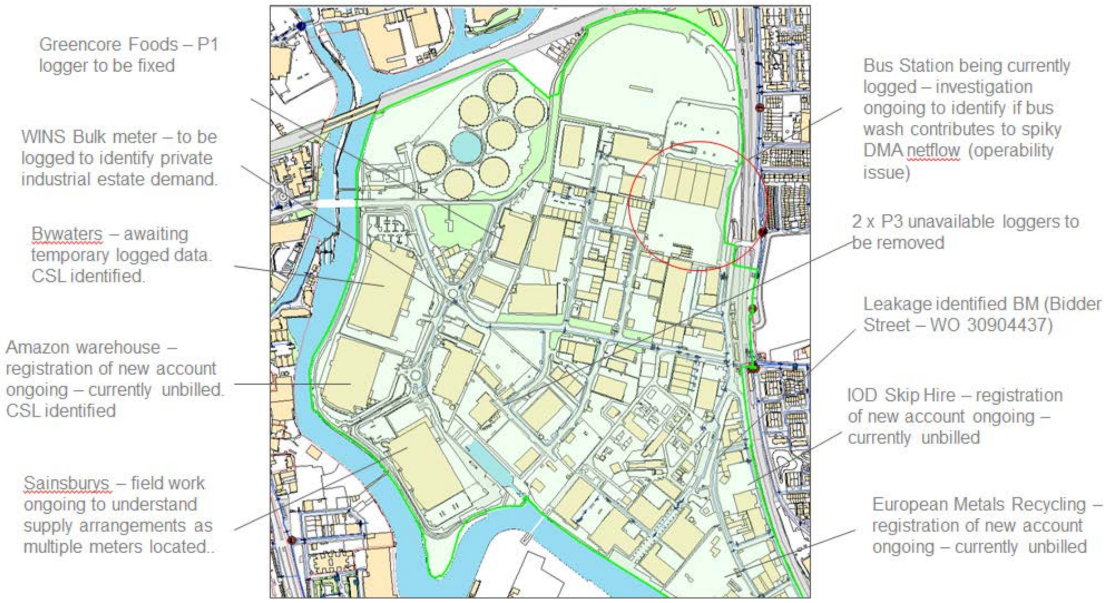
8.172 To enhance the delivery of ALC, this solution will split a number of large DMAs into smaller DMAs. It will also assess DMAs that have historically been 'unavailable' for leakage detection due to inherent network configuration issues (for example; a District Meter that is broken but requires relocation due to traffic management issues or DMA boundary issues that require new assets to resolve).

8.173 DMA Enhancement Plus will involve the installation of new District Meters, valves and washouts and the provision of enabling activities including traffic management and network investigations. This work will enable more accurate targeting and efficient repair of leaks within a DMA, where before it has not been possible to find the leakage.

8.174 To date, assumptions have been made by company experts on the expected benefit of DMA Enhancement and DMA Enhancement Plus using results from initial trials to enable the comparison of this intervention against other demand management interventions.

8.175 Figure 8-7 provides and overview of activities undertaken in DMA Enhancement and DMA Enhancement Plus.

Figure 8-7: Typical activities included under DMA Enhancement



Costs and benefits

8.176 The costs and benefits of DMA Enhancement and DMA Enhancement Plus have been derived from our DMA Enhancement trial. The DMA Enhancement trial was set up in July 2016 to test the approach, to identify the tasks involved and develop the necessary processes. The costs and benefits derived from this trial have been used to inform the costs and benefits applied to DMA Enhancement and DMA Enhancement Plus in the IDM model.

8.177 The benefits of DMA Enhancement have been derived by taking the leakage benefit delivered from DMA's currently in the trial and extrapolating it to other potential DMAs across the company. A total of 270 potential DMAs have been identified for DMA Enhancement with 70 of these including DMA Enhancement Plus.

8.178 The cost of DMA Enhancement and DMA Enhancement Plus was derived from a bottom up costing of the activities involved and the cost of each activity.

Delivery constraints

8.179 Since the DMA Enhancement interventions are new for the draft WRMP19 and we are still learning from the DMA Enhancement trials, we have constrained the number of DMAs that can be chosen in IDM to a maximum of 80. These DMAs have also been constrained to be completed in AMP7 with no further DMA Enhancement in AMP8 and 9.

