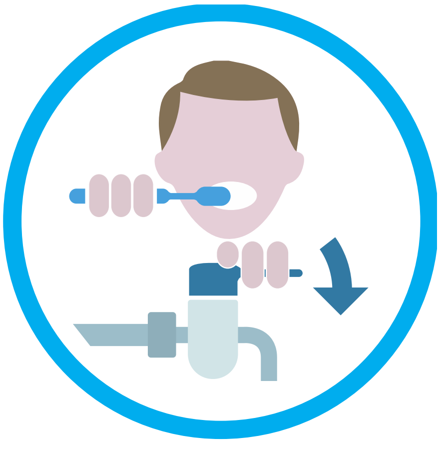
Section 8

Appraisal of demand options



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Section 8.

Appraisal of demand options

Section 8 outlines the demand management options appraisal process. This process has led to the development of a range of demand management programmes for assessment as part of the preparation of our preferred plan.

This section includes the details of:

- The three stages of demand management options appraisal; screening, evaluation and optimisation to develop a range of deliverable demand management programmes.
- The costs, benefits and delivery constraints of each feasible demand management option.
- The process of demand management optimisation using our Integrated Demand Management (IDM) model to produce a range of demand management programmes.
- The implications of the costs, benefits and delivery constraints of each feasible option on the optimisation process.

In response to the public consultation on the draft WRMP19, the following changes have been made to Section 8:

- Update to the Screening process (Section B) to clarify the feasible demand management options specifically in relation to activities categorised under the Water Efficiency, Metering and Non-Potable options.
- Update to the detail provided for each demand management feasible option, specifically in relation to Metering, DMA Enhancement, Water Efficiency and Non-Potable Solutions (Section 8.D to 8.F).
- Introduction of a Delivery Constraints and Confidence of Delivery section for the demand management feasible options (Sections 8.H and 8.I).
- Introduction of a ‘Long Term Demand Management’ section to detail the development of the 15-80 year profile of demand management and maintenance of demand management benefits (Section 8.J).

A. Options appraisal process

8.1 Section 8 details the identification and appraisal of water 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 thereby to produce demand management programmes that can best achieve water demand reduction over the plan period. These demand management programmes are then optimised alongside the supply options (Section 7: Appraisal of water resource options) for inclusion as appropriate in 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. They are the screening, evaluation and optimisation of demand management options.

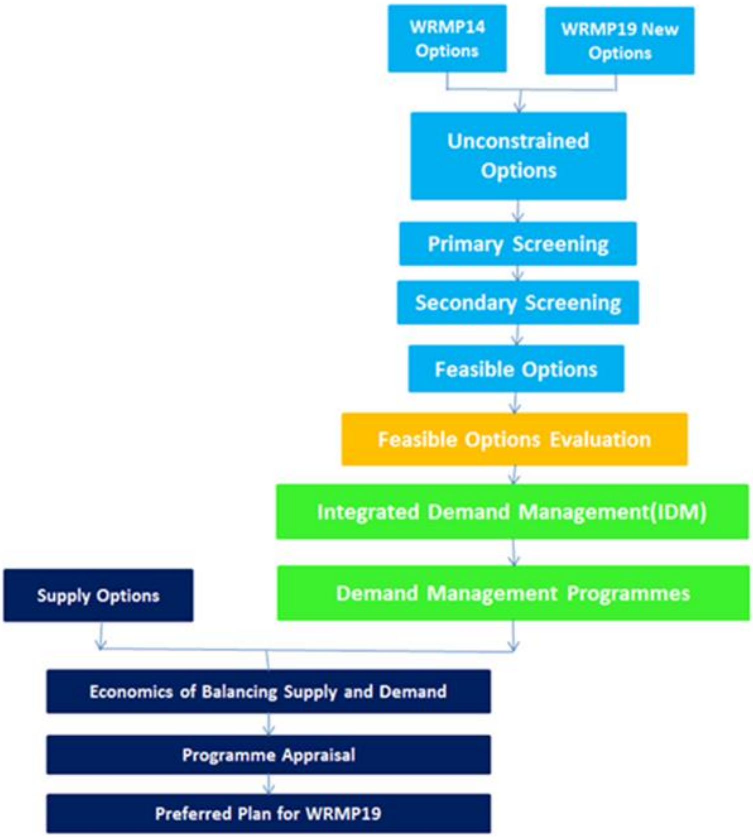
8.3 The **Screening** of options involved the identification of a list of generic demand management options. These options underwent primary and secondary screening against technological, financial, environmental, risk and resilience and legal constraint criteria. The output of this process was a list of feasible demand management options that were then evaluated in the evaluation stage of demand management options appraisal. Section 8.B sets out the principles and approach we used to screen 135 generic demand management options to produce 47 feasible options for evaluation.

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

8.5 The **Optimisation** of options involved the comparative assessment of feasible options using the IDM model. The purpose of optimisation was to develop a range of deliverable, cost efficient demand management programmes. In this exercise we looked at the overlapping costs and benefits of options that could be promoted in combination in addition to assessing each option individually. This enabled us to look at the optimised combination of options for each District Metered Area (DMA) and to assess their 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) Plus and Programme Appraisal (Section 10: Programme appraisal).

Figure 8-1: Demand management options appraisal overview



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

8.8 The output of the demand management options appraisal process was a range of water demand management programmes. A demand management programme consists of an optimised mix of demand management options or interventions to achieve a certain level of demand reduction in each Asset Management Planning (AMP) period. Section 8.K and J summarise the optimised combinations of options making up the demand management programmes and the relative usage and leakage savings achieved by each programme.

8.9 The demand management programmes produced as a result of the demand management options optimisation process were considered in the next stage of the preparation of the final WRMP19; this is where the demand programmes were assessed with the water resource options in the EBSD Plus model, through our Programme Appraisal process to produce our preferred or 'best value' plan.

B. Screening

8.10 The purpose of options screening was 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.G).

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 water demand management options that may be technically feasible but not necessarily free of environmental or planning constraints. This 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 Management 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 derive multiple potential sub-options and specific options.

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 final 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 issue giving rise to non-compliance is noted in the table in the Rejection Register
- Final 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 final WRMP19, we have developed an unconstrained list of 135 water Demand Management Options under the Generic Option categories Leakage, Metering, Water

[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

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 final 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.

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 final 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 produce the final feasible list of water demand management options.

- Does the option avoid excessive cost?

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

- 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 final 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 final 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 final WRMP19, of the 91 Demand Management Options remaining after Primary Screening, 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 WRMP19. These are grouped into 7 categories: Metering, DMA Enhancement, Mains Replacement, Pressure Management, Water Efficiency, Incentives and Tariffs and Non-Potable water. 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 final 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].

C. Evaluation

8.31 In Section 8.B we explained the screening process to derive the feasible demand management options. Section 8.C provides an overview of the approach we employed to individually evaluate these feasible options and Sections 8.D to 8.F provide the detail behind the evaluation of each option.

Leakage and usage reduction

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

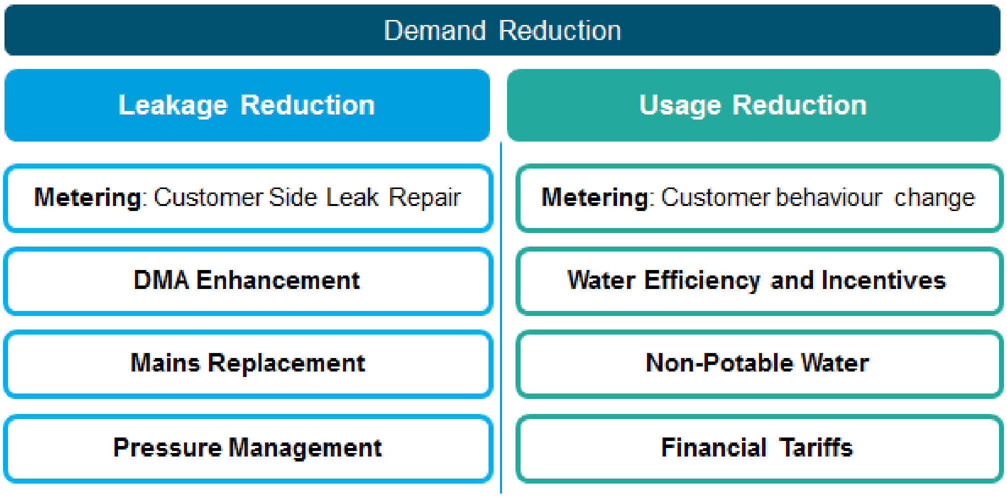
1) Metering
2) DMA Enhancement
3) Mains Rehabilitation
4) Pressure Management

[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

5) Water Efficiency and Incentives
6) Non-Potable Sources
7) 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 An additional leakage reduction option, 'AMP6 Leakage Reduction Carry Over' has been introduced. This leakage reduction occurs because the leakage in April 2020 is expected to be lower than leakage in April 2019 as a result of the leakage reduction programme in 2019/20. This leakage reduction is 34Ml/d and is applicable to year 1 of AMP7 at no additional cost to the programme.

8.35 To quantify the value of the 47 feasible options for water demand management, we evaluate the cost and reduction in demand that could be achieved by implementing these options. 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.

8.36 Figure 8-4 provides an overview for each demand management feasible option that includes the direct and indirect benefits of the option and the work required and constraints associated with implementing the option. It also shows the average cost benefit of each option relative to one another. This relative value estimate does not consider cost benefit over time (i.e. that options may become more expensive in the future) or take account of the constraints on availability and delivery (Section 8.H). However, it does highlight the demand management feasible options that are the cheapest and the most expensive.

8.37 The data lying behind this overview is presented in Sections 8.D to 8.F. These sections outline the source of data for our costs and benefits and the reason for any significant changes since WRMP14. The delivery constraint of each intervention and the impact this has on demand management optimisation is presented in Section 8.H. This detail underpins the discussion of the optimisation phase of demand management and is critical to the development of our demand management programmes (Section 8.J).

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 usage due to behaviour change due to metered bill	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 Rehabilitation	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	Street works permits Size and length of main to rehabilitate Number of network monitoring meters, chambers and customer connections to be replaced	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 maintenance)	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 street works	Maximum number of DMA Enhancement/ Plus schemes identified	**Medium**
Water Efficiency	n/a	Reduced usage Reduced wastage Reduced business usage	Aligned to customer Wider awareness through media campaigns 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	Construction and implementation of non-potable supplies on new developments	Maximum number of schemes currently available	**Very High**
Incentives	n/a	Reduced usage	Increased customer awareness	Media campaign to advertise incentives Administrative costs	Uptake rate of the incentives programme	**Low**
Financial Tariffs	n/a	Reduced usage	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 demand management options

Geographical scale

8.38 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.

8.39 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 District Metered Area (DMA).

District Metered Area (DMA)

8.40 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.

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

D. Options to reduce leakage and usage - metering

8.42 Section 8.D details the source of data for the costs and benefits of metering and the reason for any significant changes since WRMP14. The constraints and confidence in delivery are outlined in Section 8.H and Section 8.I. This information is used in the optimisation phase (Section 8.G) of demand management appraisal to calculate the total benefit expected from metering in each demand management programme (Section 8.J).

8.43 Metering is the only feasible demand option that delivers both a leakage and usage (usage and wastage) reduction.

Overview

8.44 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 the Water Resources Management Plan 2014 (WRMP14), this led to our Progressive Metering Programme (PMP) being initiated within the London WRZ.

8.45 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. Metering also has broad customer support, recognising that it is fair to pay according to how much water is used.

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

8.46 Our programme of progressive metering is underway in London with over 243,564 smart meters installed by the end of 2017/18 (Section 2: Water resources programme 2016-2020). The data from these meters is being used to educate customers on their water consumption, inform our Water Efficiency Smarter Home Visit (SHV) programme and build up our database on water consumption and customer side leaks.

8.47 This section provides an overview of our metering delivery programme used in the optimisation phase of demand management option appraisal. It sets out details of the infrastructure used, the types of benefits that can be achieved by metering (usage, wastage and CSL reduction) and the costs of metering. The delivery constrains and our confidence in the delivery of the programme is detailed in Section 8.H. Appendix N: Metering provides further information and a more detailed analysis of our approach to metering.

8.48 Appendix N: Metering includes our response to the Environment Agency Direction 3(f) and 3(h). This response details our metering costs and approach to the delivery of our smart meter programme.

Programme type

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

8.50 In the final WRMP19, our enhanced metering programme includes three delivery programmes: household metering, bulk metering and replacement metering. In the draft WRMP replacement metering was sometimes referred to as rehabilitation metering.

8.51 The fourth delivery programme, optant metering is included in our baseline water demand forecast detailed in Section 3.

Household metering (Progressive Metering Programme, PMP)

8.52 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.

8.53 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

8.54 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.

8.55 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 (proactive)

8.56 Proactive replacement metering refers to the programme to replace old 'dumb' meters with new 'smart' Automatic Meter Reading (AMR) or Advanced Metering Infrastructure (AMI) meters (Section 8.D - Technology).

8.57 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.D, 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.

8.58 In comparison, in WRMP14, the rollout of our enhanced metering programme occurred across two delivery models: progressive metering and bulk metering. The benefits from replacement metering were not included in our WRMP14 because, at this time we were replacing 'end of life' and faulty dumb meters with new dumb meters. This meant we could not get any additional benefit of a CSL reduction by changing a dumb meter for a smart meter. The work in WRMP14 was covered under our maintenance work and was due to the minimal coverage of the fixed network at the time, restricting smart meter roll out.

Optant metering

8.59 Optants are meters that have been installed at the request of the customer. Customers who request a meter are typically lower water users or single occupancy dwellings who wish to minimise their bill. The volume of Optant customers is difficult to predict and reliably model. Consequently, Optant meters are not optimised as part of the demand management programme but have been included as a fixed number removed from our baseline water demand forecast. This ensures Optant meters do not bias the optimised meter number or volume of savings that can be achieved from metering in the demand management appraisal process. Section 3 details the source of data and volume of optant meters used in the final WRMP19.

Technology

Infrastructure – fixed network

8.60 In addition to the type of metering programme undertaken, the type of meter installed influences the total demand reduction achieved. There are three types of meters currently installed on our network:

- **Advanced Metering Infrastructure (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).

- **Automatic Meter Reading (AMR):** a meter with a short range radio 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.

8.61 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.

8.62 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 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.

8.63 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.

8.64 In AMP6, we have worked with telecommunications partners to commission 106 masts in London with plans for a further 180 London masts and the rollout of masts in Thames Valley 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.

