Thames Water

Water Resources Management Plan 2019

# Demand Management

# Feasible Options Paper

June 2017

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# 1. Introduction

## 1.1. Purpose of the paper

**The purpose of this paper is to detail the benefits and assumptions applicable to the Feasible Demand Management Options identified by the Demand Management Screening Process[1].**

The Demand Management Options Screening Process, conducted in March 2017, identified a list of Feasible Demand Management Options for inclusion in the Water Resources Management Plan 2019 (WRMP19). They were categorised into five areas; Metering, Water Efficiency, Leakage, Incentive Schemes and Non-Potable Options.

This paper details the benefits and assumptions associated with three of these categories; Metering, Water Efficiency and Leakage. The Feasibility Papers for Incentive Schemes[2] and Non-Potable[3] Options have been published independently.

This paper forms an appendix to, and should be read in conjunction with, the Demand Management Options Screening Report, March 2017.

## 1.2. Feasible Demand Management Options

Table 1 summarises the Feasible Demand Management Options for inclusion in WRMP19.

| Leakage | Metering | Water Efficiency | Incentive Schemes | Non-Potable |
|---|---|---|---|---|
| Enhanced Active Leakage Control | Metering Houses Only | Smarter Home Visit | Targetted Incentives Scheme | Rainwater Harvesting |
| Pressure Management | Metering Blocks of Flats (Bulks) Only | Smarter Business Visit | Innovative Tarrifs (feasible post-smart metering) | Stormwater Harvesting |
| Mains Replacement | Metering Houses and Bulks | Housing Association Fix | | Greywater Recycling |
| Customer Side Leakage Repair | Metering Houses, bulks and individual flats | Wastage Fixes (e.g. leaky loos) | | |
| | | Intensive area based promotional campaigns | | |
| Metering Houses, bulks and individual flats + Customer Side Leakage Repair + Smarter Home Visit | | | | |
| Metering Houses, bulks and individual flats + Customer Side Leakage Repair + Housing Association Fix | | | | |
| Metering Houses + Customer Side Leakage Repair + Smarter Home Visit | | | | |

**Table 1 - Feasible Demand Management Options Summary**

[1] Thames Water, Water Resources Management Plan 2019, Demand Management Options Screening Report, March 2017
[2] Thames Water, Demand Management Options, Incentives Scheme, June 2017
[3] Arup, 'Thames Water, Non-Potable Water Reuse as a Demand Management Option for WRMP19, Options Appraisal Report', 001, Issue 26 May 2017

There are 47 individual interventions in total, categorised into five areas. The black text refers to options included in WRMP14 which have been reassessed for inclusion in WRMP19. The green text highlights new options for WRMP19 which have been identified through further work and discussions with stakeholders.

This paper provides the detail that informs 23 of these interventions under Metering (Section 2), Water Efficiency (Section 3) and Leakage (Section 4).

### 1.3. Integrated Demand Management (IDM) Model

To enable the appraisal of the Feasible Demand Management Options alongside the Constrained Resource Options[4], the Feasible Demand Management Options must be optimised to produce a set of Constrained Demand Management Programmes. The optimisation of the Feasible Demand Management Options is undertaken using the Integrated Demand Management (IDM) Model.

Figure 1 summarises the IDM Model process. The areas circled in red are the stages detailed by this paper.