8.180 This has been done to ensure we achieve the benefit from this programme in AMP7 and minimise the uncertainty risk in further AMPs. This means that the model has been constrained to optimise with other demand management interventions in AMP8 and 9 for the draft WRMP19. However, based on our findings in AMP7, it is likely we will include these interventions in subsequent AMPs. This will be revised in our next WRMP using the outcomes of our current trial and data and assessment we gain in AMP7 from DMA Enhancement.

G. Options to reduce usage

8.181 Section 8.8.179 details the costs, benefits, and constraints associated with options that reduce usage; Water Efficiency, Incentives Programme, Non-potable water usage and Innovative Tariffs. This information is used in our IDM model to calculate the total benefit expected from these interventions.

Water efficiency

8.182 Water efficiency is a core component of the sustainable management of water resources. Water efficiency has received strong support from our customers as a priority only second to leakage reduction. The UK Government has also set out its aspiration to achieve a reduction in water use and support for measures to promote the efficient use of water[16].

8.183 We agree with our stakeholders, customers and Government, that water efficiency is critical to the sustainable management of water resources. To date we have considered 56 different options to promote the efficient use of water. These options have been broken down into Feasible Options (options that are over and above the baseline) and Baseline Options.

8.184 The options taken to optimisation in the IDM model are the feasible options. The options that form part of our baseline are discussed further in Appendix O: Water efficiency.

8.185 There are five categories of Water Efficiency feasible option that were optimised in IDM:

- SHVs
- Smarter Business Visits (SBVs)
- Wastage Fix ('Leaky Loos')
- Housing Association Fix
- Intensive Area Based Promotional Campaigns.

The costs, benefits and constraints of these are detailed below.

Smarter home visit

8.186 An SHV is offered to both metered and unmeasured customers. They comprise tailored water and energy saving advice, in parallel with the installation of water saving devices. This programme includes large-scale communication and engagement across our entire customer base. It includes an App which our in-home advisors use to produce a tailored water savings report for every customer that helps our customers quantify their potential water, energy and money savings.

8.187 We have carried out over 100,000 free SHVs since we began in 2015. The data obtained from these properties has been analysed and used to determine the likely water savings from an SHV in the draft WRMP19. These water savings achieved can be broken down into three property types:

- newly metered properties

[16] Water For Life, Defra, December 2011

- existing metered properties
- unmeasured properties

Newly metered (or smart metered) properties

8.188 The benefit obtained by conducting an SHV on a newly metered property is 36 litres per household per day. This represents a further 6% saving in addition to the 17% saving achieved by installing a smart meter (Section 8.E).

8.189 This figure is based on the water savings seen from our PMP customers who have received an SHV. The analysis was carried out on 74,703 properties that received an SHV between September 2016 and June 2017. We have used data since September 2016 to coincide with our new water efficiency saving devices which are more effective than those used prior to this date and therefore more likely to give an indication of future water savings. The five months prior to September 2016 (from April 2016 when we conducted our first smart metered SHV) have not been used as this early sample is not considered representative of the programme.

Uncertainty analysis

8.190 Although this figure accurately quantifies the water savings achieved from a newly metered SHV, there were some properties in the 74,703 property sample that were not yet paying on a metered tariff. This means there is a risk that these customers had not yet made all the changes we would expect from going on a metered tariff and the assistance of the SHV expedited the process rather than added such a significant degree of additional benefit.

8.191 However, in contrast, there was a large volume of customers in this sample who were more likely to achieve a much higher reduction in water consumption as a result of an SHV than in previous studies. This is because they had received a meter as part of our PMP rather than opting for one. In addition, following the rollout of our new water saving devices in September 2016, we are seeing a 5 litre per property per day increase in savings achieved. This means that the higher SHV savings seen by this study are likely to be in addition to the changes customers make from being billed on a meter when extrapolated across our area.

8.192 To understand this risk associated with the uncertainty around this figure, we optimised the IDM model with both a 17% reduction and a 15% reduction in usage (i.e. to account for any potential double counting with the newly metered SHV) to account for any crossover between the metering and water efficiency interventions. Due to the greater number of properties this test applied, the comparison of results between the two scenarios would be much greater than any crossover between the metering and water efficiency interventions. These IDM optimisations showed a difference of 3Ml/d reduction between the scenarios, which, in the overall programme was considered immaterial.