Monitoring – Smart Metering Operations Centre (SMOC)

8.65 Following the commissioning of a fixed network in London, we have established a Smart Metering Operations Centre (SMOC), to monitor the performance data from smart meters installed in AMP6. This team has been established to recognise potential leaks at a customer’s property, identify disproportionate consumption to assist in our DMA enhancement programme (Section 8.E) and identify where a meter has gone missing resulting in a drop in communications. In response, the SMOC team will proactively dispatch technicians to investigate meters that are not performing as expected, and refer cases of suspected leakage onto our customer side leakage repair team to facilitate a timely repair.

8.66 In contrast, with traditional or ‘dumb’ meters, meter issues and suspected leakage would not have been dealt with proactively but rather in response to biannual meter readings.

Quantity

8.67 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'[8] to different property types to account for the fact that not all properties can be metered.

External and internal installations

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

- **External**: a meter is fitted in the pavement in the boundary box which houses the outside stop tap. 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.

8.69 To determine the number of external and internal meters in a DMA, the internal-external split is applied per property type. The data providing this information is obtained from the number of internal and external installations carried out throughout AMP6.

8.70 In WRMP14, we planned to install 441,000 smart domestic water meters by the end of AMP6. So far, we have installed 243,564 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.

8.71 To ensure we can provide a realistic and achievable programme for the final WRMP19, we have used the internal and external data split from the last two years of our PMP, 2015/16 and 2016/17 (Appendix N: Metering for details). 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

8.72 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.

8.73 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 to identify the number of properties that can have a meter fitted. The survey to fit ratios applicable to the final WRMP19 are based on access rates achieved during the PMP[9]. Compared with WRMP14, the average survey to fit ratio across all

[8] The ratio applied to different property types to identify the number of properties that can have a meter fitted – see subheading 'Survey to fit ratios' for full description.
[9] Based on survey to fit ratios and approach of three London boroughs during 2016

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).

Demand reduction

8.74 There are two demand reduction benefits associated with metering. They are a reduction in customer usage (including usage and wastage), and repair of Customer Side Leakage (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

8.75 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.

8.76 In the final WRMP19, we have used the results of the metered consumption model (MCM) and the Domestic Water Use Study (DWUS) to estimate the usage savings achieved through household metering[10]. This study estimated an average 17-19% reduction in overall usage if 20% of unmeasured flats and all unmeasured houses were metered. We have used the 17% figure to represent the change in customer behaviour resulting from being billed on a metered tariff. It does not include any savings achieved from a CSL fix or the customer taking part in any Water Efficiency interventions (Section 8.F).

8.77 The average usage reduction of 17% per property is based on a comparison between two models; the MCM, which models the usages of 8,567 metered properties, and DWUS which models usages of 1,000 unmeasured properties.

The metered consumption model (MCM) – measured usage

8.78 The metered consumption model used for this study is based on 8,567 properties, across all property types and demographics. These properties had a dumb meter which had been fitted for up to 27 years (i.e. since 1990). We also had occupancy data, or data regarding the number of people living in each property, which is critical to accurately understand any change in usage (see subsection 'why do we need to know occupancy')[11]. The metered properties included in the MCM are:

- **New Domestics:** We 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

[10] Cocks R, February 2017, '*Using Household Consumption Models to Estimate the Impact of Metering'*, Thames Water.
[11] 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.

- **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

Domestic water use study (DWUS) – unmeasured usage

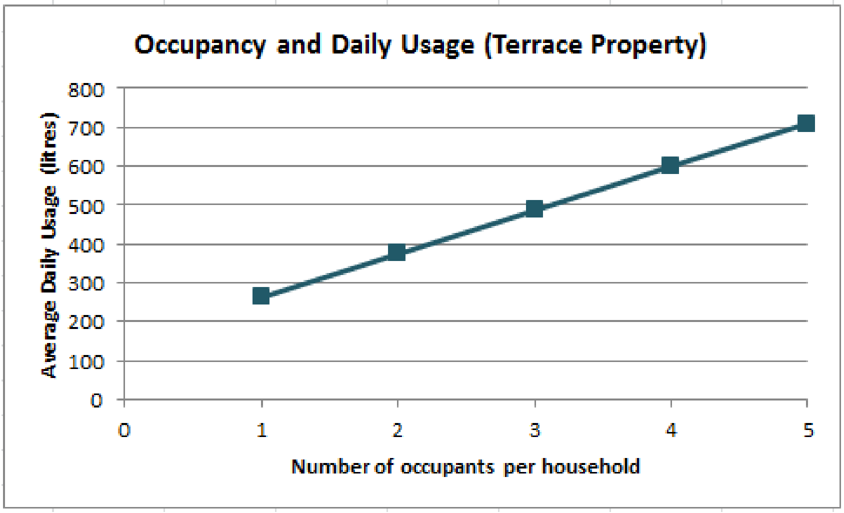
8.79 Our DWUS dataset consists of approximately 1000 properties whose consumption is metered but they are not charged on a metered bill (i.e. they are charged as unmetered customers). This means they behave as unmetered customers. Similar to the MCM, the property type and property occupancy is known for all properties included in DWUS. The DWUS dataset is also used in our regulatory reporting to extrapolate to the unmeasured household population.

8.80 By comparing the water use for each property type between MCM and DWUS, (i.e. by comparing property metered usage with property unmetered usage), we can estimate the average usage saving made by a household when it becomes metered. Comparison and analysis between the MCM and DWUS shows that, on average, a 17% reduction occurs in customer usage when a property is metered due to behaviour changes reducing wastage (i.e. fixing small household leaks).

Why do we need to know occupancy?

8.81 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 as it relates to base usage such as garden water usage or property wastage. This means household water usage is not only related to the number of occupants (Figure 8-5), so when modelling usage we need to understand both components.

Figure 8-5: Example of the impact of occupancy on household use[12]



8.82 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

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

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.

8.83 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?

8.84 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 final 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 final 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.

8.85 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 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. However, this resulted in a much lower estimate of usage reduction in comparison with the subsequent study conducted for the final WRMP when occupancy was known.

Benchmarking our savings

8.86 To understand how our savings compare with the water industry in the UK, we have benchmarked our 17% average usage saving against studies by Southern Water, Affinity Water and South East Water. In a report by Southampton University in February 2015, Southern Water present 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.

8.87 This added to confidence that our average 17% usage saving from installing a meter was within expected bounds seen by the industry.

[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

One year journey

8.88 To minimise the billing impact on customers, we currently implement a 'one year journey' from the time a customer has a meter installed to the time they begin paying on a metered tariff. Within this one year window, customers receive comparative bills which show the cost of water on an unmeasured and measured tariff. This incentivises customers to save water prior to being put on a metered tariff at the end of their one year journey.

8.89 This information is included in the optimisation stage of modelling so that the savings expected from household metering do not occur at the same time as a meter install but rather one year after the meter install.

Leakage reduction

8.90 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, toilet or internal small pipe leak). Continuous flow on an internal meter indicates the customer has wastage within their property.

8.91 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 final WRMP19, it is assumed that a POI is applicable when a property has continuous flow greater than 10l/hr.

Customer side leakage

8.92 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 final WRMP19.

8.93 In the final 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 10l/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.

8.94 To model the volume of CSL, 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 for each property type. Appendix N: Metering details the numbers to calculate the POI, percentage attributed to CSL and the savings achieved per repair.

8.95 This data is based on real data collected from our PMP customers who have had a CSL detected and repaired in the last three years (Appendix N: Metering for details). The leakage deterioration rate is applied to CSL savings to account for deterioration.

Cost

Meter installation

8.96 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.

8.97 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.

8.98 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.

8.99 The metering costs used in the final 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.

Meter replacement

8.100 The cost to replace a dumb meter with a smart meter is based on the cost of the smart meter alone and the overheads to conduct the replacement. A replacement meter does not require the additional cost to survey or install a new boundary box. Consequently, it is cheaper to replace a dumb meter than install a new meter at a property.

Asset life and cost effectiveness of metering programme type

8.101 The asset life of a meter has been assumed to be 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. This assumption has also been applied to dumb meters for the purpose of the proactive replacement meter programme.

8.102 The cost effectiveness of each metering programme type has been detailed in Appendix N: Metering in relation to the comparative cost benefit of each type.

CSL repair

8.103 The CSL repair cost is based on the average CSL repair cost achieved in the first three years of AMP6.

Fixed network

8.104 The cost of the fixed network is included as one fixed cost. This is because there is a certain cost to commission and maintain further masts in both London and Thames Valley that is independent of the number of meters installed. The meters covered by the fixed network includes, all smart meters rolled out under the progressive, bulk, replacement and optant programmes.

8.105 The cost of the fixed network includes the cost to commission new masts and operate and store data each year of each AMP. That is, 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 IT infrastructure to manage the real time data.

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

Smart Metering Operations Centre (SMOC)

8.107 The cost of the SMOC team is based on the number of meters installed each AMP. That is, once the number of household, bulk and replacement meters has been modelled, and the optant meter number confirmed, the SMOC cost is calculated based on the unit rate per meter to enable the SMOC team to monitor and follow up any issues for existing smart meter data and maintain this performance.

E. Options to reduce leakage

8.108 Leakage management consists of two predominant components:

- **Maintain:** 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
- **Enhanced:** 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 final WRMP19

8.109 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.

8.110 Section 8.E details the source of data for the costs and benefits of options that reduce leakage: DMA Enhancement, Pressure Management, Mains Rehabilitation and AMP6 Leakage Reduction Carry Over. The constraints and confidence in delivery are outlined in Section 8.H and Section 8.I. This information is used in the optimisation phase (Section 8.G) of demand management appraisal to calculate the total leakage reduction expected from each demand management programme (Section 8.K).

8.111 Trunk mains leakage reduction 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.

DMA enhancement

8.112 DMA Enhancement comprises two demand management interventions, DMA Enhancement and DMA Enhancement Plus (Figure 8-6).

8.113 DMA Enhancement replaces the demand management option, enhanced Active Leakage Control (ALC) that was included in WRMP14. ALC in WRMP14 referred to enhanced levels of 'find and fix' activity on top of the leakage activity being undertaken to maintain current levels of leakage. We have continued to pursue ways to improve our find and fix activity throughout AMP6, but, due to the condition of our network and volume of work we have undertaken in AMP6 (final WRMP19 Section 2.0: Water Resources Programme 2016-2020), further conventional find and fix work is limited for the final WRMP19.

8.114 Consequently, if we are to detect and repair enhanced levels of leakage on our network into AMP7, we need a more innovative solution. DMA Enhancement and DMA Enhancement Plus are the innovative solutions to achieve this objective and have been included in the final WRMP19 to replace the traditional 'enhanced ALC' option.

DMA enhancement

8.115 DMA Enhancement is defined as improving the accuracy of leakage detection by better accounting for demand in a DMA, and then targeting particular areas with more intensive leak detection techniques.

8.116 To do this, the data that defines a DMA is checked; water supplied, water consumed and leakage. This includes looking at the number of assets, properties and expected customer water use in a DMA which can uncover anomalies in any of these areas. Corrections and improvements to these anomalies are then used to increase the data quality available regarding water supplied, water consumed and leakage in a DMA. The interaction between these components either reduces leakage directly or helps to narrow the search for leaks in a DMA.

8.117 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

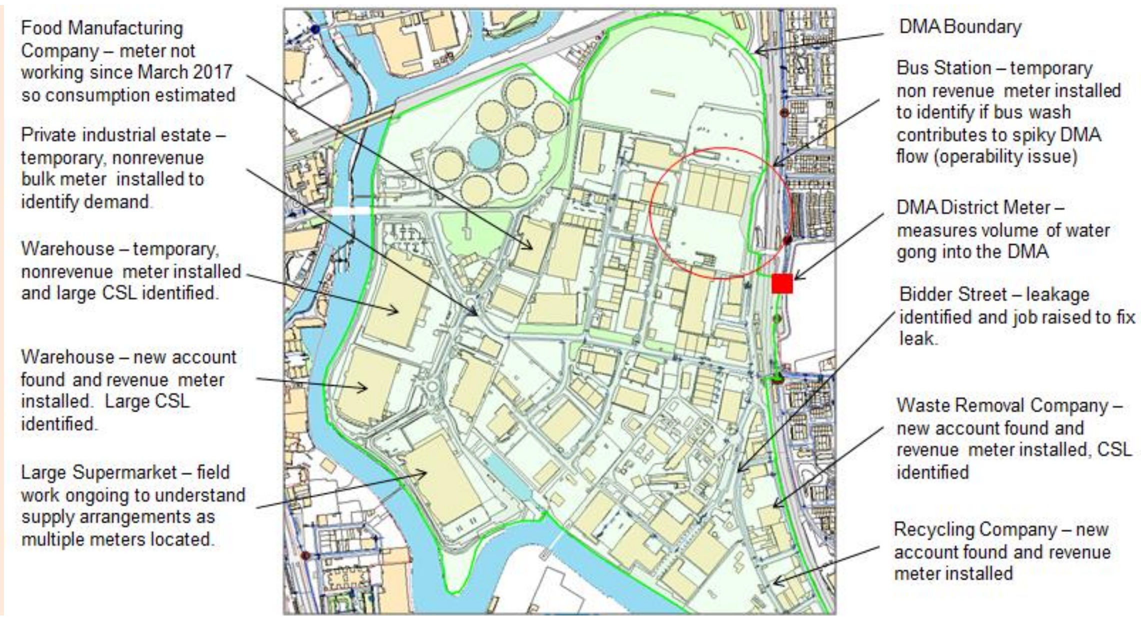
8.118 DMA Enhancement Plus combines DMA Enhancement with network reconfiguration activity. There are two parts of DMA enhancement plus; splitting large DMAs to create smaller DMAs and investigating historically 'unavailable' DMAs to make them available for leakage detection again.

8.119 DMA splitting is required because some DMAs are particularly large (> 5,000 properties or > 6 District Meters). This makes 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 which makes it easier to know the water supplied, water consumed and leakage in that DMA and therefore yield much larger leakage control results. DMA splitting 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.

8.120 There are a number of DMAs that have historically been 'unavailable' for leakage detection due to inherent network configuration issues. For example, a DMA may have a broken district meter that it has not been possible to repair for a number of years because the meter is located beneath a main road on a major bus route lane. This means that the exact volume of water going into the DMA is not known for this time. To access and repair the meter requires substantial traffic management and a rerouting of the bus route. Permission to access this area may only be granted once every five years to minimise disruption to the community. Moving the meter to another location may also require additional network reconfiguration in the DMA. Consequently, the purpose of DMA Enhancement plus is to investigate and resolve these longer term issues to ensure all DMAs are available for leakage detection and repair.