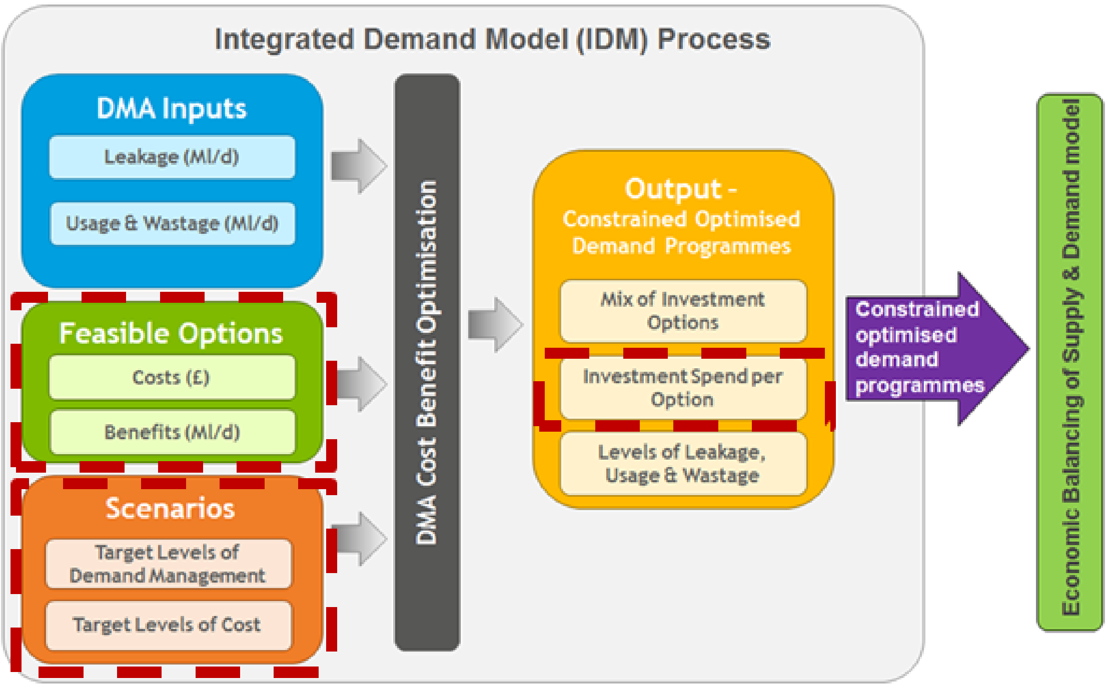


**Figure 1 - Integrated Demand Management Model[5]**

The IDM model is based around a GIS representation of Thames Water's network. This provides the list of District Metered Areas (DMAs) and the physical attributes of the network within those DMAs. Background data relating to property distribution and number, leakage and water usage and wastage forms the base data in the model at a DMA level (blue-square in Figure 1).

[4] MottMacDonald Cascade (2017), 'Thames Water WRMP19, Resource Options, Fine Screening Report Update', February 2017.
[5] DMA is Figure 1 refers to a District Metered Area

Data relating to each of the Feasible Demand Management Options is then input to IDM at a DMA level (green-square in Figure 1). This is entered in the form of total cost (capital and operating costs) and benefit in terms of the volume of water saved (reduction in leakage and/or usage).

In order to optimise the model, scenarios are then applied in the form of varying constraints on the model output. For example, to find out the benefits achievable for the lowest cost, a minimise total cost scenario is applied. Conversely, to ascertain the benefits achievable without any financial constraints a maximum investment scenario is applied. For later model runs, specific demand savings achieved per 5 year planning period (AMP) can be applied. For example, in London, the model must optimise to achieve a demand saving of 100Ml/d in AMP7, 50Ml/d in AMP8 and 50ML/d in AMP9. Each model run is constrained by a choice of scenarios (orange-square in Figure 1).

Using the DMA Inputs, Feasible Options Data and Scenarios, the IDM model can conduct alternative cost and benefit optimisations to produce a range of potential demand management programmes, known as the Constrained Optimised Programmes.

**Sections 2.0 - 4.0 detail the benefits and assumptions input to IDM for the Metering, Water Efficiency and Leakage Feasible Options.** These sections also present the output of the first model run which was conducted with no financial constraints to understand the savings that can be achieved by each intervention.