8.193 To improve our understanding of the impact of smart metering usage and SHV reductions we will continue to monitor our customers on the PMP and update this data accordingly.

Existing metered (dumb) households

8.194 The benefit obtained by conducting an SHV on an existing metered property is 11 litres per household per day. This represents an additional 2.2% reduction in usage to that achieved by installing the meter and transferring the customer to pay on a metered tariff.

8.195 This figure is based on the analysis carried out by our innovation team which used data since 2015 for households that received an SHV and had an existing meter. The savings achieved by existing metered households is significantly lower than that of a newly metered household as there were a high proportion of optants in the existing metered sample. This means these customers opted to have a meter and therefore tended to use less water originally.

Unmeasured households

8.196 The benefit obtained by conducting an SHV on an unmeasured property is 25 litres per household per day.

8.197 This figure is based on an analysis in comparison with DWUS data to determine water savings of unmeasured households having smarter home visits. However, the number of unmeasured households who have received an SHV since 2015 has been too small to consider this result statistically significant. Therefore, we applied the lower range of savings, 25l/hh/day. Analysis has suggested that the water savings could be higher for unmeasured households compared with existing metered households, but less than newly metered households. This is something we will continue to quantify.

Smarter business visit

8.198 SBVs are currently offered to twelve different business cohorts across the Thames Water area. The SBV initiative is similar to an SHV in that a qualified representative attends the business to assess where they can make improvements to their discretionary water usage by installing water saving devices or fixing leaking toilets.

8.199 Each business type is identified by their Standard Industrial Classification (SIC) code to ensure the majority of business types can be captured under each cohort.

8.200 The benefit assigned to each cohort is the average benefit achieved in that cohort using the outcome of 200 SBVs conducted from January 2016 to January 2017. On average, SBVs have been shown to save approximately 2,500 litres per day per property. The percentage savings reduction achieved by a SBV in each cohort and input into the IDM model is summarised in Table 8-2.

Table 8-2: SBV benefits by cohort

Cohort	Percentage saving
Agriculture	40%
Business and Social Welfare	67%
Chemical and Metal Goods Manufacturing	30%
Defence	3%
Education	67%
Health	2%
Hotels and Catering	24%
Miscellaneous Manufacturing	18%
Miscellaneous Minor	85%
Public Administration	29%

Cohort	Percentage saving
Retail	1%
Transport, Construction and Other	34%

8.201 The current dataset is showing a variety of benefits across the cohorts, depending on the type of business (by SIC codes) that come under that cohort. For example, the Retail cohort is showing a 1% saving compared with the Miscellaneous Minor cohort showing an 85% saving. This is due to the categorisation of business by their SIC code. That is, the Miscellaneous Minor cohort includes hairdressers, nurseries, large supermarkets, churches and mechanics which can all achieve a significant benefit following a SBV. In comparison, the Retail cohort includes smaller corner stores and 'pop up' roadside stands which are showing lower savings.

8.202 As our SBV programme develops further and more data is gathered, we should be able to analyse this in more detail to compare to actual meter data.

Wastage fix ("leaky loos")

8.203 This is a new water efficiency option for inclusion in the draft WRMP19. It includes free internal leak fixes (i.e. leaky loos and leaking taps).

8.204 The benefit obtained by conducting a wastage fix is 212 litres per household per day.

8.205 The wastage savings applied under the Water Efficiency intervention are predominantly due to the repair of 'leaky loos'. This saving was proven in the Fixed Network Trial whereby 12% of toilets were found to be severely leaking, 67% moderate and 21% minimal. On average, this equated to a saving of 405 l/day per repair. Factoring in the properties where there were no obvious savings, this equated to an average of 212 l/day saved per 'leaky loo' repair which is the average saving applied in the IDM model.

8.206 The Wastage Fix solution avoids double counting with the wastage savings attributed to metering due to the degree of wastage picked up by metering compared with the wastage detected by Water Efficiency. That is, the volume of water lost due to a leaky loo may not prompt a metered customer to call out a plumber based on their meter readings alone. Consequently, metering captures significant wastage volumes on a proportion of metered properties and often a 'leaky loo' may be overlooked. However, following the water efficiency wastage campaign, the volume of water lost by each leaky loo can be captured and repaired.