8.121 Figure 8-6 provides an overview of activities undertaken in DMA Enhancement and DMA Enhancement Plus.

Figure 8-6: Typical activities included under DMA Enhancement



Leakage reduction and cost

8.122 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, identify the tasks involved and develop the necessary processes to enable DMA Enhancement and DMA Enhancement Plus. 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.

8.123 The leakage reduction resulting from DMA Enhancement has been derived by taking the leakage benefit delivered from DMAs currently in the trial and extrapolating it to other potential DMAs across the company.

8.124 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.

8.125 In addition to the enhanced find and fix activity, DMA Enhancement and DMA Enhancement Plus will also be a primary contributor to our ongoing programme of Smart District Metered Areas (Section 8.J.)

Mains rehabilitation

8.126 Mains rehabilitation is a long term sustainable option that involves the rehabilitation of water mains and communication pipes to achieve two objectives; maintain our existing level of leakage by preventing leakage recurrence and achieve further leakage reduction.

8.127 The objective to maintain our existing level of leakage (i.e. to prevent leakage increasing from our current level) is part of the asset health part of the business covered by the PR19 plan. To maintain our existing level of leakage we undertake activity to reduce:

- Bursts, visible leaks and active leaks on our network
- Deterioration of our network
- The number of interruptions to supply and therefore, complaints of no water or low pressure
- Interruptions to traffic and local amenities due to emergency and planned repairs

8.128 The objective to reduce leakage further is part of final WRMP19. To reduce our existing level of leakage we undertake mains replacement activity.

Leakage reduction

8.129 To calculate the level of leakage reduction expected from mains replacement activity, we have considered mains replacement across four activities:

- Rehabilitate 25% of mains in a DMA
- Rehabilitate 50% of mains in a DMA
- Rehabilitate 75% of mains in a DMA
- Rehabilitate 100% of mains in a DMA

8.130 This means that during the optimisation phase, we input data into the IDM model (Section 8.G) so it can choose whether to rehabilitate all the mains in a DMA or only a portion of the mains in the 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 (for example, 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.

8.131 Consideration of mains rehabilitation at a partial DMA level means we can fully optimise the demand management solutions in each DMA. This is an improvement on WRMP14 where we only considered 100% mains rehabilitation for each DMA, meaning that if a DMA was selected to receive mains rehabilitation, it could not also include any other demand management solution.

Asset Investment Manager (AIM) distribution mains model

8.132 The level of leakage reduction that can be achieved in each DMA is obtained from the output of our AIM Distribution Mains Model. This means that we use the AIM Distribution Mains Model to model the level of leakage reduction achieved from mains replacement at a pipe level. This pipe level is then grouped together by DMA and the output of the AIM model is used as an input into the IDM model to model the level of leakage reduction at a DMA or partial DMA level.

8.133 The AIM 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.

8.134 The output file from the AIM Distribution Mains Model is used as the input file for the mains rehabilitation component of the WRMP model optimisation (Section 8.G).

Cost

8.135 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 used as an input file for the mains rehabilitation component of the WRMP model optimisation (Section 8.G).

8.136 The cost of mains rehabilitation is modelled at DMA level and is 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, based on costed schemes by borough/cost zone models.
- For Thames Valley, based on inner city and outer city cost models.

8.137 The total cost of mains rehabilitation is made up of two predominant components, unit costs and uplifts.

Unit costs

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

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

8.139 In doing this we have assumed that 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.

8.140 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.

Uplifts

8.141 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 both longer and shorter lengths of pipe. Including shorter lengths of pipe 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.

8.142 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 final WRMP19

8.143 In addition, we have undertaken some improvement work in the final 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 final WRMP19.

Pressure management

8.144 Pressure Management refers to the reduction of excess pressure within the water mains network to reduce leakage in a discrete area. Pressure Management also minimises pressure fluctuations in the network, thereby reducing burst frequency and increasing the asset life of infrastructure in a pressure-managed network.

8.145 Pressure Management is achieved through the installation of Pressure Reducing Values (PRVs) in a discrete area termed a Pressure Managed Area (PMA). That is, a discrete area is established within a DMA by closing existing or installing new valves so that the area receives water via one or two PRVs. Each PRV in a PMA is set to deliver water at a certain pressure. The pressure being delivered by each PRV is monitored by the Critical Pressure Point (CPP) located at the highest point in the PMA. The CPP regularly feeds back to the PRV through telemetry systems so that any change in pressure is rectified and the pressure throughout the PMA is minimised and remains constant.

Leakage reduction

8.146 The volume of leakage reduction achieved from a PMA has been modelled using data from Water Net. Water Net is a data management system that holds data for our existing PMAs whereby the average pressure reduction and resulting leakage reduction has been recorded for the life of the PMA. Water Net is our system for forecasting, calculating, reporting and monitoring leakage savings and PMA maintenance.

8.147 The total volume of pressure management available on our network in the plan period has been examined and verified internally and working in conjunction with our alliance partners. This is based on experience with AMP6 activity and includes the following assumptions:

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

8.148 DMAs with a current pressure below 30m were not considered as there are minimal leakage savings that can be achieved by dropping pressure 1-3m head. DMAs are also required to have an average minimum pressure of 25m head 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.

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

- Network restrictions: areas with significantly higher pressures usually require the maintenance of the 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 development solution. Although this is the developer responsibility at construction stage, present and future customers in the supply area will be unaware of this and a significant reduction in pressure by us will cause additional costs to these customers
- Customer complaints: when pressure is reduced by more than 10% customer complaints increase to high volumes. 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).

8.150 The total number of PMA schemes available and the leakage reduction expected from each scheme has been used as an input file for the pressure management component of the WRMP model optimisation (Section 8.G).

Cost

8.151 The cost to implement PMAs is based on our EES Cost Models. The output of the EES cost model is used as an input file for the pressure management component of the WRMP model optimisation (Section 8.H). 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; including the assumption that there is a 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.
- Ongoing maintenance Opex.

8.152 In the final WRMP19, we have also included a cost to maintain the benefits from pressure management beyond 20 years by maintaining the infrastructure. This is an improvement on WRMP14 where we assumed a pressure management scheme would provide no further benefit to leakage reduction at the end of its asset life of 20 years.

AMP6 Leakage reduction carry over

8.153 In the final WRMP19, an additional reduction option, 'AMP6 Leakage Reduction Carry Over' has been introduced. This option recognises the impact on annual average leakage as a result of a reduction in the April 2020 leakage level (compared to April 2019) resulting from the delivery of the 2019/20 leakage reduction programme. This leakage reduction is 34Ml/d and is applicable to year 1 of AMP7 at no additional cost to the programme.

8.154 Section 8.0, Annex 1 explains the source of the 34 Ml/d AMP6 Leakage Reduction Carry Over.

F. Options to reduce usage

8.155 Section 8.F details the source of data for the costs and benefits of options that reduce usage; Water Efficiency, Non-potable water usage and Innovative Tariffs. The constraints and confidence in delivery are outlined in Section 8.H and Section 8.I. This information is used in the optimisation phase (Section 8.G) of demand management appraisal to calculate the total usage reduction expected from each demand management programme (Section 8.K).

Water efficiency

8.156 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[15].

8.157 We agree with our stakeholders, customers and the 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 as part of the Demand Management Options Screening Process[16]. These options have been broken down into Baseline Options (Section 3) and Feasible Options. Baseline options are the activity that we undertake to promote the efficient use of water and ensure we deliver our statutory duty to promote water efficiency and develop and maintain an efficient and economical system of water supply. The options that form part of our baseline are discussed further in Section 3 and Appendix O: Water efficiency.

8.158 Feasible Options are options that promote the efficient use of water above the baseline activities and promote a level of water efficiency activity greater than the baseline activity to deliver a larger reduction in customer usage. The feasible water efficiency options are optimised in IDM to be included in the demand management programmes.

8.159 The Water Efficiency feasible options are categorised into five areas:

- Smarter Home Visits (SHVs)
- Smarter Business Visits (SBVs)
- Wastage Fix ('Leaky Loos')
- Housing Association Fix
- Incentives

8.160 There is a sixth area, Intensive Area Based Media Campaigns that has not been included in the IDM optimisation but that has been included in our overall preferred plan. This has been included in our final WRMP19 to facilitate more widespread campaigns across our whole supply area.

[15] Water For Life, Defra, December 2011
[16] Thames Water (2017), 'Thames Water WRMP19 Demand Management Options Screening Report', March 2017.

Smarter home visit

8.161 A SHV comprises a free in-home visit by one of our qualified staff to install water saving devices and provide personalised water savings advice to households. 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. SHVs are the most intensive and face-to face communication we have with our customers about water use across our entire customer base.

8.162 SHVs are offered to both measured and unmeasured customers, with a focus that complements our rollout of smart water meters. A SHV can be applied to five different property types:

- newly metered properties
- existing metered properties
- unmeasured properties
- replacement metered properties
- bulk metered properties

8.163 Two of these categories, replacement metered properties and bulk metered properties are new for the final WRMP19, representing innovation in future water efficiency opportunities.

8.164 The usage reduction achieved by implementing an SHV in each of these categories is based on data collected from over 100,000 SHVs conducted since 2015.

Newly metered (PMP smart metered) properties

8.165 The benefit used in IDM for conducting a SHV on a newly metered property is 37 litres per property per day. This saving represents a further 6% saving in addition to the 17% saving achieved by installing a smart meter (Section 8.D).

8.166 This figure is based on the water savings seen from our PMP customers who have received a SHV in AMP6. The analysis was carried out on 112,428 properties that received an SHV between September 2016 and November 2017. We commenced our IDM modelling in January 2018 so this was the most up to data dataset at that point in time.

8.167 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 – PMP and newly metered SHVs

8.168 Although this figure of 37 litres per property per day accurately quantifies the water savings achieved from a newly metered SHV, it may underrepresent the full benefit of undertaking a Smarter Home Visit. That is, more recent data for the period between June and November 2017 indicated that a Smarter Home Visit could achieve up to an average of 52 litres per property per day.

8.169 The higher figure was not used in IDM to ensure we were conservative in the prediction of future benefit. Also, there were some properties in the 112,428 property sample that were not yet paying on a metered tariff. This means there was a risk that these customers had not yet made all the changes we would expect from households once they pay for a metered bill. In the latter instances the SHV could have expedited the process rather than adding such a significant degree of additional benefit. Consequently, the figure of 37 litres per property per day was considered to be a more reliable and conservative figure to accurately represent the savings achieved from a newly metered Smarter Home Visit in the longer term.

8.170 To ensure we understood the impact of the Smarter Home Visit and benefit from paying on a metered tariff on an overall demand management programme, we undertook an uncertainty analysis around the usage benefit from PMP and the usage benefit from a newly metered SHV. This means 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.

8.171 This uncertainty analysis between the two optimisations showed that the demand management programme with a 15% reduction applied to metering has a total usage saving 3Ml/d lower than the demand management programme with a 17% reduction applied. Due to the size of the overall programmes developed in the final WRMP, a 3Ml/d difference was considered immaterial.

8.172 To improve our understanding of the impact of PMP usage and SHV usage reductions we will continue to monitor our customers on the PMP and update this data throughout AMP7.

Existing metered (dumb) properties

8.173 The benefit obtained by conducting a SHV on an existing metered property is 11 litres per household per day.

8.174 This figure is based on the analysis carried out on 7,836 properties which had received a SHV since 2015 and who were already paying on a metered tariff (on a dumb meter). The savings achieved by existing metered households are significantly lower than that of a newly metered household as there were a high proportion of optants in the existing metered sample. Customers who opt to have a meter installed tend to use less water prior to the meter installation in comparison to the average property.

Unmeasured properties

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

8.176 This figure is based on analysis in comparison with DWUS data to determine water savings of unmeasured households having smarter home visits. Since unmeasured customers have been proven to use more water and therefore have the potential to achieve more savings, the final figure of 25 litres per property per day is considered the more conservative position.

Bulk metered (smart metered) properties - dwellings

8.177 Conducting a smarter home visit on a dwelling in a bulk metered property is a new demand management option for the final WRMP19. This involves targeting dwellings within Small Blocks of Flats and Large Blocks of flats for a smarter home visit.

8.178 The benefit obtained by conducting an SHV on a dwelling in a bulk metered property is 15 litres per household per day.

8.179 Since this is a new option, this saving is based on expert judgement that the benefit will be close to that expected for an existing metered SHV. The additional 4 litres per property per day has been added due to the ability for Thames Water to use the bulk smart meter data to identify additional wastage savings on shared assets of a block of flats.

8.180 Although, these dwellings are considered unmeasured customers, on account that the bulk meter has been installed for CSL detection purposes and each customer remains on an unmeasured bill tariff, the savings assumed for this option have been based on the savings for an existing metered SHV to be conservative.

Replacement metered (smart metered) properties

8.181 Conducting a smarter home visit on a property with a dumb meter replaced to a smart meter is a new demand management option for the final WRMP19.

8.182 The benefit obtained by conducting an SHV on a replacement metered property is 15 litres per household per day.

8.183 Since this is a new option, this saving is based on expert judgement that the benefit will be close to that expected for an existing metered SHV. The additional 4 litres per property per day has been added due to the ability for the customer to benefit from new smart data and associated longer term water efficiency engagement, using smart meter data.

Smarter business visit

8.184 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, fixing internal leaks (wastage), converting toilets to dual-flush and installing urinal controls.

8.185 Although, following the introduction of non-household market competition in April 2017, we are no longer a retailer to business customers, businesses in our supply area make up a significant proportion of our demand. Consequently, we will still carry out water saving activities to business customers within our supply area to ensure the long term security of supply.

8.186 The benefit obtained by conducting an SBV on a business property is, on average, 1,316 litres per property per day. This information is based on the pilot study conducted throughout AMP6 where over 350 SBVs were conducted between April 2017 and November 2017. We commenced our IDM modelling in January 2018 so this was the most up to data dataset at that point in time. We will continue to monitor the savings achieved throughout AMP6 and into AMP7.

8.187 Figure 8-7 illustrates our leaflet to promote the activities carried out under our SBV.

Figure 8-7: Smarter Business Visits leaflet

Wastage fix ("leaky loos")

8.188 This is a water efficiency option specifically for free internal leak fixes (i.e. leaky loos and leaking taps). Following a collaborative UK water sector research project, and a parallel Thames Water initiative, it was found that 'Leaky loos' are one of the most common causes of high water use, but often go unnoticed or just left leaking. Our smart meter data and research shows that leaky loos can lose between 100 and 2,500 litres per day, often more than doubling a metered water bill. Consequently, we have devised our wastage fix programme to specifically target this usage.