# 2. Metering

## 2.1. Metering Interventions

The Demand Management Options Screening Process identified nine feasible metering interventions that have been broken down by Property Type and Technology to enable IDM to model the different costs and benefits associated with each. These interventions have been input into IDM as per Table 2.

| No | Feasible Intervention | Intervention Name in IDM | Description |
|---|---|---|---|
| 1 | Metering - Houses | MET HOUSE_AMI | Meter all houses (detached, semi-detached and terrace) using AMI technology and repair CSL's found |
| 2 | | MET HOUSE_AMR | Meter all houses (detached, semi-detached and terrace) using AMI technology and repair CSL's found |
| 3 | Metering - Bulks | MET BULK_AMI | Bulk meter flats (AMI technology) and repair CSL's found |
| 4 | | MET BULK_AMR | Bulk meter flats (AMR technology) and repair CSL's found |
| 5 | Metering - Houses and Bulks | MET HOUSE AND BULK_AMI | Meter all houses and bulk meter blocks of flats (AMI technology) and repair CSL's found |
| 6 | | MET HOUSE AND BULK_AMR | Meter all houses and bulk meter blocks of flats (AMR technology) and repair CSL's found |
| 7 | Metering - | MET DWELL AND | Meter all houses and flats (dwelling) and bulk |

| | | | |
|---|---|---|---|
| | Houses, Flats (Dwellings) and Bulks | BULK_AMI | meter flats (AMI technology) and repair CSL's found |
| 8 | | MET DWELL AND BULK_AMR | Meter all houses and flats (dwelling) and bulk meter flats (AMR technology) and repair CSL's found |
| 9 | | MET DWELL AND BULK_DUMB | Meter all houses and flats (dwelling) (Dumb technology) and bulk meter flats (AMR technology) and repair CSL's found |

**Table 2 - Feasible Metering Interventions**

### 2.1.1. Property Type

**Metering - Houses**: installation of an external or internal meter on a Detached, Semi-Detached or Terrace property. External meters require the installation of a standard boundary box outside the property to house the meter.

**Metering - Bulks:** installation of a single bulk meter on the supply pipe of a block of flats. This requires the installation of a large chamber outside the property to house the meter which is significantly more expensive than the standard boundary box required for houses.

**Metering - Flats (dwellings):** installation of multiple meters at a block of flats to meter each individual dwelling. The meters may be installed internally or externally but only if each dwelling has a single supply pipe. i.e. this does not apply to dwellings with shared supplies.

where:

**Small Block of Flats**: defined as a property with up to 12 dwellings. These properties are typically converted houses or terraces which have been developed into multiple individual dwellings.

**Large Blocks of Flats**: defined as a property with greater than 12 dwellings. These properties are typically purpose built blocks of flats.

### 2.1.2. Meter Technology

**Advanced Metering Infrastructure (AMI)**: using the Thames Water, fixed network meter system, meters are read electronically and do not require a meter reader. 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.

**Automatic Meter Reading (AMR):** a meter with a short range radio is installed at each property. The meter reader equipped with a meter reading device is required to walk by the meter in order to take a meter reading but does not require physical access to the meter. This process can also be undertaken in certain circumstances by vehicle – known as drive-by reading. The data is captured electronically.

**Dumb Meter Reading (DUMB):** 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.

## 2.2. Meter Penetration

To assess the benefit and cost of the feasible metering interventions, the number of meters for installation must be modelled. This is done by modelling the number of meters in each DMA based on property type, internal-external split and survey to fit ratio. These terms are explained below:

### 2.2.1. Internal-external split

Meters can be fitted either externally or internally at a property.

**External** - a meter is fitted in the pavement at the stop tap position. This has the benefit that the meter will record leakage on the customer's supply pipe aiding quicker leakage repair and the meters are easier to install and read.

**Internal** - a meter is fitted at the first stop tap inside the property. This location is used if the property does not have an individual supply.

To model the distribution of external and internal meters in a DMA, the internal-external split is input into IDM and applied per property type. This is represented by the percentage of each property type requiring an internal or external meter (Table 3). i.e; 85% of detached properties will be eligible to have an external meter fitted and 15% an internal meter.

| Property Type | Internal/External Split | |
|---|---|---|
| | External | Internal |
| Detached | 85% | 15% |
| Semi-detached | 80% | 20% |
| Terraced | 83% | 16% |
| Small Block of Flats (Dwellings) | 25% | 75% |
| Large Block of Flats (Dwellings) | 17% | 83% |
| Small Block of Flats (Bulk) | 100% | n/a |
| Large Block of Flats (Bulk) | 100% | n/a |

Table 3 - Internal/External Split by Property Type

These figures have been provided by the Thames Water PMP programme and stored in the CustARD database which also provides the number of properties of each type within a DMA and the proportional water use for each type.