Housing association fix

8.207 This is a new water efficiency option for inclusion in the draft WRMP19. It includes water efficiency retrofitting schemes with local authorities and housing associations.

8.208 The benefit obtained by conducting a Housing Association Fix is 15 litres per property per day. This has been derived from analysis of Housing Association Fix data from AMP6. These are proven benefits from the installation of water saving devices and repair of wastage issues in Housing Association Properties.

Water Efficiency Costs

8.209 The cost of Water Efficiency interventions ranges between £20 and £400 per visit/fix. This is based on the actual average cost to conduct Water Efficiency visits and wastage fixes since 105.

Intensive area based promotional campaigns

8.210 This is a new water efficiency option for inclusion in the draft WRMP19. It includes both large-scale baseline awareness raising and intensive marketing campaigns targeting specific locations throughout our supply area. Such full-time awareness raising and campaign work would help increase the public understanding of water resources, water efficiency and assist the take-up of specific water saving initiatives.

8.211 Intensive area based promotional campaigns are critical to ensuring a long term behavioural change and facilitate ongoing communications regarding all water efficiency activity streams.

8.212 We are currently trialling an intensive area campaign in Oxford. In Spring 2017 we set the scene about water resources and explained that there was the same amount of water for a growing demand. Our campaign, based around the message 'more people, less water to go around' included local advertising channels, comprising posters, press, digital advertising, radio, plus targeted door drops.

8.213 For autumn 2017 we have continued on from the spring campaign to show there is no substitute for water to help customers really value water (Figure 8-8). This provides a solid base to encourage people to be water smart and demonstrate the collective benefit of communities taking simple actions.

Figure 8-8: Intensive media campaign poster

8.214 The pre and post-campaign market research to date has shown very positive reactions to the campaign and proven that it has helped raise awareness of the water issues that we face. We will continue to collect data about the impact of these campaigns to determine the quantitative impact on water saving. This information, together with the cost will be included in the draft WRMP19 to facilitate more widespread campaigns across our whole supply area.

Water efficiency benefits over time

8.215 The life of water efficiency devices supplied by an SHV, SBV or Housing Association Fix has been assumed to be seven years. This deviates significantly from the assumption made in WRMP14 that water efficiency devices had a half-life of seven years based on the Waterwise evidence for large scale water efficiency in homes. This change has been made in response to a greater dataset available for the draft WRMP19 which has shown that water efficiency devices require rehabilitation much sooner than originally anticipated. Therefore, to ensure an accurate representation of Water Efficiency benefits, the life of water efficiency devices has been reduced to a total of seven years for the draft WRMP19.

8.216 The life of water efficiency behavioural change has also been reduced in comparison with WRMP14. That is, in WRMP14, it was assumed there was a half-life of 10 years for behavioural changes in response to water efficiency. This has been revised to a total life of seven years. This means that the repeat frequency for SHVs, Housing Association Fixes and Wastage Fixes has been assumed to be seven years for the draft WRMP19.

Water efficiency uptake rate

8.217 Water Efficiency Intervention Uptake Rates are based on the Water Efficiency Programme Uptake throughout AMP6. Table 8-3 summarises the rates applied to each water efficiency intervention in the IDM model.

Table 8-3: Water efficiency uptake rates

Intervention	Uptake rate
SHV	20% of current measured and unmeasured properties 23% of newly metered properties
SBV	13% of Non-Household properties within designated cohorts
Housing Association Fix	15% of housing association properties (based on access rate)
Wastage Fix	5% of properties (based on 1 in 20 properties have a leaky loo)

8.218 For an SHV, the higher uptake by newly metered properties is because these newly metered customers are offered an SHV as part of the meter installation. Customers are more likely to take up an SHV offer when they have the convenience of a meter installation and SHV in the one appointment. This is based on data collected for all SHVs between January and December 2016.

8.219 Throughout AMP6 SBVs have been taken up at a rate of 13% across non-household properties based on data collected from January 2016 to January 2017. However, we have been targeting twelve specific cohorts of business within their area of supply meaning this assumption cannot be entered into the IDM model and applied to all non-household properties. Instead, the model assumes 13% of businesses within each cohort within each DMA receive a SBV. This does slightly limit the potential volume of SBVs in the longer term. However, with the introduction of the Non household retail market this is considered a realistic and achievable application of the potential SBV volume for the draft WRMP19.