8.189 The benefit obtained by conducting a wastage fix is, on average, 212 litres per household per day.

8.190 The wastage savings applied under the wastage fix option 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.

Housing association fix

8.191 We are working with local authorities, housing associations and other types of housing organisations to promote water efficiency advice to their residents This includes water efficiency retrofitting schemes, access to our specialist 'TAP app' water and energy saving calculator and app, and providing content for resident communications.

8.192 The benefit obtained by conducting a Housing Association Fix is 20 litres per property per day. This has been updated from our draft WRMP which was 15 litres per property per day. This updated assumption is based on updated data that shows our housing association visits were matching our weighted average (of metered and unmetered) smarter home visit savings.

8.193 This is based on our analysis of Housing Association Fix data from AMP6 which measure benefits from the installation of water saving devices and repair of wastage issues in Housing Association Properties.

Water efficiency costs

8.194 The cost of Water Efficiency options can range between £20 and £400 per visit/fix dependent on the activity required. This is based on the actual average cost to conduct Water Efficiency visits and wastage fixes since 2016.

Intensive area based media campaigns

8.195 Intensive area based media campaigns 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.

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

8.197 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.

8.198 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 for Oxford

8.199 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 is included in the final WRMP19 to facilitate more widespread campaigns across our whole supply area.

Water efficiency benefits over time

8.200 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 final 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 final WRMP19.

8.201 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 final WRMP19.

Water efficiency uptake rate

8.202 The uptake rates for each water efficiency activity are based on the Water Efficiency Programme Uptake throughout AMP6. Table 8-1 summarises the rates applied to each water efficiency option in the IDM model.

Table 8-1: Water efficiency uptake rates

Water Efficiency Activity	Uptake Rate
SHV - newly metered properties	33%
SHV - current metered properties	23%
SHV - unmeasured properties	20%
SHV - bulk metered properties	20%
SHV - replacement metered properties	33%
SBV - non household properties	13%
Wastage Fix - measured and unmeasured properties	5%
Housing Association Fix - Housing Association Properties	20%

8.203 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 July 2017.

8.204 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 final WRMP19.

8.205 For a Wastage Fix, the percentage uptake is based on the assumption that 1 in 20 properties across our supply area had a 'leaky loo'. This is based on the results of investigations during the installation of a new meter, the findings during SHVs between January 2016 and July 2017 and the evidence obtained from the Fixed Network Trial.

8.206 For a Housing Association Fix, the uptake rate has been based on access rates to housing association properties from January 2016 to July 2017.

8.207 With the exception of SHV – bulk metered properties and SHV – replacement metered properties, all uptake rates are based on uptake rates from properties in water efficiency activity since January 2016. The uptake rate of SHV – bulk metered properties has been assumed to be that of SHV – unmeasured properties based on the dwellings of a bulk metered property being unmeasured for billing purposes. The uptake rate of SHV – replacement metered properties has been assumed to be that of a SHV – newly metered property as replacement metered properties will receive the same communications when they are fitted with their smart meter as properties in the PMP programme.

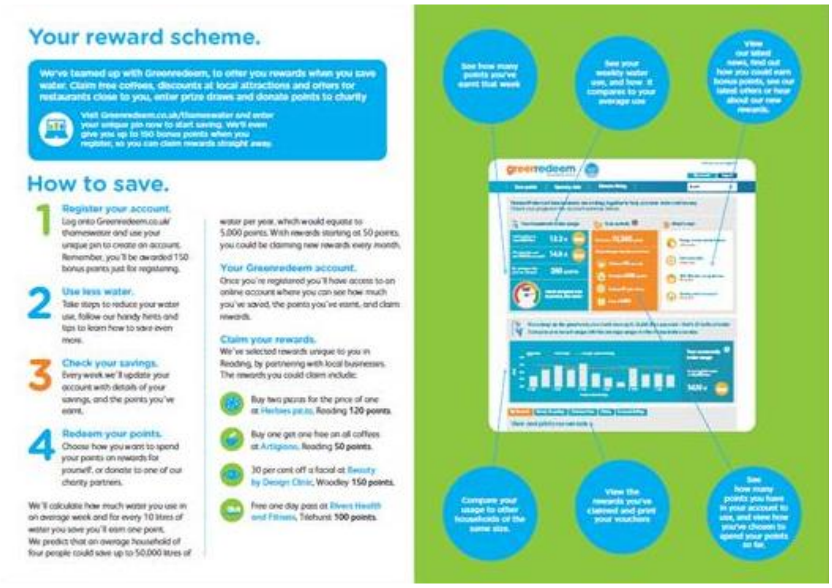
Incentives

8.208 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. It 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.

8.209 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 customers' behaviours through offering positive rewards as opposed to the imposition of negative dis-benefits.

8.210 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: Water Efficiency).

Figure 8-9: Greenredeem leaflet to customers as part of the incentives trial



8.211 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 final WRMP19. Current results show that customers are saving up to 2% of household water through this scheme. Of those homes that were offered the scheme, 24% of properties signed up. However, due to the small sample size (3,000 properties) of this trial and considering the rollout of this scheme across our entire area, we have reduced the uptake rate used in IDM to 1.2% of applicable households (i.e. households with a smart meter) to ensure we don't overestimate the savings.

Non-potable water

8.212 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.

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

- rainwater harvesting
- stormwater harvesting
- greywater recycling

Rainwater harvesting

8.214 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.

8.215 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

8.216 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.

8.217 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

8.218 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.

8.219 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.

Non-potable water and future innovation

8.220 The schemes that have been considered in the final WRMP19 demand management programmes are made up of a combination of all three non-potable components. Due to the high cost of non-potable water options, the IDM optimisations did not select non-potable water for inclusion in the demand management programmes.

8.221 However, due to the support within the water industry to explore non-potable water opportunities and Thames Water's direction to drive future innovation in demand reduction management, an allocation of 0.52 Ml/d per AMP has been included in the London demand management programmes for non-potable water. This will support our direction to explore emerging technologies and practices to achieve long term, sustainable reductions in demand management.

8.222 The outcome of our AMP7 programme for non-potable water will be monitored and quantified to inform our plan in WRMP24.

Innovative tariffs

8.223 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.

8.224 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 2030's when it is expected we will have at least 65% meter penetration.

8.225 To understand and quantify customers' response to alternative tariffs and different communication approaches, as well as helping to understand the logistics, systems and technology requirements and costs of implementing tariffs, we have undertaken two studies:

- a desk based review of tariffs which have been trialled and adopted internationally[17]
- an assessment of innovative charging options for Thames Water[18]

8.226 Based on these studies, for the final WRMP19, we have assumed a 5% reduction of measured household consumption with the introduction of tariffs in 2035. This has been introduced when meter penetration is planned to be much greater than 65% to ensure fairness to our customers.

G. Optimisation

8.227 In Sections 8.B and 8.C we explained the screening and evaluation process used to determine the feasible demand management options. In Section 8.D to Section 8.F, we detailed the costs and benefits associated with each feasible demand management option to assess the value of each option independently of one another.

8.228 Section 8.G. describes the final step in the demand management options appraisal process, optimisation of the feasible options to produce a range of demand management programmes.

Purpose of optimisation

8.229 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 deliverable or reliable programme. This is because on average demand management is cheaper than the supply options but, individually, the demand management options do not supply as much water to meet the supply demand deficits in AMP7. Therefore, the demand management options are

[17] RPS Literature Review, October 2017
[18] Review of Innovative Tariff Options, Nera, April 2015

developed into demand management programmes so they can be more accurately appraised against the supply options.

8.230 A demand management programme consists of a suite of demand management options to achieve a certain level of demand reduction in each AMP period. There is a wide range of demand management option 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).

8.231 However, simply selecting for the cheapest demand management options does not take account of the limitations to deliverability and availability. It also doesn't consider the additional benefits of combined options (i.e. following the installation of a meter with a water efficiency smarter home visit), 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.G).

8.232 Section 8.H details the limitation on deliverability and constraints employed in the modelling process for each demand management option.

Integrated demand management (IDM) model

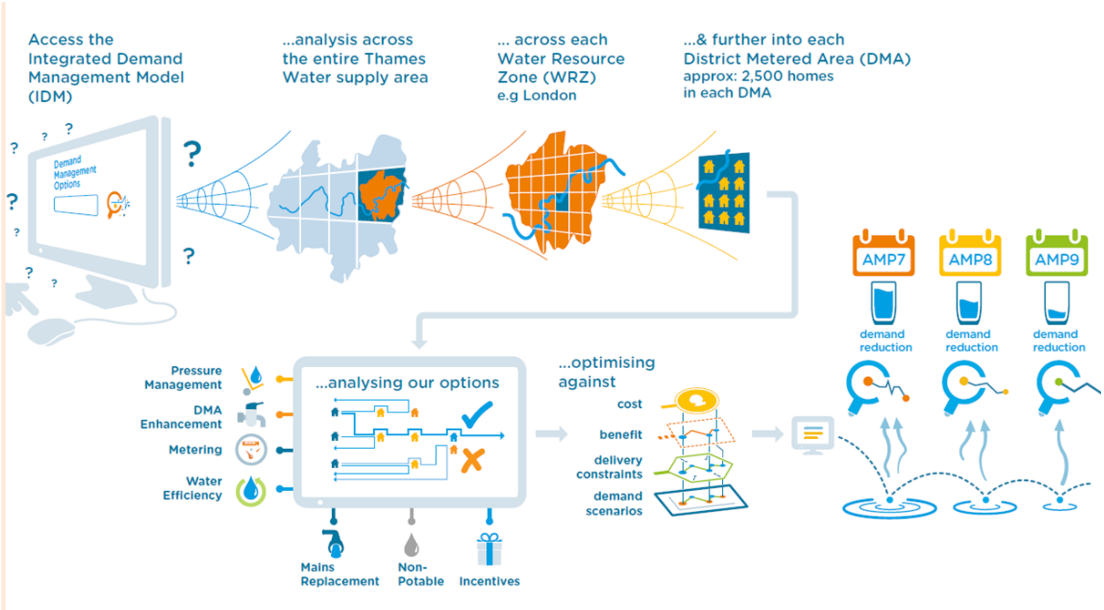
8.233 IDM is the optimisation modelling process we use to develop cost efficient demand management programmes. We do this using an optimisation tool called the IDM model. This involves appraising the overlapping costs and benefits of options that can be promoted in combination, in addition to evaluating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

8.234 For example, considered independently, there is a fixed cost to install and read a meter at a customer's property. The benefit achieved is a reduction in usage 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.

8.235 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 any DMA and in as many DMAs as is required.

8.236 The IDM model process encompasses three phases: data input, optimisation and programme outputs (Figure 8-10).

Figure 8-10: IDM process



Data input

8.237 All data inputs are made at the beginning of the process represented by the IDM model computer screen in Figure 8-10.

- **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.D to 8.F 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

8.238 The specific scenarios input into IDM to derive our range of demand management programmes are detailed in Table 8-2 in Section 8.K.

Optimisation

8.239 Once all the data have been input to IDM and the deliverability constraints set (Section 8.H), IDM can be set to optimise. IDM will search for a minimum whole life cost demand management programme over the 15 year planning period specified. IDM conducts this optimisation at DMA level. This process is illustrated in Figure 8-10. The optimisation is conducted by reference to multiple parameters including cost, demand benefits and programme delivery constraints to produce demand management programme outputs.

8.240 Appendix N: Metering includes the detail behind this optimisation in IDM.

Programme outputs

8.241 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.

8.242 Sections 8.K and 8.J summarise the demand management programmes that have been produced for the final WRMP19.

Accounting for mains deterioration: changes between the draft and final WRMP

8.243 For the final WRMP, the IDM model optimised the demand management options to achieve a reduction in leakage. This leakage reduction is over and above that required to manage leakage deterioration (i.e. leakage that occurs as the infrastructure deteriorates), which is part of the capital maintenance part of the business.

8.244 In comparison, for the draft WRMP19, the IDM model optimised the demand management options to achieve both a reduction in leakage and to manage leakage deterioration. This meant that for the draft WRMP19, IDM identified the level of mains rehabilitation required to manage leakage deterioration, and, the level of mains rehabilitation required to reduce leakage further.

8.245 The reason for the change in the approach is due to the degree of modelling done in both the IDM model, and, a separate model, known as the AIM Distribution Mains Model (AIM)[19]. The purpose of the AIM model is to determine the level of mains rehabilitation required to manage leakage deterioration (i.e. the leakage to manage as part of the capital maintenance part of the business).

8.246 Both the IDM and AIM model utilise the same leakage costs and benefits. However, the AIM has pipes as the relevant assets in its base data whereas IDM has DMAs as its main base scale. In addition, the AIM model optimises to also reduce 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.

8.247 In the draft WRMP19, the volume of mains replacement activity that is required to manage leakage deterioration (as determined by the AIM model), was included in the IDM model to ensure the most cost beneficial mains infrastructure was not targeted in both the IDM and Distribution Mains Model. This would happen because the two models could potentially select

[19] The change in the degree of modelling was due to the decision to move from a 9% leakage reduction to 15% leakage reduction. This resulted in a substantially larger range and degree of demand management programmes for the final WRMP19.

the same pipes or DMAs to replace (i.e. the most cost/beneficial) therefore underestimating the total cost and length of mains rehabilitation required. To prevent this occurring, we included the leakage deterioration requirement in the IDM model, and at the demand management programme output stage (Section 8.H), we removed the mains rehabilitation required to manage leakage deterioration so only the enhanced programme was presented (note: the mains rehabilitation to manage leakage deterioration will be held within the Asset Health section of the overall price review).

8.248 For the final WRMP19, a wider range of scenarios was modelled in IDM to reflect the business commitment to achieve more ambitious leakage reductions in future planning periods. In modelling these higher demand reduction scenarios, it was proven that modelling both deterioration and enhanced mains rehabilitation was not feasible in later AMPs.

8.249 Consequently, for the final WRMP19, IDM was updated to consider the enhanced component of mains rehabilitation only. To eliminate the issue of IDM targeting the same, most cost beneficial DMAs as the AIM Model, the most cost beneficial DMAs were not input into the IDM model. This meant that the DMAs available for IDM to optimise in the enhanced programme did not include the most cost beneficial DMAs that had already been selected by the AIM model to manage deterioration.