### 2.2.2. Survey to Fit Ratio

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, (i.e. expensive fitted kitchen), more than one supply serves the property or a single supply serves more than one property. Economic reasons are generally that it would be prohibitively expensive to fit a meter.

To accurately model the potential number of meters installed in a DMA, a survey to fit ratio is applied to each property type in IDM to identify the number of properties that can have a meter fitted. The survey to fit ratios applicable to WRMP19 are summarised in Table 4.

| Property Type | Survey to Fit Ratio (as %) | |
|---|---|---|
| | External | Internal |
| **Detached** | 97% | 29% |
| **Semi-detached** | 98% | 20% |
| **Terraced** | 98% | 20% |
| **Small Block of Flats (Dwellings)** | 81% | 19% |
| **Large Block of Flats (Dwellings)** | 73% | 19% |
| **Small Block of Flats (Bulk)** | 65% | n/a |
| **Large Block of Flats (Bulk)** | 65% | n/a |

**Table 4 - Survey to Fit Ratios by Property Type for WRMP19**

The meter fit rates presented in Table 4 are based on access rates during the Progressive Metering Programme (PMP)[6]. Compared with WRMP14, the average survey to fit ratio across all properties has remained consistent but with slight changes in the distribution. This is because the Survey to Fit ratios have been updated on the latest three boroughs to be progressively metered. This is considered to be the most accurate representation of the survey to fit situation into the future and subsequent AMPs.

The number of meters that can be installed in each DMA is calculated within IDM using this information and according to the equations:

- **Number of Household meters installed, Houses** = Number of unmeasured houses – PMP installs * ((percentage external * fit to install ratio external) + (percentage internal * fit to install ratio internal)).

This method applies to detached, semi-detached, terraced and unknown properties.

- **Number of Household meters installed, Flats (Dwellings)** = Number of unmeasured dwellings in blocks of flats – PMP installs * ((percentage external * fit to install ratio external) + (percentage internal * fit to install ratio internal)).

This is applied to dwellings in large blocks of flats and small blocks of flats.

- **Number of Bulk meters installed =** Number of unmeasured blocks of flats - Bulk Installs)* fit to install ratio.

This is applied to large blocks of flats and small blocks of flats.

The results of the IDM modelling relating to metering volume are summarised in Section 2.5.

[6] Based on survey to fit ratios and approach of 3 London boroughs during 2016

## 2.3. Metering Benefits

Metering provides demand management benefit through usage, wastage and leakage reduction. The assumed benefits are input into IDM to model the total benefit expected from metering. Sections 2.3.1 - 2.3.3 summarise the assumptions and data input into IDM to model the total benefit.

### 2.3.1. Usage

For WRMP19, the usage benefits of metering have been derived from an assessment of usage at measured properties compared to a statistically robust equivalent set from the unmeasured consumption monitor (DWUS panel). This assessment used a subset of 10,000 measured customers, across all property types and demographics, and compared their usage against the Thames Water unmeasured baseline (DWUS)[7].

**This assessment showed an average usage reduction of 17% per property when a meter was fitted.** Compared with the assumptions made for WRMP14, this is a 5% increase in the predicted average usage benefit obtained from metering. However, since the beginning of WRMP14, Thames Water has installed and received readings from a greater number and greater variety of property types and across a wider population of different ethnicities. This has given a better dataset that more accurately represents the property type and population make up of Thames Water's area. This increase is also supported by Southern Water showing a 16.5%[8] reduction over 500,000 customers from their universal metering program (UMP) and Affinity showing a 16%[9] reduction from a 70,000 meter program in Kent.