8.220 For a Housing Association Fix, the uptake rate has been based on access rates to housing association properties from January to December 2016.

8.221 For a Wastage Fix, the percentage uptake is based on the assumption that 1 in 20 properties across our supply area has a 'leaky loo'. This is based on the results of investigations during the installation of a new meter, the findings during SHVs between January and December 2016 and the evidence obtained from the Fixed Network Trial.

Delivery constraints

8.222 The Water Efficiency interventions are one of the most cost beneficial demand management options available in the IDM model. This means that when left unconstrained, IDM will chose to conduct as much water efficiency activity as possible.

8.223 However, due to the connection between an SHV and the level of metering, the volume of SHVs that the IDM model will select depends on meter penetration. This is because the number of SHVs that can be conducted on newly metered properties is dependent on the number of properties which become metered in that year and AMP. Therefore, due to the modelling constraint that we will do up to 400,000 meter installations across our area per AMP the number of SHVs to a newly metered property is also limited.

8.224 There are no delivery constraints on the SBVs, Wastage Fixes and Housing Association Fixes. However, due to the mix of constraints applied in the model, which require it to choose a minimum of multiple activities as a priority (i.e. for Pressure Management, DMA Enhancement and mains rehabilitation – See Section 8.F), and the limit to the amount of demand the model can solve for each AMP, there is a limit on the number of these Water Efficiency interventions. This means the size of the Water Efficiency programme chosen by IDM is less than it would have been without the imposition of other intervention constraints.

8.225 Since these constraints are required to ensure we develop a deliverable and reliable programme, this consequence is accepted. However, due to the substantial and widespread customer support, the long term educational value and the high cost benefit of our water efficiency interventions, it is plausible to opt for an enhanced programme above that chosen by IDM for water efficiency. This is something to be considered within the business as we further develop our preferred programme.

Incentives programme

8.226 The Incentives Programme is a scheme whereby customers are incentivised through non-financial offers (vouchers, prize draws, community rewards) to be more efficient with their water consumption.

8.227 The incentive scheme works by incentivising customers to use less water through the awarding of points that can be exchanged for money-off vouchers, charity donations, prize draw entries and days out. We provide water reduction targets for customers based on their current usage and award points that may differ depending on whether they reach their water saving target, whether they sustain the reduction in water usage and or whether they exceed their target.

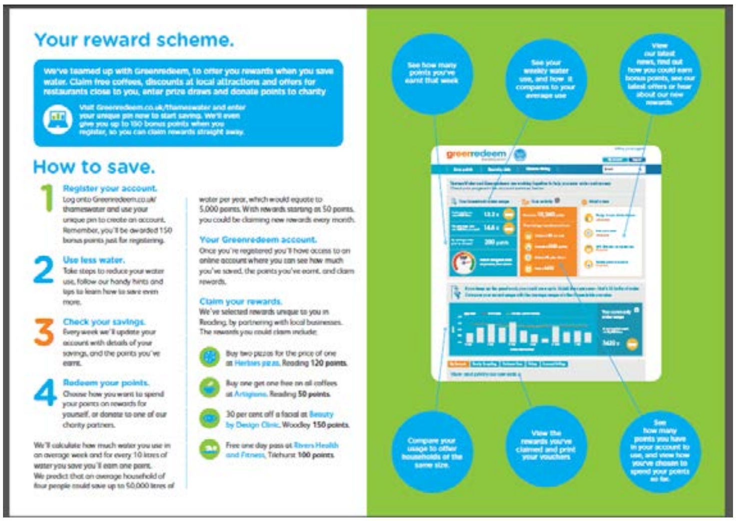
8.228 The incentives programme works in a similar way to financial tariffs with the main difference being that the incentive scheme does not directly affect customers' bills. We will not need to obtain a high level of meter penetration prior to implementing the scheme as there are no negative impacts on customers' bills. The scheme aims to influence customer's behaviours through offering positive rewards as opposed to the imposition of negative dis-benefits.