H. Delivery and modelling constraints

8.250 Section 8.H specifies the modelling constraints used in IDM to reflect the practical delivery of the demand management programmes.

8.251 That is, in the absence of any constraints on the model, IDM will select the most cost beneficial demand management options first and leave the more expensive options for later AMPs. This is because we ask IDM to find the most cost beneficial demand management programme over the modelling period (15 years). This means it will 'use up' the cheaper options before selecting the more expensive options. For example, without constraints, IDM will select to meter the majority of properties and undertake water efficiency activity in the first AMP. It will then leave the more expensive options such as mains replacement and non-potable water sources to later AMPs. Not only does this pose a risk to the reliability of the overall programme (i.e. it relies heavily on a reduction in customer usage and does not include a significant reduction in leakage in earlier AMPs) and relegates some innovative solutions such as non-potable water to much further in the future, it also poses a risk to the deliverability of the programme.

8.252 To minimise the risk of delivery failure, we have constrained some areas of work in each AMP. These constraints have been determined following discussion with our delivery teams. For example, to ensure the continued quality roll out of the metering programme across all water resource zones including excellent communications with each of our customers, we have constrained the level of metering that can be undertaken in each AMP in IDM. In this way, we have ensured that the final demand management programmes reflect a practical level of delivery for each individual demand management option that is included in the programme.

8.253 The constraints used in IDM and the explanation for each constraint, are detailed in the following subsections; Demand Reduction, Metering, Options to reduce leakage and Options to reduce usage.

Demand reduction

8.254 To produce a range of demand management programmes, we specified the level of demand reduction required in each AMP in IDM. For example, in one scenario we would specify that IDM must optimise to achieve a 50Ml/d demand reduction in AMP7, 40Ml/d demand reduction in AMP8 and 10Ml/d demand reduction in AMP9 to give a total demand reduction of 100Ml/d over 15 years. By comparison, a different scenario would request 100Ml/d demand reduction in AMP7, 80Ml/d in AMP8 and 40Ml/d in AMP9 to give a total demand reduction of 220Ml/d over 15 years.

8.255 The minimum level of demand reduction specified for each WRZ was:

- London: 80 Ml/d demand reduction in AMP7 and no further demand reduction in AMP8 and 9. This was based on the minimum level of demand management required to meet the AMP7 supply demand deficit in combination with small supply options.
- SWOX: 2.3 ML/d demand reduction in AMP7 and no further demand reduction in AMP8 and 9. This was based on the minimum level of demand management required to meet the AMP7 supply demand deficit.
- Guildford: 2.1 Ml/d demand reduction by the end of AMP8 and no further reduction in AMP9. This was based on the minimum level of demand management required to meet the AMP8 supply demand deficit.
- SWA: 1 Ml/d demand reduction by the end of AMP9 based on the minimum level of demand management required to meet the AMP9 supply demand deficit.
- Kennet Valley and Henley: between 0.5 – 2Ml/d in by the end of AMP9 based on a reasonable minimum level of demand management for these WRZs in the absence of any supply demand deficit up to AMP9.

8.256 Using the minimum level of demand reduction as the base, IDM optimised for incrementally higher demand management programmes in each WRZ.

8.257 In total, 90 demand management programmes were created across the 6 WRZs. These were input into EBSD Plus to be assessed against the supply options (Section 10: Programme appraisal).

Metering

8.258 To confirm the deliverable level of metering, we needed to determine three points:

- Maximum number of meters possible
- Level of metering in our most cost effective demand management programme
- Deliverable level of metering in each AMP

8.259 These points were confirmed by optimising IDM for each scenario. These optimisations were done using the input data specified in Section 8.D relating to the type, quantity, benefits and costs of metering.

Maximum number of meters

8.260 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 input data to the model(i.e. the 'internal and external split' and 'survey to fit' information, Section 8.D).

8.261 The results of the unconstrained IDM run showed that we could install just above 1 million 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

8.262 To determine whether it was cost effective to undertake metering in comparison to the other demand management options, we ran IDM with constraints on total demand but no constraints on metering. This allowed the model to choose between metering and all other demand management options.

8.263 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 modelling period (i.e. by the end of AMP9 in 2034) for every demand scenario.

8.264 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

8.265 Although the cost effective level of metering indicated up to 680,000 meters 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.

8.266 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 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.

8.267 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.

8.268 Our teams can increase their performance over time to achieve a higher level of successful meter installations. Consequently, we have determined that an ambitious but realistic metering programme includes the constraints set out in Figure 8-11.

Figure 8-11: Metering Delivery Constraints

Type of Metering	Constraint
Household Meters	Up to 421,000 installations in each AMP. This aligns with our total meter installation programme to deliver just over 1 million household meters by the end of AMP9.
Replacement Meters	Up to 130,000 installations in AMP7 with an increase to 260,000 in subsequent AMPs.
SBF Bulk Meters	Up to 35,000 installations in AMP7 with no constraint on subsequent AMP's
LBF Bulk Meters	Up to 2,500 installations in AMP7 with no constraint on subsequent AMP's

This level of metering 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.

Options to reduce leakage

DMA enhancement

8.269 The available volume of DMA Enhancement across our area has been constrained to 30Ml/d in AMP7 and 20Ml/d in AMP8. We have not planned to undertaken any new DMA Enhancement schemes from AMP9 onwards but instead will invest in the maintenance of savings achieved from AMP7 and 8. This has been done to ensure we achieve the benefit from DMA Enhancement in early AMPs and minimise the uncertainty risk in further AMPs.

8.270 Since DMA Enhancement is a new option for the final WRMP19, we have limited our commitment in AMP7. That is, the total leakage reduction we expect to achieve from DMA Enhancement is 50Ml/d by carrying out activity in 675 DMAs. To ensure we plan for a realistic and achievable target in AMP7, we have constrained the AMP7 leakage reduction from DMA Enhancement to 30Ml/d with the remaining 20Ml/d to be achieved in AMP8.

8.271 Although DMA Enhancement has a 'low' cost benefit in comparison to other demand management interventions, we considered it a high risk of delivery failure to plan to complete all 50Ml/d benefit in AMP7. We have used our lessons from the AMP6 DMA Enhancement trial to assess the approach, processes and tasks involved to achieve this leakage reduction to determine the optimum level of DMA Enhancement for AMP7 should be increased from the very limited constraint imposed in the final WRMP19, to an ambitious but deliverable constraint which achieves just over half of all potential savings in AMP7.

Pressure management

8.272 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.

8.273 There are two components to pressure management: pressure management to offset water network deterioration (asset health) and pressure management to achieve a leakage reduction (WRMP19). Due to the limited areas remaining that are available for pressure management, there is also a limited volume of pressure management that can be assumed for future planning.

8.274 In the PR19 plan we have assumed a portion of the available pressure management schemes across our area will contribute to offsetting water network deterioration. The remaining volume of pressure management available has been assumed to achieve a leakage reduction for WRMP19. Consequently, in the optimisation phase of demand management options appraisal, pressure management has been limited to AMP7 and London only as we will have exhausted all pressure management opportunities across our area by 2024. From AMP8 onwards, all pressure management activity will be to maintain the benefits achieved from pressure management schemes previously installed.

8.275 This is a significant reduction compared with WRMP14 but it emphasises the work we have already conducted in this area over previous planning periods.

Mains rehabilitation

8.276 Mains rehabilitation has one of the highest cost benefit ratio (second only to non-potable interventions) demand management options available in IDM. This means that, in earlier AMPs when all demand management options are available, IDM will select the cheaper demand management options in preference to mains rehabilitation. In later AMPs when IDM selects larger volumes of mains rehabilitation, the deliverability is managed by the total demand constraint. Consequently, mains rehabilitation has not been constrained in IDM for the final WRMP19.

8.277 In comparison, for the draft WRMP19, mains rehabilitation was constrained to ensure the model chose a minimum number of mains rehabilitation each AMP. The benefits achieved from this minimum number of kilometres contributed to the Water Infrastructure (maintenance) side of the business rather than the WRMP. If the IDM model optimised to include additional mains rehabilitation above this minimum, then the benefit achieved from the additional kilometres of mains rehabilitation became the enhanced demand management programme for the draft WRMP19. This was done to ensure the deterioration of our network was considered reliably and the cost of mains rehabilitation was not underestimated. However, since IDM has been updated to only take account of the enhanced or WRMP19 demand management programme, this constraint is not necessary in the final WRMP19.

Mains rehabilitation cost over time in the IDM model

8.278 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.

8.279 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.

8.280 The relationship of mains rehabilitation costs over time is also reflected in the Thames Water Mains Replacement Programme Independent Review[20]. This states that in the period to 2010, we achieved an average leakage saving of 1Ml/d for each 12km of mains rehabilitated. Based

[20] 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

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.

8.281 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.J) that will be optimised against the supply side solutions in EBSD plus.

Options to reduce usage

Water efficiency and incentives

8.282 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 choose to conduct as much water efficiency activity as possible.

8.283 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. Therefore, due to the modelling constraint that we will carry out up to 420,000 meter installations across our area per AMP, the number of SHVs to a newly metered property is also limited.

8.284 Smarter Business Visits (SBVs) have been constrained to up to 12Ml/d benefit across our supply area. This is because a SBV is a relatively new demand management option being undertaken in AMP6 with the added constraint of our business customers being moved to another entity. This means we don't have direct access to billing our business customers and therefore, there is some risk to delivery of these savings in the longer term. Consequently, although SBVs are a cost efficient water efficiency solution, they have been constrained to ensure the planned savings are realised.

8.285 There are not constraints on Wastage Fixes and Housing Association Fixes. However, due the to mix of constraints applied for all demand management options in the model, there is a limit on the number of these water efficiency options. This together with the limit on metering and therefore SHVs, means the size of the water efficiency programme chosen by IDM is less than it would have been without the modelling constraints.

8.286 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.

Non-potable water

8.287 Non-Potable water has the highest cost benefit ratio of all demand management options available in IDM. This means that, in earlier AMPs when all demand management options are available, IDM will select the cheaper demand management options in preference to non-potable water. In later AMPs when IDM starts to select non-potable water options, the deliverability is managed by the total demand constraint. Consequently, non-potable water has not been constrained in IDM for the final WRMP19.

Tariffs

8.288 Tariffs have not been included in the IDM model as they are not applicable until AMP10, when the metering programme is complete. The application of tariffs has been discussed in Section 8.J: Long Term Demand Management.

I. Confidence in delivery

8.289 Sections 8.D to 8.F presented the costs and benefits expected from the implementation of each feasible demand management option and Section 8.H detailed the constraints used in the modelling process to ensure the deliverability of the demand management programmes.

8.290 Section 8.I details the basis for confidence in the delivery of demand management options that make up a demand management programme. This section also outlines the influence of lessons from AMP6 in informing the confidence in delivery for AMP7 and beyond.

Metering

Usage reduction

8.291 Section 8.D. described the metered consumption model to confirm the 17% average usage savings expected from household metering.

8.292 This dataset used in the metered consumption model was considered our most realistic and robust dataset to date and therefore a reliable prediction of usage savings that will be achieved from household metering. The four predominant foundations for this confidence are:

- **Savings decay is captured**. The data used in the metered consumption model includes a proportion of customers who 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.
- **The 17% is conservative and therefore lower risk of not being realised.** The data used is based on customers using a dumb rather than a smart meter meaning the savings achieved would be lower than that expected from a smart meter. Dumb meter customers were used in the metered consumption model because a significantly large portion of customers on a smart meter where the property type and

occupancy is known is not yet available. This dataset of smart metered customers is expected to be available as more customers are metered throughout AMP7.

- **Occupancy is known.** The metered properties all had a Smarter Home Visit 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). This means the savings derived by the metered consumption model are accurate and are not an over or underestimation of household use due to incorrect or absent occupancy figures.
- **The impact of Optants has been removed.** When unmeasured households opt to have a meter, on average they use water more carefully than other metered customers. This risks artificially increasing the savings achieved by having a meter. To ensure this risk is mitigated, the impact of optants is removed from the metered consumption model.

8.293 The dataset used in the metered consumption model 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'[21] 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%

Monitoring our savings in AMP7

8.294 To continue to verify our metered consumption model, we will be targeting the customers who first entered our smart meter PMP for a SHV. Unfortunately, due to the extended adjustment period or 'two year journey' afforded to all customers on our PMP there was not a population far enough through the journey to assess as part of the metering consumption model that informed the final WRMP.

8.295 To ensure these customers can verify our metered consumption model, we will be targeting customers who have completed their two year journey for a SHV. This will be done to confirm the occupancy of these properties since our billing system does not hold this information. We

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

expect the first customers of the smart meter PMP to complete their two year journey in the summer of 2018 when they convert to a metered bill. 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.

8.296 This monitoring will be in addition to the monitoring conducted by the SMOC team. Throughout AMP7, the SMOC team will continue to monitor meter data on a daily basis and follow up potential leaks and damaged meters. Previously, with traditional or 'dumb' metering technology, this would not have been possible and issues would only have been picked up reactively at the twice biannual meter readings.

AMP7 delivery based on AMP6 lessons

8.297 In WRMP14 we forecast that we would install 441,270 household meters, however, following an optimisation of the different metering programme types, delivery for the remainder of the AMP was revised to a programme of 300,000. The reduction in household meters was due to the higher than expected number of attempted internal meter installations in flats and converted houses which share supplies. A higher volume of properties requiring an internal installation, particularly in London, meant that the total cost of metering increased as the mix of installations changed from predominantly external to predominantly internal in the areas of London that were being targeted by the PMP programme.

8.298 Internal installations are at a higher cost because of the additional cost to get in touch with customers, book an appointment and the high rate of failure due to the customer not being at home for the time of that appointment. Internal installations also have a higher risk of being unmeterable due to communal water supplies and pipework being inaccessible. This incurs an abortive cost and also leads to poor customer satisfaction.

8.299 In response to these lessons from AMP6, planning for AMP7 has included varying the property mix we plan to meter which directly impacts the installation mix. That is, in addition to our household metering programme, we will be targeting bulk meters to minimise the disruption and risk of failure from internal installations on dwellings within flats. Shifting the short term focus from many internal installations to few shared supply installations (for leakage detection purposes) will also allow time for internal metering technology to evolve that would reduce the volume of properties deemed unmeterable, and subsequently moved on to an assessed household charge which is applicable for unmeterable properties.