The usage reductions are based on behaviour changes of customers over their 'metering journey'. The current progressive program allows for an adjustment period of two years between meter installation and the customer having their bill changed to measured. Consequently, the change in customer behaviour is input into IDM as a two year depreciation toward the final expected level. That is:

- 10% of complete reductions in a year of intervention
- 50% of complete reductions in year after intervention
- 100% of complete reductions in second year after intervention

### 2.3.2. Customer Side Leakage and Wastage

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 Customer Side Leak (CSL) on their supply pipe or wastage within their property (i.e. a leaking tap). Continuous flow on an internal meter indicates the customer has wastage within their property.

[7] Thames water analysis on 10,000 dumb metered customers compared to DWUS over 6 months usage preceding a Smart home visit.
[8] The UMP programme: Effects of metering, water efficiency visits and billing University of Southampton, Universits' di Bolzano in collaboration with Southern Water
[9] https://www.affinitywater.co.uk/water-saving-programme-faq.aspx

When a property is identified as having continuous flow, it is labelled as a point of interest (POI) and TW leakage teams will visit the property and prove whether there is a customer side leak or wastage. For WRMP19, it is assumed that a POI is applicable when a property has continuous flow greater than 25l/hr.

To calculate the volume of water attributed to customer side leakage and wastage, IDM multiplies the number of POI's raised by the % POIs confirmed as CSL or wastage by the l/p/d savings.

**Number of Properties with POIs**

To calculate the number of properties where a POI is applied in IDM, the following assumptions are applied per property type (Table 5). This data has been derived from the Progressive Metering Programme (PMP). For example, IDM will assume 1.28% of all detached properties in a DMA with an external meter will have a POI raised against that property indicating it has a potential customer side leak or wastage issue.

| Property Type | % POI's from External Meters | % POIs from Internal Meters |
|---|---|---|
| Detached | 1.3% | 0.6% |
| Semi-detached | 1.7% | 1.1% |
| Terraced | 1.9% | 1.2% |
| Small Block of Flats (Dwellings) | 1.3% | 0.1% |
| Large Block of Flats (Dwellings) | 0.3% | 0.1% |
| Small Block of Flats (Bulk) | 8.7% | n/a |
| Large Block of Flats (Bulk) | 8.7% | n/a |

Table 5 - % POI raised by Property Type

A scaling factor of 50% was applied to the POI values in Table 5 for AMR and Dumb meters to account for the delay in POIs being found and raised through non-AMI technologies. i.e. 6 month delay for reads to occur.

**Number of POIs with proven CSL or Wastage**

To calculate the number of properties where a POI has been raised and then proven to be a customer side leak or wastage, the following assumptions are applied per property type (Table 6). These figures have also been derived from the PMP[10].

| Property Type | % External POIs classed as CSL | % External POIs classed as wastage | % Internal POIs classed as wastage | % POIs where leak not found |
|---|---|---|---|---|
| Detached | 41.67% | 36.33% | 78% | 22% |
| Semi-detached | 28.48% | 49.52% | 78% | 22% |
| Terraced | 29.32% | 48.68% | 78% | 22% |
| Small Block of Flats | 71% | 22% | 22% | 22% |
| Large Block of Flats | 71% | 22% | 22% | 22% |

Table 6 - POIs confirmed as CSL or Wastage

[10] Based on results of find & fix work generated by the PMP programme in London 2015/16

Note that it is assumed for bulks that all savings are applicable to CSL and none to wastage to avoid double counting wastage benefits. The assumptions applied to bulks are also currently under review but are not expected to materially change from the figures presented.

**Assumed CSL and Wastage Volumes**

To calculate the customer side leakage or wastage volume applicable per property type the following assumptions were input into IDM (Table 7).

| Property Type | CSL Savings (l/prop/day) | Wastage Savings (l/prop/day) |
|---|---|---|
| Detached | 2,520 | 2,180 |
| Semi-detached | 2,520 | 2,180 |
| Terraced | 2,520 | 2,180 |
| Small Block of Flats (Dwellings) | n/a | 2,180 |
| Large Block of Flats (Dwellings) | n/a | 2,180 |
| Small Block of Flats (Bulk) | *Calculated | n/a |
| Large Block of Flats (Bulk) | *Calculated | n/a |

Table 7 - Assumed CSL and Wastage Volumes per Property Type

* The CSL savings from bulks are calculated based on the number of dwellings there are in a block of flats.