8.229 The costs and benefits for the incentives scheme have been based on the results of our trial scheme launched in Reading in autumn 2016 (Figure 8-9). The Reading incentives programme was developed in partnership with Greenredeem, a recycling reward specialist with more than 5 years' experience in managing incentives. The trial involves offering this scheme up to 3,000 homes which are part of the smart metered fixed area network in Reading (Appendix O).

8.230 The results achieved from these homes and the costs to roll out the programme have been used to inform the optimisation of Incentives Programme in IDM for the draft WRMP19. That is, of those homes that were offered the scheme, 24% of properties signed up. Due to the small sample size of this trial, we have reduced the uptake rate used in IDM to 12% of applicable households (i.e. households with a smart meter) to ensure we don't overestimate the savings.

8.231 The properties who took part in the Reading incentives programme showed a 4% reduction in usage. However, due to the short timeframe of the programme (data commencing in winter 2016) and the small sample size, the expected savings used in IDM were also halved to 2% to ensure we did not overestimate the savings.

Figure 8-9: Incentives programme leaflet



Innovative tariffs

8.232 The imposition of tariff or pricing controls can be an effective strategy for water demand management if the water rate structures contain strong incentives to conserve water. This view is supported by behavioural economic theory that indicates that consumers may respond to economic incentives by assuming behaviours that maximise their economic self- interest.

Tariff charging can be implemented by reforming water rates, introducing surcharges or establishing penalties to deter high water or wasteful water usage practices, and encourage consumers to conserve water. However, tariff strategy with respect to water management has not been adopted in the UK mainly because it requires a high level of metering which may have significant financial impact on low income households of above average size.

8.233 We had previously planned to undertake variable tariffs trials in AMP6 with the aim of introducing them early in AMP7. Due to our AMP6 relatively low level of meter penetration and views expressed by customers during customer focus groups, we will not consider the introduction of Innovative Tariffs until the 2030s when it is expected we will have at least 65% meter penetration.

Non-potable water

8.234 Non-potable water is water that is not of drinking water quality, but that can be used for other purposes such as toilet flushing, laundry and garden watering to reduce the total demand on potable supply. We have engaged Arup consulting to undertake an assessment of the non-potable water opportunities that are available within our area. The full details are in Appendix L: Water reuse.

8.235 There are three main components that have been considered in the non-potable schemes:

- rainwater harvesting
- stormwater harvesting
- greywater recycling

Rainwater harvesting

8.236 Rainwater harvesting refers to the collection of rainwater from property roof surfaces or freestanding collection vessels for reuse on site. Application of rainwater harvesting provides a substantial benefit for both water supply and wastewater in that it reduces the demand on the potable water system, decreases the volume of storm water that enters the sewer system and minimises storm water runoff polluting freshwater bodies.

8.237 Rainwater from roof surfaces is the least polluted source of non-potable water and requires minimal treatment prior to reuse. In most circumstances only physical treatment systems such as filtration are required. However, to guarantee the health of building occupants, and minimise the risks from cross contamination, the rainwater harvesting options that we assessed also include chlorine dosing for disinfection.

Stormwater harvesting

8.238 Stormwater harvesting refers to the collection of storm water from pedestrianised and road surfaces for reuse on site. It also refers to the collection of water from other urbanised environments such as parks, gardens and playing fields.

8.239 Stormwater has a higher pollutant load than rainwater and requires both physical and chemical treatment. To manage the risk to public health, we have assessed these options using greywater reuse systems.

Greywater recycling

8.240 Greywater refers to the relatively clean waste from baths, bathroom sinks and showers that can be collected in a central system and then treated for reuse in households and offices.

8.241 Greywater recycling systems can be installed at individual building level within a development or as a network between buildings. Greywater is treated using both physical and chemical treatment on site to a standard that can be reused for non-potable purposes.

8.242 The schemes identified across our area for non-potable opportunities included combined rainwater, stormwater and greywater systems and individual systems. Although there is support within the water industry to explore non-potable water opportunities, the costs of these schemes remain prohibitive and consequently, when optimised against the other demand management interventions the IDM model would select minimal non-potable solutions.

Old Ford Water Recycling Plant

8.243 The exception to this is our Old Ford Water Recycling Plant. Our Old Ford Water Recycling Plant, located next to the main site of the London 2012 Olympic and Paralympic Games, is the UK's largest community wastewater recycling scheme. It treats wastewater from the Northern Outfall Sewer and feeds in to a non-potable network that connects to the Olympic Park for toilet flushing and irrigation, and to the Energy Centre for cooling water.