8.300 Additionally, successful methods of customer engagement have prompted us to implement a multi channelled customer journey that utilises text messages, emails, and online appointment booking to secure appointments to complement with a higher tariff for customers who refuse to engage with us. This improved method of customer communication has resulted in us installing more than 10,000 meters per month in 2017. Consequently, we are confident that using this method of customer communication we can maintain and exceed this level of installation in AMP7.

Collaboration with energy companies

8.301 We are currently in discussions with two of the big six energy companies to understand whether we can collaborate on our smart meter roll outs. This includes smart meter installation through to how we use the data. Discussions are still in early stages and we need to understand how this could work including the differing skill set between plumbers and electricians. A big difference in the energy roll out is that customers already have a meter and they are being upgraded; for our customers they are going from no meter to a smart meter. Also energy retailers are not geographically rolling out meters in the same way Thames Water are rolling out a street by street installation programme and energy meters are predominantly external, which doesn't require an appointment or a customer to be in to carry out the install. Energy retailers have customers throughout the UK based on the customer selection of retailer, which does make collaboration and timing slightly more challenging. In the meantime, we are focussing our communications to customers that saving water also saves energy. We are clear that our free smarter home visits can help our customers to save water, energy and money from their bills and our online water energy calculator also supports with this messaging.

Vulnerable customers

8.302 Some of our customers will see an increase in their bill after the meter is installed. To manage this 'bill shock' we allow customers one year to switch over to a metered bill. For the first three years of AMP6, we allowed customers two years before switching to a metered bill. During this time, we use smart meter data to write to customers after three months, six months and one year to let them know what their metered bill is likely to be compared to their current bill based on the rateable value of their home.

8.303 The meter reads are also being used by our online customer platform 'my meter online', to populate daily usage graphs allowing customers to log in online regularly and view their water use. Educating our customers on how much water they use, when they use it and how they can reduce it is a hugely important part of our programme. All homes who receive a smart meter as part of our progressive metering programme will be offered a free smarter home visit, to help them save water, energy, and money.

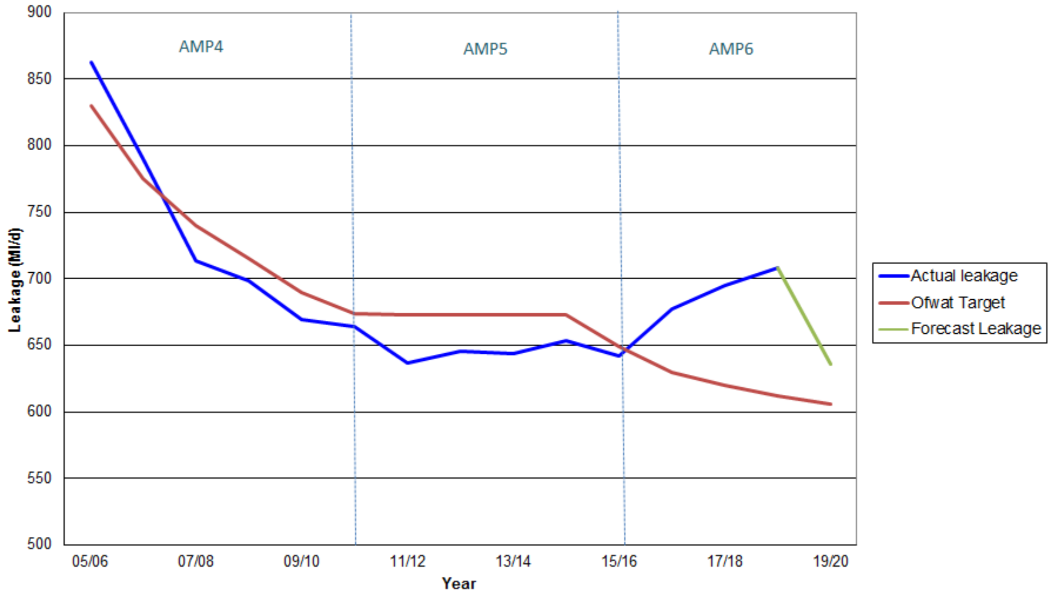
8.304 Additionally, we continually communicate our affordability offering to customers through our metering journeys and literature, this includes setting up regular and manageable payment schemes, our social tariffs WaterSure and WaterSure plus, and grants. Our teams are also trained to identify customers who may be eligible for extra support, including our extra care services, and are able to refer these customers at any time. Through our Smarter Home Visits, we also undertake benefits entitlements checks where appropriate.

Options to reduce leakage

8.305 Section 8.E presented the costs and benefits expected from the implementation of each demand management option to reduce leakage; DMA Enhancement, Pressure Management, Mains Replacement and AMP6 leakage reduction carry over. Section 8.D detailed the costs and benefits expected to achieve a reduction in leakage from the repair of CSL's on newly metered properties. With the exception of the AMP6 leakage reduction carry over and the enhanced nature of DMA Enhancement above our current practice of Active Leakage Repair (ALC), the options to reduce leakage in our WRMP19 are identical to those being undertaken in AMP6.

8.306 It follows that our confidence in delivery of future leakage reduction is consequent upon our understanding of our ability to delivery leakage reductions in previous AMPs. Since our peak leakage in 2003/04, we have reduced total company leakage by 30% and consistently delivered against our leakage targets from 2005/06 until 2016/17 (Figure 8-12).

Figure 8-12: Leakage reduction performance against target



8.307 In AMP4 (2005-2010) we achieved our leakage reduction target through the implementation of a large mains replacement programme which delivered over 400km of replacement each year. This was supported by a programme of new pressure management schemes and a proactive plan to detect and repair leakage on both the distribution mains and trunk mains network. Large levels of find and fix activity continued to manage leakage recurrence.

8.308 In AMP5 (2010-2015), we predominantly maintained the low level of leakage achieved in AMP4 as we did not plan to significantly reduce leakage in this period. That is, company leakage was reduced by 2% in this AMP period. In this period, mains replacement expenditure was reduced to maintain asset condition only, smaller PMA schemes were implemented as the larger schemes has been delivered in AMP4 and work continued on find and fix activity to manage leakage recurrence.

8.309 In AMP6 (2015-2020) we committed to reduce leakage by 59Ml/d. This would be achieved through a combination of mains replacement, pressure management, repair of CSL's from newly metered properties and enhanced find and fix activity. However, in 2016/17, we exceeded our target by 46.8Ml/d, the first time we had missed our leakage target in 11 years.

8.310 Our current leakage performance is also not what we would like it to be, largely because of the extreme weather events in 2018. While we remain committed to the original 606Ml/d target, we estimate that performance, on a risk adjusted basis, is more likely to be around 636Ml/d for 2019/20.

AMP6 insight

8.311 The following subsections detail our insight into our AMP6 performance and the lessons we have incorporated into our leakage plan. These lessons have been applied in AMP6 and will be carried forward to our AMP7 delivery plan. We have shown that we have learnt from and managed our changing environment to ensure we have a high confidence in delivery of our targets into the future.

The impact of weather

8.312 Our performance in 2018/19 has been heavily affected by two challenging weather events; the extreme cold weather in March 2018 – the Beast from the East; and the hot, dry weather between April and July 2018. Both have contributed to increases in leakage and we have struggled to recover our performance sufficiently to keep our original forecasts of 2019 year end value and our 2019/20 average leakage level. Our current best view is that we have ended the year on 31st March 2019 at a spot value of 663Ml/d, which is 30Ml/d higher than our previous forecast of 633Ml/d.

8.313 This means we begin 2019/20 at a higher level of leakage than we had expected to, which has a knock-on effect on our ability to reduce leakage during the year. We will continue our efforts to achieve our annual average leakage target in 2019/20 of 606Ml/d, but from the experience of the past year, our forecast is likely to be more realistic, central figure of 636Ml/d. This will still surpass our best ever leakage reduction performance.

8.314 We have committed to recovering the 30 Ml/d increase by 2024/25. This aligns with the commitment in our Business Plan which includes further find and fix activity to make up lost ground from AMP6.

8.315 Our update to the final WRMP19 will achieve a reduction of 15% from our end of AMP6 target of 606Ml/d. This aligns with the commitment in our business plan, which includes further active leakage activity deferred from the AMP6 recovery plan. Allowing for this deferral, we forecast an overall reduction of 134Ml/d in AMP7, which implies a 20% reduction.

Management of the network

8.316 In AMP6, the environment in which we managed our water network changed significantly. This was due to three factors; internal policies, internal structural arrangements and external pressures.

Internal Policies

8.317 For the duration of AMP6, we have focussed on keeping customers in supply as we fix leaks and bursts. In contrast, in previous AMP's we would consistently isolate customer' supply to conduct all repairs. To keep customers in supply during a repair requires a high level of internal planning that requires communication coordination between multiple departments and field resources. At the commencement of AMP6, we were not sufficiently equipped to execute this level of planning and consequently failed to undertake many planned repairs.

Internal Structural Organisation

8.318 Commencing in AMP6, we formed a new partnership alliance, the Infrastructure Alliance to encourage better, smarter and more collaborative working. It was expected that this alliance would embed proficiently and provide company efficiencies within the first year of operation. Unfortunately, the alliance proved more complex than expected and consequently it resulted in inefficiencies in leakage detection and repair in terms of volume and time of repair for years 1, 2 and 3 of AMP6.

External pressures

8.319 Throughout AMP6, we have had increasing pressure from the Highways Authorities regarding street access to carry out repairs. This is in response to their increasing pressure to keep London moving whilst undertaking major infrastructure projects including the cycle super highway, Cross rail and HS2. Combined with our internal structural issues for planning, this has resulted in a lower level of planned repairs being undertaken.

8.320 In order to address the shortfall of repairs during the first three years of AMP6, we have a detailed leakage recovery plan in place which addresses these issues. We have also committed additional funding for further detection and repair, including the use of more advanced technologies, further pressure management and more investment into improving understanding and accounting for water use which draws heavily on the increasing numbers of smart meters being installed in AMP6. This is all supported by improved governance, clearer accountability and reorganising the delivery model with the detection and repair service providers.

Confidence in future leakage delivery

8.321 We recognise the importance of reducing leakage from our ageing network. Our current leakage performance is not what we would like it to be.

8.322 We have put increased focus on our leakage activity since the submission of our September business plan. In November 2018, we set up a dedicated cross-functional Leakage Task Force to:

- Get better insight into why the network breaks, so we can better prevent leaks from happening.
- Make better use of new and existing data, to better predict leaks and improve the accuracy of leakage detection.
- Ensure we maximise the productivity of our find and fix machine; Understand the implication of the level of find and fix on our network and weather it causes increased network deterioration; and
- Accelerate the CALM networks programme to reduce pressure related bursts.

8.323 We have returned governance and accountability to us from the Alliance Partners and implemented a new organisational design for the water networks team.

8.324 These measures will continue into AMP7 to ensure delivery of our future leakage targets.

Accounting for the impact of weather in future AMP's

8.325 The winter of 2017/18 saw a significant freeze/thaw event which may become more frequent in the future. This event resulted from network infrastructure, rather than water resource availability issues. The resilience of Thames Water, water resource infrastructure to freeze/thaw events, as well as other factors such as flooding, is addressed through our resilience plans within the wider PR19 Business Plan. Continued investment in the network through AMP7 will improve resilience to such non-drought hazards in the future

8.326 As part of the WRMP approach we have included a level of uncertainty against the benefit of each option, including leakage benefit. This is included in the overall headroom and protects us against a level of underperformance in the event of extreme weather events. We have also included a few smaller supply options to provide further protect our security of supply.

8.327 In advance of WRMP24, work will be completed to investigate the probability of freeze thaw events occurring simultaneously with a dry year. This will determine whether such an event falls within, or outside of the probabilities of resilience trends considered and planned to within the final WRMP19. At this time we consider this is outside of a 1 in 200 year event but our future analysis will confirm this.

8.328 We have the oldest water network in the industry with the highest burst rate. The underlying asset health issues can only be improved through main rehabilitation as a part of the long-term programme of work. The targeting of this work will be improved by the investment in metering and DMA enhancement in the next 10 years.

J. Long term demand management

Creating an 80 year demand management programme

8.329 Section 8.G describes the IDM model and the optimisation process to produce demand management programmes. This optimisation occurs over 15 years, or until the conclusion of AMP9 (2034/35).

8.330 To determine our long term ambition for demand management, we must optimise our demand management options over an 80 year period. This section describes how our 15 year optimised programme is developed into an 80 year demand management programme.

8.331 Figure 8-13 displays the relative cost benefit value of each demand management option that is optimised in the IDM model. It also shows the time step of each option and when that option will no longer be available. An option is no longer available either because we have run out of areas to implement that option, or, we have completed the roll out of that demand management intervention.

8.332 Figure 8-13 shows that, at the conclusion of the 15 year IDM optimisation, 7 of the 15 demand management options remain; CSL fixes from SBF bulk meter installations, Mains rehabilitation, Innovation, Financial tariffs, Non-potable water sources and Water efficiency and Incentives.

Figure 8-13: Availability of Demand Management Options each AMP

Demand Management Option	Relative Cost Benefit	Availability						
		AMP7	AMP8	AMP9	AMP10	AMP11	AMP12	AMP13
Metering								
Household	Medium	✔	✔	✔	✗	✗	✗	✗
Bulk - SBF	Medium	✔	✔	✔	✔	✗	✗	✗
Bulk - LBF	High	✔	✔	✔	✗	✗	✗	✗
Replacement	High	✔	✔	✔	✗	✗	✗	✗
Innovative Tariffs	Very Low	✗	✗	✗	✔	✗	✗	✗
Options to reduce leakage								
AMP6 Carry Over	No Cost	✔	✗	✗	✗	✗	✗	✗
DMA Enhancement	Medium	✔	✔	✗	✗	✗	✗	✗
Pressure Management	Medium	✔	✗	✗	✗	✗	✗	✗
Mains Rehabilitation	High	✔	✔	✔	✔	✔	✔	✔
Innovation	High	✗	✗	✔	✔	✔	✔	✔
Options to reduce usage								
Water Efficiency - Household	Low	✔	✔	✔	✗	✗	✗	✗
Water Efficiency - Business	Low	✔	✔	✔	✗	✗	✗	✗
Water Efficiency - Innovation	Low	✔	✔	✔	✔	✔	✔	✔
Incentives	Low	✔	✔	✔	✔	✗	✗	✗
Non-Potable	Very High	✔	✔	✔	✔	✗	✗	✗

8.333 To create the 80 year demand management programme, the relative cost benefit of each of these options was assessed and, similar to the IDM optimisation, the most cost beneficial options were included in earlier AMPs (e.g. AMP10) and the least cost beneficial options included in later AMPs. This means that high levels of usage options were added in AMP10 and 11, and then, as this ran out, more mains replacement was added to later AMPs (AMP12 to 14).