The leakage deterioration rate is applied to CSL savings to account for deterioration.

## 2.4. Meter Asset Life

It has been input into IDM that the asset life of meters is 15 years. For AMI and AMR meters, this is the point where the manufacturer expects the battery to die and therefore stop the transmission of data.

# 3. Water Efficiency

The Demand Management Options Screening Process identified eight feasible water efficiency interventions, three of which are combined with metering. These have been input into IDM as per Table 8.

| No | Feasible Intervention | Intervention Name in IDM | Description |
|---|---|---|---|
| 1 | Combined Water Efficiency and Metering - Smarter Home Visits | MET DWELL AND BULK_AMIALL_SHV | Metering all houses and flats (dwellings) and bulk metering flats (AMI) and conduct a SHV to newly metered, PMP and measured properties (LAHA and non-LAHA). A SHV involves fitting water efficiency devices, water audit and water savings plan with customer. |
| 2 | | MET DWELL AND BULK_AMIHHB_SHV | Metering all houses and bulk metering flats (AMI) and conduct a SHV to newly metered, PMP and measured properties (LAHA and non-LAHA). A SHV involves fitting water efficiency devices, water audit and water savings plan with customer. |
| 3 | | MET DWELL AND BULK_AMIHH_SHV | Metering all houses (AMI) and conduct a SHV to newly metered, PMP and measured properties (LAHA and non-LAHA). A SHV involves fitting water efficiency devices, water audit and water savings plan with customer. |
| 4 | Water Efficiency - Smarter Home Visits | WAT EFF_SMARTER HOME VISIT | Smarter Home Visit to unmeasured properties. A SHV involves fitting water efficiency devices, water audit and water savings plan with the customer. |
| 5 | Water Efficiency - Smarter Business Visits | WAT EFF_SMARTER BUSINESS VISIT | Smarter Business Visit to Non Household Properties within 13 designated cohorts. A SBV involves fitting water efficiency devices (for staff facilities), fit free urinal controls where practical, identification of leaking toilets, a water audit and recommended water savings plan with the business. |
| 6 | Water Efficiency - Housing Association Fix | WAT EFF_HOUSING ASS FIX | Housing Association fixes problems found at Household properties (LAHAs only) |
| 7 | Water Efficiency - Wastage Fix | WAT EFF_WASTAGE | Wastage fix at all unmeasured, measured, PMP and newly metered properties (i.e. leaky loos and leaking taps) LAHA and non-LAHA |
| 8 | Water Efficiency - Promotional Campaigns | Intensive marketing campaigns targeting specific areas | |

Table 8 - Feasible Water Efficiency Interventions

## 3.1. Scale of Water Efficiency

To assess the benefit and cost of the feasible water efficiency interventions, the number of water efficiency visits must be modelled. This is done by modelling the number of visits in each DMA based on intervention type, intervention uptake rate and extent of metering.

### 3.1.1. Water Efficiency Intervention Uptake Rate

Water Efficiency Intervention Uptake Rates are based on the Water Efficiency Programme Uptake throughout AMP6. Table 9 summarises the rates applied to each intervention in IDM.

| Intervention | Uptake Rate |
|---|---|
| **Smarter Home Visit** | 20% of current measured and unmeasured properties<br>23% of newly metered properties |
| **Smarter Business Visit** | 13% of Non-Household properties within designated cohorts |
| **Housing Association Fix** | 15% of housing association properties (based on access rate) |
| **Wastage Fix** | 5% of properties (based on 1 in 20 properties have a leaky loo) |

Table 9 - Water Efficiency Uptake Rates

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

Throughout AMP6, Smarter Business Visits have been taken up at a rate of 13% across non-household properties based on data collected from January 2016 to January 2017. However, Thames Water have been targeting twelve specific cohorts of business within their area of supply (Section 3.2.2) meaning this assumption cannot be entered into IDM and applied to all non-household properties. Instead, the model assumes 13% of businesses within each cohort within each DMA receive a Smarter Business Visit. This does slightly limit the potential volume of Smarter Business Visits 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 Smarter Business Visit volume for WRMP19.