8.244 The benefit of continuing to run Old Ford is cost effective in addition to the beneficial educational resource it provides. Throughout AMP7 we will continue to investigate non-potable water opportunities and work with Old Ford to further promote non-potable water schemes.

H. Demand management programmes

Summary of demand management programmes

8.245 The demand management programmes developed for the draft WRMP are summarised in Table 8-4. These are the programmes that have been included in the next stage of development (Section 10: Programme Appraisal and Scenario Testing).

8.246 The total demand reduction per AMP for each programme is made up of the total usage reduction and total leakage reduction per AMP. This leakage reduction is the enhanced leakage reduction meaning it is above that required to offset mains deterioration.

Table 8-4: Demand management programmes

Scenario	Demand Management Programme														
	Usage Reduction (Ml/d)					Leakage Reduction (Ml/d)					Total Demand Reduction (Ml/d)				
	AMP7	AMP8	AMP9	AMP10	AMP11	AMP7	AMP8	AMP9	AMP10	AMP11	AMP7	AMP8	AMP9	AMP10	AMP11
DMP_London_1	67.0	24.0	0.0	0.0	0.0	38.0	1.0	0.0	0.0	0.0	105.0	25.0	0.0	0.0	0.0
DMP_London_2	61.0	46.0	16.0	0.0	0.0	44.0	14.0	4.0	0.0	0.0	105.0	60.0	20.0	0.0	0.0
DMP_London_3	57.0	53.0	27.0	0.0	0.0	48.0	22.0	23.0	0.0	0.0	105.0	75.0	50.0	0.0	0.0
DMP_London_4	62.0	40.0	18.0	0.0	0.0	48.0	12.0	4.0	0.0	0.0	110.0	53.0	22.0	0.0	0.0
DMP_London_5	61.0	46.0	17.0	0.0	0.0	49.0	15.0	3.0	0.0	0.0	110.0	60.0	20.0	0.0	0.0
DMP_London_6	63.0	41.0	18.0	0.0	0.0	52.0	12.0	4.0	0.0	0.0	115.0	53.0	22.0	0.0	0.0
DMP_London_7	62.0	46.0	16.0	0.0	0.0	53.0	15.0	3.0	0.0	0.0	115.0	61.0	20.0	0.0	0.0
DMP_London_8	63.0	41.0	17.0	0.0	0.0	57.0	13.0	4.0	0.0	0.0	120.0	54.0	21.0	0.0	0.0
DMP_London_9	61.0	50.0	25.0	0.0	0.0	64.0	15.0	11.0	0.0	0.0	125.0	64.0	36.0	0.0	0.0
DMP_London_10	63.0	42.0	18.0	0.0	0.0	71.0	13.0	3.0	0.0	0.0	135.0	54.0	21.0	0.0	0.0
DMP_London_11	61.0	32.0	19.0	5.0	0.0	53.0	35.0	30.0	22.0	0.0	114.0	67.0	49.0	27.0	0.0
DMP_SWA-1	8.0	4.0	0.0	0.0	0.0	10.0	2.0	0.0	0.0	0.0	18.0	6.0	0.0	0.0	0.0
DMP_SWA-2	0.0	0.0	6.6	4.6	0.0	0.0	0.0	3.0	2.5	0.0	0.0	0.0	9.5	7.1	0.0
DMP_SWA-3	0.0	0.0	4.9	6.1	0.0	0.0	0.0	1.9	2.5	0.0	0.0	0.0	6.8	8.5	0.0
DMP_SWA-4	7.7	3.0	0.0	0.0	0.0	2.8	1.7	0.0	0.0	0.0	10.5	4.7	0.0	0.0	0.0
DMP_SWA-5	4.6	6.6	0.0	0.0	0.0	1.8	2.6	0.0	0.0	0.0	6.4	9.2	0.0	0.0	0.0
DMP_SWA-6	7.8	2.8	0.0	0.0	0.0	2.8	1.7	0.0	0.0	0.0	10.6	4.4	0.0	0.0	0.0
DMP_SWX-1	12.0	6.0	0.0	0.0	0.0	13.0	6.0	0.0	0.0	0.0	25.0	12.0	0.0	0.0	0.0
DMP_SWX-2	10.0	6.5	0.0	0.0	0.0	4.0	3.2	0.0	0.0	0.0	14.0	9.7	0.0	0.0	0.0
DMP_SWX-3	9.9	7.0	0.0	0.0	0.0	5.1	3.7	0.0	0.0	0.0	15.0	10.7	0.0	0.0	0.0
DMP_SWX-4	7.1	9.9	0.0	0.0	0.0	2.8	4.4	0.0	0.0	0.0	9.9	14.3	0.0	0.0	0.0
DMP_SWX-5	6.5	5.4	2.7	0.0	0.0	2.5	2.5	1.5	0.0	0.0	9.0	7.9	4.2	0.0	0.0
DMP_SWX-6	11.4	4.3	0.0	0.0	0.0	4.6	2.7	0.0	0.0	0.0	16.0	7.0	0.0	0.0	0.0
DMP_GUI-1	2.0	0.9	0.0	0.0	0.0	0.8	0.5	0.0	0.0	0.0	2.8	1.3	0.0	0.0	0.0
DMP_GUI-2	0.0	0.0	1.9	1.0	0.0	0.0	0.0	0.8	0.5	0.0	0.0	0.0	2.7	1.5	0.0
DMP_GUI-3	1.7	1.0	0.2	0.0	0.0	0.7	0.5	0.2	0.0	0.0	2.3	1.5	0.4	0.0	0.0
DMP_GUI-4	0.0	0.0	1.6	1.4	0.0	0.0	0.0	0.9	0.7	0.0	0.0	0.0	2.4	2.1	0.0
DMP_HEN-1	0.0	0.0	0.6	0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.8	0.3	0.0
DMP_HEN-2	0.5	0.2	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.0
DMP_HEN-3	0.0	0.0	0.3	0.5	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.4	0.7	0.0
DMP_HEN-4	0.1	0.7	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.1	0.9	0.0	0.0	0.0
DMP_KV-1	5.0	2.1	0.0	0.0	0.0	2.1	1.3	0.2	0.0	0.0	7.1	3.4	0.2	0.0	0.0
DMP_KV-2	0.0	0.0	2.8	5.0	0.0	0.0	0.0	1.7	2.5	0.0	0.0	0.0	4.5	7.5	0.0
DMP_KV-3	1.2	6.6	0.0	0.0	0.0	0.6	2.7	0.0	0.0	0.0	1.8	9.3	0.0	0.0	0.0
DMP_KV-4	0.0	0.0	5.0	2.2	0.0	0.0	0.0	2.1	1.2	0.0	0.0	0.0	7.1	3.5	0.0