8.334 This process, together with the IDM model outputs were combined to produce a range of 80 year demand management programmes that were input to EBSD plus (Section 10: Programme Appraisal).

Demand management in the longer term – Policy Position

8.335 Section 8.I detailed the confidence in delivery of each demand management option that comprises our demand management programmes. However, in response to customer expectations and National Infrastructure Commission (NIC) requirements, our programmes include particularly ambitious targets for leakage and PCC in the longer term.

Leakage reduction

8.336 Within the development of our plan we have taken account of customer and stakeholder preferences and guidance. Customers have stated a preference for leakage reductions before moving to supply options. Defra have also provided guidance to Ofwat ('The Government's strategic priorities and objectives for Ofwat', September 2017, Defra) that states a need to 'promote ambitious action to reduce leakage and per capita consumption'. Further to this the National Infrastructure Commission (NIC) report recommends continued reduction in leakage to 50% by 2050 and full metering coverage in the 2030's ('Preparing for a drier future', 2018).

8.337 Due to these policy decisions, a large number of our demand management programmes include the provision to meet these higher leakage reductions.

8.338 To develop demand management programmes that included a 15% leakage reduction in AMP7, IDM was set to optimise for a higher demand management reduction in AMP7 as per the constraints detailed in Section 8.H. This meant that IDM was left to optimise different demand management options that would achieve a 15% leakage reduction in AMP7. This commitment aligns to customer preference to reduce leakage before supply options, and stakeholder expectation.

8.339 To develop demand management programmes that included both the 15% leakage reduction in AMP7 and the 50% leakage reduction by 2050, those IDM demand management programmes that achieved the 15% reduction were combined with the 15 to 80 year programmes that included the 50% leakage reduction. The 50% leakage reduction was achieved by combining cheaper demand management options such as CSL savings from Small Bulk Meters with Innovation in Leakage reduction and more traditional mains replacement (Figure 8-13).

8.340 Section 11 specifies the demand management options that make up the 15% leakage reduction in AMP7 and 50% leakage reduction by 2050 in our preferred programme. The confidence in delivery of each of these demand management options is detailed in Section 8.I.

Per capita consumption (PCC)

8.341 PCC targets will drive the direction of available demand reduction options from AMP7 onwards, such as metering, water efficiency, customer engagement campaigns, customer propositions and partnership projects.

8.342 To develop our reduction in customer usage, IDM was set to optimise for various demand management reductions over the planning period. IDM selected to implement metering, to achieve a customer usage reduction and, a selection of water efficiency options. The water efficiency options input into IDM are based on options that we currently implement in AMP6. This gives us confidence in their delivery and achievable benefits.

8.343 However, we also recognised there was opportunity to be more ambitious with our customer usage reductions. Consequently, to enhance customer usage reductions, specifically in AMP7, we included further water efficiency activity in the form of innovation. This innovation is based on our work with other water companies through the Water Efficiency Network, our role within the UK Water Efficiency Strategy Steering and Leadership Groups, and our efforts during the 2017/18 ‘heatwave’. Potential areas of demand reduction innovation to be considered could include; non-potable supply options, alternative water supply options for large irrigation users, innovative engagement through partner digital platforms, and working closely with Defra on water labelling.

8.344 To develop our longer term reduction in customer usage, further innovative water efficiency activity was included from AMP10 onwards together with the introduction of Tariffs in AMP10 (Figure 8-13). Tariffs have only been included once the metering programme is complete at the conclusion of AMP9.

8.345 Section 11 specifies the demand management options that make up the reduction in customer consumption in AMP7 and in our longer term demand management programme.

8.346 We have also reviewed the Artesia PCC study commissioned by Ofwat. This tests reductions in PCC down to 50l/p/d. We are reviewing the same study in detail for our own region. It is our belief, aligned to views given back to the recent government 25 year Environmental Review[22] , that water companies will need assistance to achieve lower PCC. This will require support with such things as water labelling on white goods (as per the system in Australia), recommending the strengthening of fittings regulations and the planning system to ensure that better toilet technology/mechanisms are installed in our region to reduce the growing problem of 'leaky-loos', and to assist the development of non-potable water systems in new builds.

Smart District Metered Areas

8.347 Smart District Metered Areas are DMAs where the water delivered, water consumed and the leakage level of the DMA is known and monitored in real time. Smart DMAs are achieved by combining the demand management options of DMA Enhancement and DMA Enhancement Plus, Metering (including household, bulk and replacement) and Water Efficiency.

8.348 This means that from AMP7 we will be aiming to achieve Smart DMAs by rolling out the metering and water efficiency programmes in conjunction with DMA Enhancement and DMA Enhancement plus activity. This will be done to target areas where we may know the amount of water feeding in to a DMA but not necessarily where all the water is consumed.

8.349 In this way, DMA Enhancement will ensure the volume of water entering a DMA is known and monitored in 'real' time, and the Metering and Water Efficiency activities will ensure the volume of customer usage is known in 'real' time and any wastage issues are resolved or accounted for.

8.350 Smart DMAs will also help us to improve:

- the accuracy of our water balance calculations
- our quantification of CSLs
- our understanding of night time consumption to more accurately account for leakage
- our prediction of active leakage before they become visible and cause disruption

8.351 In the longer term, smart DMAs will help us plan for future investment and ensure we target leakage repair and mains replacement in areas with significant leakage reduction benefits.

[22] https://www.gov.uk/government/publications/25-year-environment-plan

Maintenance of demand management savings

8.352 In order to maintain the savings achieved in both the IDM optimisation phase of demand management appraisal and the development of an 80 year demand management programme, a cost to maintain these benefits must be included in the programme.

8.353 This is done by factoring in the repeat costs for each demand management programme. Repeat costs are based on asset life, repeat frequency of demand management option and innovative solutions to maintain benefits. For example, the benefits achieved by DMA Enhancement will be maintained in the longer term by implementing mains replacement to maintain the same level of benefits achieved by DMA Enhancement in earlier AMPs. This is done to ensure both the leakage and usage reductions achieved in earlier AMPs are maintained throughout the 80 year demand management programme period.

8.354 In the final WRMP19, we have also included a cost to maintain the benefits from pressure management beyond 20 years by maintaining the infrastructure. This is an improvement on WRMP14 where we assumed a pressure management scheme would provide no further benefit to leakage reduction at the end of its asset life of 20 years.

Option uncertainty

8.355 The uncertainties applied to each demand management option are presented in Section 5 and Appendix V.

Environmental and carbon appraisal

8.356 Strategic environmental assessments have been undertaken for each demand management option. These assessments are provided in final WRMP19 Section 9: Environmental Appraisal.

8.357 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 a unit rate, with the values given 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 plus. These assessments are provided in Appendix R: Scheme Dossiers.

K. Demand management programmes

Summary of demand management programmes

8.358 For the final WRMP19, we have optimised over 80 demand management programmes across the six Water Resource Zones. All of these programmes have been included in the next stage of development (Section 10: Programme Appraisal and Scenario Testing).

8.359 A selection of these demand management programmes have been summarised in Table 8-2. We have filtered the scenarios presented to include the demand management programmes around the lower, middle and upper end of the range of demand management programmes for each WRZ.

8.360 The details of the preferred programme, including the total benefit for each demand management option is summarised in Section 11: Preferred Plan. Further information about the range of demand management programmes is detailed in the attachment, 'EA Table Notes' to Appendix P: Options List Tables.

Table 8-2: Demand management programmes

Demand M'gement Programme	Demand Management Programme (DYAA)																							
	Usage Reduction (Ml/d)								Leakage Reduction (Ml/d)								Total Demand Reduction (Ml/d)							
	AMP 7	AMP 8	AMP 9	AMP 10	AMP 11	AMP 12	AMP 13	Total Usage Reduction	AMP 7	AMP 8	AMP 9	AMP 10	AMP 11	AMP 12	AMP 13	Total Leakage Reduction	AMP 7	AMP 8	AMP 9	AMP 10	AMP 11	AMP 12	AMP 13	Total Demand Reduction
LONDON																								
DMP_LON_80.A7M	17.29	0.00	0.00	0.00	0.00	0.00	0.00	**17.29**	62.76	0.00	0.00	0.00	0.00	0.00	0.00	**62.76**	80.05	0.00	0.00	0.00	0.00	0.00	0.00	**80.05**
DMP_LON_106.A7_SD	37.50	0.00	0.00	0.00	0.00	0.00	0.00	**37.50**	71.35	0.00	0.00	0.00	0.00	0.00	0.00	**71.35**	108.85	0.00	0.00	0.00	0.00	0.00	0.00	**108.85**
DMP_LON_123.A7	43.75	0.00	0.00	0.00	0.00	0.00	0.00	**43.75**	78.61	0.00	0.00	0.00	0.00	0.00	0.00	**78.61**	122.36	0.00	0.00	0.00	0.00	0.00	0.00	**122.36**
DMP_LON_159.A8_SD	23.41	33.65	0.00	0.00	0.00	0.00	0.00	**57.06**	82.40	20.81	0.00	0.00	0.00	0.00	0.00	**103.21**	105.81	54.46	0.00	0.00	0.00	0.00	0.00	**160.28**
DMP_LON_110_70_7	35.26	32.06	7.23	0.00	0.00	0.00	0.00	**74.54**	75.11	37.57	0.00	0.00	0.00	0.00	0.00	**112.69**	110.37	69.63	7.23	0.00	0.00	0.00	0.00	**187.23**
DMP_LON_225.A8	49.06	34.01	9.29	0.00	0.00	0.00	0.00	**92.35**	90.23	41.92	0.21	0.00	0.00	0.00	0.00	**132.35**	139.29	75.92	9.50	0.00	0.00	0.00	0.00	**224.71**
DMP_LON_244.A9	46.52	38.76	20.51	0.00	0.00	0.00	0.00	**105.79**	83.10	46.85	10.41	0.00	0.00	0.00	0.00	**140.36**	129.62	85.61	30.92	0.00	0.00	0.00	0.00	**246.15**
DMP_LON_270.A10	46.52	38.76	20.51	5.73	0.00	0.00	0.00	**111.52**	83.10	46.85	10.41	20.30	0.00	0.00	0.00	**160.66**	129.62	85.61	30.92	26.03	0.00	0.00	0.00	**272.18**
DMP_LON_329.A10	43.92	44.03	13.02	35.00	0.00	0.00	0.00	**135.96**	100.32	47.68	33.62	0.00	0.00	0.00	0.00	**181.61**	144.23	91.71	46.64	35.00	0.00	0.00	0.00	**317.57**
DMP_LON_355.A10	47.55	37.35	28.72	40.73	0.00	0.00	0.00	**154.34**	110.51	47.95	18.64	14.30	0.00	0.00	0.00	**191.40**	158.06	85.30	47.36	55.03	0.00	0.00	0.00	**345.74**
DMP_LON_411.A12	47.55	37.35	28.72	40.73	5.00	0.00	0.00	**159.34**	110.51	47.95	18.64	40.80	24.80	0.00	0.00	**242.70**	158.06	85.30	47.36	81.53	29.80	0.00	0.00	**402.04**
DMP_LON_S4b	54.85	46.94	20.04	43.98	5.00	5.00	0.00	**175.81**	85.70	46.73	29.42	40.80	24.80	10.00	7.50	**244.94**	140.55	93.67	49.46	84.78	29.80	15.00	7.50	**420.75**
DMP_LON_450	54.85	46.74	20.25	40.73	5.00	5.00	0.00	**172.57**	85.71	46.73	29.42	40.80	34.80	20.00	20.00	**277.46**	140.56	93.47	49.67	81.53	39.80	25.00	20.00	**450.03**
DMP_LON_585.A11	54.85	46.44	20.25	40.73	4.20	0.00	0.00	**166.47**	85.70	46.73	29.42	40.80	34.80	50.00	50.00	**337.45**	140.55	93.17	49.67	81.53	39.00	50.00	50.00	**503.92**
SWINDON AND OXFORDSHIRE																								
DMP_SWOX_6.A7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	5.670	0.000	0.000	0.000	0.000	0.000	0.000	**5.670**	5.670	0.000	0.000	0.000	0.000	0.000	0.000	**5.670**
DMP_SWOX_15.A8	3.100	1.000	0.000	0.000	0.000	0.000	0.000	**4.100**	5.670	2.220	0.000	0.000	0.000	0.000	0.000	**7.890**	8.770	3.220	0.000	0.000	0.000	0.000	0.000	**11.990**
DMP_SWOX_18_12_1	7.464	4.809	0.950	0.000	0.000	0.000	0.000	**13.223**	7.595	5.401	0.000	0.000	0.000	0.000	0.000	**12.996**	15.059	10.210	0.950	0.000	0.000	0.000	0.000	**26.219**