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

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

The number of water efficiency visits that can be conducted in each DMA is calculated according to the equations:

- **Number of Smarter Home Visits combined with Metering** = (number of newly metered and current PMP properties * SHV uptake with metering) + (number of current measured properties * SHV uptake of current measured) + (number of unmeasured properties * SHV uptake of unmeasured (LAHA and non LAHA)

- **Number of Smarter Business Visits** = number of non-household properties by cohort in DMA * percentage of take up of smarter business visits.

- **Number of Housing Association Fixes** = (number of unmeasured properties of all ethnicities and property types * percentage of unmeasured housing association properties in DMA) + (number of measured properties of all property types * percentage of measured housing association properties in DMA) * percentage of take up of housing association fix.

- **Number of Wastage Fixes** = (number of newly metered and current PMP properties + number of current measured properties + number of unmeasured properties) * wastage fix uptake (LAHA and non-LAHA).

## 3.2. Water Efficiency Benefits

Water Efficiency provides demand management benefit through usage and wastage reduction. The leakage savings provided through metering (for the combined metering and water efficiency interventions) are attributed to the metering benefit (Section 2). The assumed benefits for water efficiency are summarised in Table 10.

| Intervention | Benefit in IDM (litres per property per day) |
|---|---|
| **Smarter Home Visit** | 11l/p/d/ for current measured household properties<br>25 l/p/d* for newly metered household properties<br>25 l/p/d for unmeasured properties |
| **Smarter Business Visit** | By cohort - see |
| **Housing Association Fix** | 15 l/p/d for household properties |
| **Wastage Fix** | 212 l/p/d/ for household properties |

Table 10- Water Efficiency Benefits by Intervention

* actual value is 36-40l/p/day - see Section 3.2.2

### 3.2.1. Smarter Home Visit

The average benefit following a Smarter Home Visit to current measured and unmeasured household properties is based on the statistical analysis, conducted by Thames Water's Decision Support Modelling Team. For existing metered customers who received a Smarter Home Visit, the reduction in consumption was determined by comparing metered consumption before and after a Smarter Home Visit. To determine the impact of a Smarter Home Visit on unmeasured customers, the average consumption of a metered customer (minus the impact of metering) following a Smarter Home Visit was compared with the average consumption of the Thames Water Domestic Water Use Study (DWUS) panel. The DWUS panel is used to report the average unmeasured consumption across Thames Water's area. The assumed benefit for an unmeasured property is higher than for a current measured property as this also incorporates additional behaviour changes and wastage fixes. i.e. a property which is unmeasured is unlikely to notice longer term low level wastage in their home.

The average benefit following a Smarter Home Visit to newly metered properties has been shown to be between 36 and 40 litres, per property, per day. This is based on an analysis undertaken by Crowder's consulting which compared the Smart Meter consumption data of properties before and after a Smarter Home Visit. This was based on a sample size of up to 8,000 meters from June 2016 to January 2017. Although these preliminary results were statistically significant, expert judgement was employed regarding the value to input into IDM. That is, the benefits seen for a SHV to a newly metered property have been assumed to be the same as for an unmeasured property for the purposes of IDM modelling in WRMP19. This was to ensure there was no double counting between the behaviour change seen from installing a meter and the behaviour change seen following a Smarter Home Visit.

As the Crowder's and Thames Water studies continue to progress, the benefits from Smarter Home Visits will be updated. The figures input into IDM are considered to be the most statistically robust figures to date.

### 3.2.2. Smarter Business Visit

Smarter Business Visits are currently offered to twelve different business cohorts across the Thames Water area. Each business type is identified by their SIC code to ensure the majority of business types can be captured under each cohort.