8.1 We present fewer scenarios compared with the draft WRMP14, but more when compared with the final WRMP14. This is because in WRMP14, the scenarios presented were filtered in the final plan to include only those that could meet the supply demand gap.

8.2 For the draft WRMP19, we have filtered the scenarios presented to only those that cover our current supply demand gap to be consistent with the final plan methodology. For example, a demand scenario that requires 80Ml/d in AMP7 will not achieve the supply demand gap as very few supply options are deliverable within this timescale.

Option uncertainty

8.3 The costs of demand management options such as metering, mains rehabilitation and pressure management have been taken from our actual contractual unit rates or our EES. We have considerable experience in these types of project and have company specific data. Given the programme nature of these activities and our delivery experience, no adjustment for risk of optimism bias was made for these options.

Environmental and carbon appraisal

8.4 Strategic environmental assessments have been undertaken for each demand management intervention. These assessments are provided in Section 9: Environmental Appraisal.

8.5 It is also important that we assess the likely carbon emissions from both the construction (i.e. for mains rehabilitation and pressure management) and operational phases. In the construction phase, embodied energy is the energy expended in the process of sourcing, manufacturing and supplying a product, material or service. This product, material or service may then expend further energy in its operation. The embodied carbon is a one-off cost that goes with the construction phase of the option. This cost is calculated off-line as unit rate, with the values in tonnes of carbon. These costs together with the carbon associated with ongoing operation of demand management interventions (i.e. pressure management) are calculated for each demand management programme and included in the modelling for EBSD. These assessments are provided in Appendix R: Scheme Dossiers.