DMP_SWOX_45.A9	9.546	6.178	1.821	0.000	0.000	0.000	0.000	**17.545**	10.744	6.347	1.074	0.000	0.000	0.000	0.000	**18.166**	20.291	12.526	2.895	0.000	0.000	0.000	0.000	**35.711**
DMP_SWX_S4b	8.710	7.310	1.940	6.658	0.000	0.000	0.000	**24.618**	9.841	6.781	0.578	0.000	0.000	0.000	0.000	**17.200**	18.551	14.091	2.518	6.658	0.000	0.000	0.000	**41.818**
DMP_SWOX_70.A8	9.546	6.178	1.821	0.000	0.000	0.000	0.000	**17.545**	10.744	6.347	1.074	15.000	10.000	0.000	0.000	**43.166**	20.291	12.526	2.895	15.00	10.00	0.000	0.000	**60.711**
GUILDFORD																								
DMP_GUI_2	0.00	1.00	0.11	0.00	0.00	0.00	0.00	**1.11**	0.00	1.01	0.00	0.00	0.00	0.00	0.00	**1.01**	0.00	2.02	0.11	0.00	0.00	0.00	0.00	**2.13**
DMP_GUI_5	0.65	1.02	0.25	0.00	0.00	0.00	0.00	**1.92**	2.10	1.67	0.74	0.00	0.00	0.00	0.00	**4.51**	2.75	2.69	0.99	0.00	0.00	0.00	0.00	**6.44**
DMP_GUI_S4b	0.88	0.80	0.31	1.10	0.00	0.00	0.00	**3.09**	2.08	1.47	0.49	0.00	0.00	0.00	0.00	**4.04**	2.96	2.27	0.80	1.10	0.00	0.00	0.00	**7.13**
DMP_GUI_SD	0.00	1.14	0.81	0.00	0.00	0.00	0.00	**1.95**	0.01	0.98	5.51	0.00	0.00	0.00	0.00	**6.49**	0.01	2.12	6.32	0.00	0.00	0.00	0.00	**8.44**
SLOUGH, WYCOMBE AND AYLESBURY																								
DMP_SWA_SD.v2	0.00	0.57	1.91	3.21	0.00	0.00	0.00	**5.69**	0.00	1.99	0.00	0.39	0.39	0.00	0.00	**2.77**	0.00	2.56	1.91	3.60	0.39	0.00	0.00	**8.46**
DMP_SWA_0_5_9	0.00	1.27	4.56	0.51	0.00	0.00	0.00	**6.34**	0.00	3.94	1.90	0.06	0.06	0.00	0.00	**5.97**	0.00	5.21	6.47	0.57	0.06	0.00	0.00	**12.31**
DMP_SWA_S4b	0.00	5.39	1.83	4.01	0.00	0.00	0.00	**11.23**	0.00	4.70	0.72	1.08	0.00	0.00	0.00	**6.50**	0.00	10.09	2.55	5.09	0.00	0.00	0.00	**17.73**
KENNET VALLEY																								
DMP_KV_S4b	0.0	0.0	3.5	3.8	0.0	0.0	0.0	**7.3**	0.0	0.0	3.8	0.0	0.0	0.0	0.0	**3.8**	0.0	0.0	7.3	3.8	0.0	0.0	0.0	**11.1**
HENLEY																								
DMP_HEN_S4b	0.0	0.0	0.4	0.4	0.0	0.0	0.0	**0.8**	0.0	0.0	0.3	0.0	0.0	0.0	0.0	**0.3**	0.0	0.0	0.8	0.4	0.0	0.0	0.0	**1.2**

Annex 1 AMP6 Leakage reduction carry over

8.361 In the final WRMP19, an additional reduction option, 'AMP6 Leakage Reduction Carry Over' has been introduced. This option recognises the impact on annual average leakage as a result of a reduction in the April 2020 leakage level (compared to April 2019) resulting from the delivery of the 2019/20 leakage reduction programme. This leakage reduction is 34Ml/d and is applicable to year 1 of AMP7 at no additional cost to the programme.

8.362 There are three activities to consider:

- Weather
- Offsetting Leakage Recurrence. i.e. maintaining leakage at the current level
- Leakage Reduction. i.e. reducing leakage further from the current level

8.363 An explanation of these activities is detailed in subsections; Offsetting leakage recurrence, Weather and leakage reduction.

8.364 The derivation of the AMP6 Leakage reduction carry over volume, 34Ml/d is detailed in subsection 'AMP6 Leakage Reduction Carry Over'.

Offsetting leakage recurrence

8.365 Leakage recurrence refers to the level of leakage that will increase over a year due to deterioration.

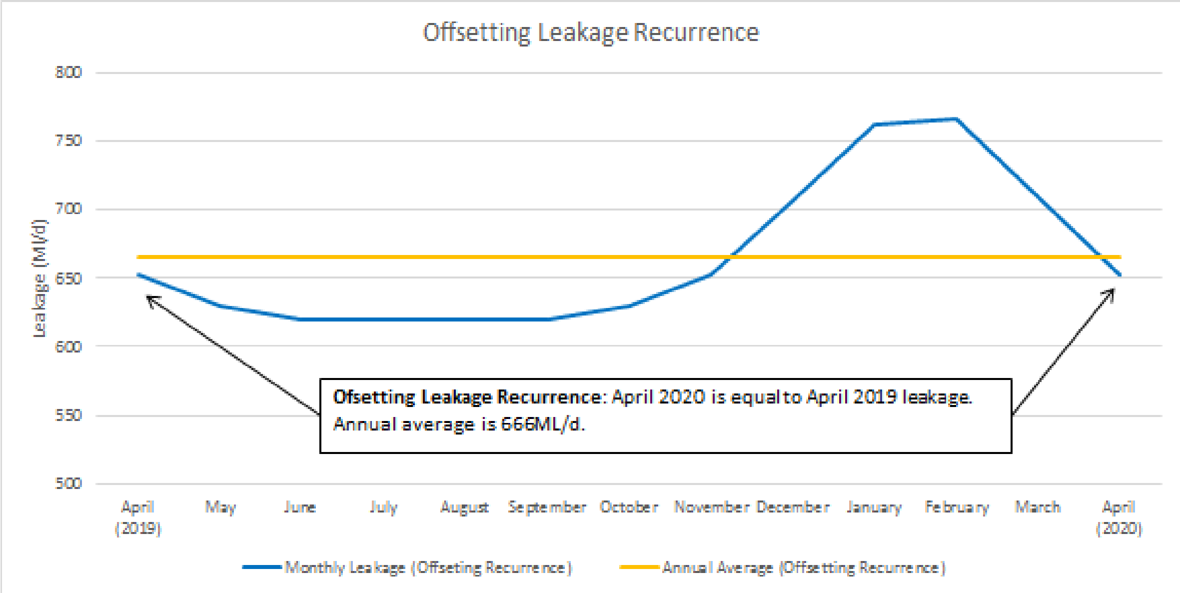
8.366 The impact of leakage recurrence on the annual level of leakage is offset by leakage repair activity. The purpose of offsetting leakage recurrence is to ensure that sufficient leakage repair activity is completed each year so that the annual average leakage level remains constant, year on year.

8.367 This is demonstrated in Figure 8-14 which shows the monthly and annual average leakage profile over a 13 month period. The monthly leakage profile shows that leakage increases over the winter months and decreases over the summer months. The decrease over summer is caused by additional leakage reduction work being undertaken to offset the increase in the winter months. This means that, over the 13 month period, the both annual average and the April monthly leakage levels remain constant. Without sufficient leakage repair work over the year, the annual average leakage would increase as more leaks occur than are repaired.

8.368 If the same level of activity is undertaken to offset leakage recurrence in the following year, the annual average will also remain the same.

64

Figure 8-14: Offsetting Leakage Recurrence



8.369 Offsetting leakage recurrence is a different activity to offsetting leakage deterioration (paragraphs 8.242 to 8.248). Leakage deterioration is offset by asset renewal rather than by leakage repair activity.

Weather

8.370 Leakage increases over the winter months because, as the temperature decreases, water mains contract and expand and therefore develop more leaks. Conversely, as the temperature increases into Spring, joints expand and leakage decreases.

8.371 Winter is a reversible impact that affects annual average but, under normal conditions, does not lead to a change in leakage between two years. However, particularly severe weather (e.g. Beast from the East), can impact recurrence level.

Leakage reduction

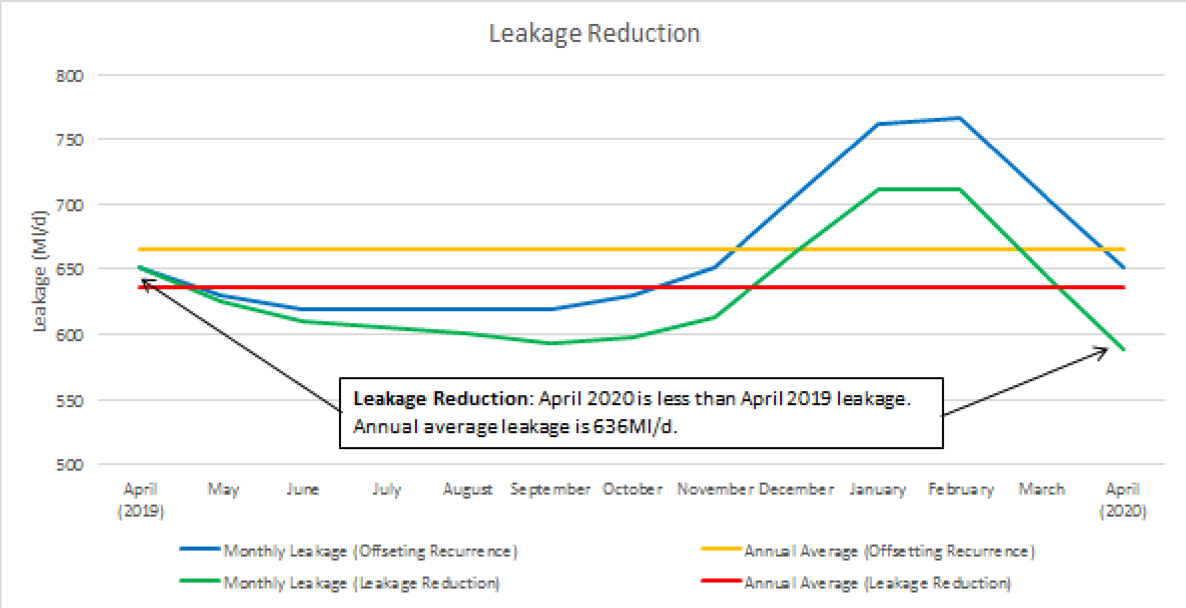
8.372 Leakage reduction refers to a reduction in the annual average leakage level. To achieve a leakage reduction, there must be a reduction in leakage from April in one year to April in the next year.

8.373 Figure 8-15 shows the difference between offsetting leakage recurrence and achieving a leakage reduction. The leakage profile (both monthly and annual) for offsetting recurrence is the same as that presented in Figure 8-14. This shows an April leakage of 652Ml/d at the start and end of the 13 month period and, an annual average leakage of 666 Ml/d. These values are forecast for when activity is undertaken to offset leakage recurrence only.

8.374 When activity is conducted to reduce leakage, an additional 63Ml/d of leakage reduction work is undertaken over the 13 month period. This means that the forecast April leakage in 2020 is 589Ml/d which is 63Ml/d lower than the forecast April leakage in 2019 (652Ml/d). For comparison, when activity is undertaken to offset leakage recurrence only the April leakage at the start and end of the 13 month period is the same, at 652Ml/d.

8.375 A reduction in the monthly leakage profile results in a reduction in the annual average leakage value. For example, when activity is undertaken to offset leakage recurrence only, annual average leakage is 666Ml/d. When additional activity is undertaken to reduce leakage, the annual average leakage is 636Ml/d.

Figure 8-15: Difference between Offsetting Leakage Recurrence and Leakage Reduction



'AMP6 Leakage Reduction Carry Over'

8.376 'Carry Over' leakage refers to the difference between the annual average leakage in 2019/20 (Year 5 of AMP6) for achieving a leakage reduction and 2020/21 (Year 1 of AMP7) for offsetting leakage recurrence. This difference occurs because the leakage in April 2020 is expected to be lower than the leakage in April 2019 as a result of the leakage reduction programme in 2019/20.

8.377 Figure 8-15 illustrated that a leakage reduction is forecast for the 2019/20 reporting year. This means the leakage for April 2020 (589Ml/d) is forecast to be 63Ml/d lower than the April 2019 leakage (652Ml/d). This corresponds to an annual average leakage of 636Ml/d for 2019/20.

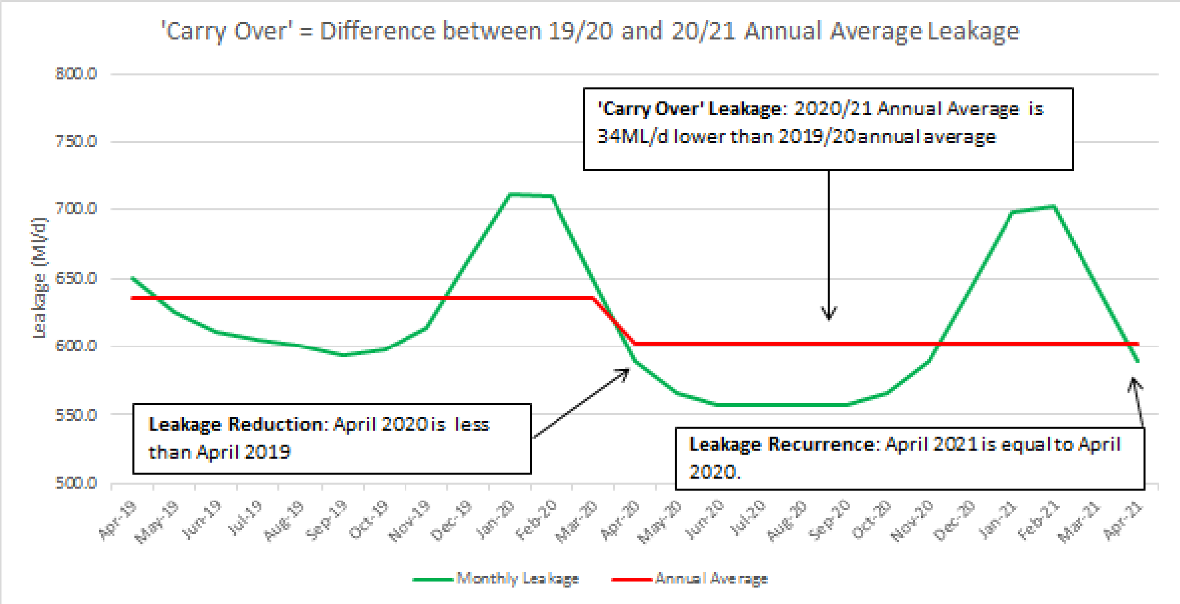
8.378 Figure 8-16 illustrates the 2019/20 leakage reduction and extends this to include the forecast for 2020/21. To understand the 'carry over' leakage value, the forecast presented for 2020/21 is to offset leakage recurrence only.

8.379 To offset leakage recurrence in 2020/21, the April 2021 leakage must be the same as the April 2020 leakage. This means the April 2021 leakage is forecast to be 589Ml/d (i.e. April 2020 = 589Ml/d). This corresponds to an annual average leakage of 602Ml/d for 2020/21.

8.380 Due to the leakage reduction forecast for 2019/20, the April 2020 leakage starts at a lower point than the April 2019 value. This means the annual average leakage for 2020/21 (602Ml/d) is 34Ml/d lower than the annual average leakage for 2019/20 (636Ml/d).

8.381 The 34Ml/d difference between the annual average leakage in 2019/20 and 2020/21 is referred to as the 'AMP6 Leakage Reduction Carry Over' because it occurs as the result of the leakage reduction programme in 2019/20. The 'AMP6 Leakage Reduction Carry Over' (34Ml/d) is applied to Year 1 of the AMP7 programme at no additional cost.

Figure 8-16: 'AMP6 Leakage Reduction Carry Over'



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