The benefit assigned to each cohort is the average benefit achieved in that cohort using the outcome of 200 Smarter Business Visits conducted from January 2016 to January 2017. On average, Smarter Business Visits have been shown to save approximately 2,500 litres per day per property. The percentage savings reduction achieved by a Smarter Business Visit in each cohort and input into the IDM model is summarised in Table 11.

| Cohort | Percentage Saving |
|---|---|
| **Agriculture** | 40% |
| **Business and Social Welfare** | 67% |
| **Chemical and Metal Goods Manufacturing** | 30% |
| **Defence** | 3% |
| **Education** | 67% |
| **Health** | 2% |
| **Hotels and Catering** | 24% |
| **Miscellaneous Manufacturing** | 18% |
| **Miscellaneous Minor** | 85% |
| **Public Administration** | 29% |
| **Retail** | 1% |
| **Transport, Construction and Other** | 34% |

**Table 11 - Smarter Business Visit Benefits by Cohort**

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

The limited savings seen for the Defence and Health cohorts is due to the limited scope for water saving reduction as an overall percentage of their total use. That is, the average saving for a defence barracks is 1,196l/d compared with the average consumption of a defence barracks being 37,542l/d.

The benefits associated with Smarter Business Visits will be updated as further Smarter Business Visits are carried out across the cohorts.

### 3.2.3. Housing Association and Wastage Fixes

The benefit attributed to a Housing Association Fix has been derived from analysis of Housing Association Fix data from AMP6. These are proven benefits from the installation of water saving devices and repair of wastage issues in Housing Association Properties.

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

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

### 3.2.4. Water Efficiency Benefits Decay

The life of water efficiency devices supplied by a Smarter Home Visit, Smarter Business Visit or Housing Association Fix has been assumed to be 7 years. This deviates significantly from the assumption made in WRMP14 whereby it was assumed that water efficiency devices had a half-life of 7 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 WRMP19 which has shown that water efficiency devices require replacement 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 7 years for WRMP19.

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 10 years. This means that the repeat frequency for Smarter Home Visits, Housing Association Fixes and Wastage Fixes has been assumed to be 10 years for WRMP19.

# 4. Leakage

The Demand Management Options Screening Process identified seven feasible leakage interventions.  These interventions have been input into IDM as per Table 12.

| No | Feasible Intervention | Intervention Name in IDM | Description |
|---|---|---|---|
| 1 | Leakage - Pressure Management | PRESSURE MANAGEMENT | Install new pressure management schemes in individual DMAs |
| 2 | Leakage - Enhanced Active Leakage Control | ENHANCED ALC_DMAENHANCE | Network Reconfiguration to enable more leakage detection from 'Find and Fix' activities. Includes splitting large DMAs, installing new District Meters, installing new valves and washouts and enabling activities to operate difficult to access valves. |
| 3 | Leakage - Mains Replacement (Full) | FULL DMA REPLACE | DMA Mains Replacement of at least 90% of the DMA - includes mains and communication pipe replacement and boundary box install if not a PMP area (does not include CSL repair*) |
| 4 | Leakage - Mains Replacement (25%) | PARTIAL DMA REPLACE_25 | DMA Mains Replacement of 25% of the DMA - includes mains and communication pipe replacement and boundary box install if not a PMP area (does not include CSL repair*) |
| 5 | Leakage - Mains Replacement (50%) | PARTIAL DMA REPLACE_50 | DMA Mains Replacement of 50% of the DMA - includes mains and communication pipe replacement and boundary box install if not a PMP area (does not include CSL repair*) |
| 6 | Leakage - Mains Replacement (75%) | PARTIAL DMA REPLACE_75 | DMA Mains Replacement of 75% of the DMA - includes mains and communication pipe replacement and boundary box install if not a PMP area (does not include CSL repair*) |
| 7 | Leakage - CSL | See Metering Options - Section 3.0 | |

Table 12 - Feasible Leakage Interventions

* the leakage benefits due to a CSL repair have been accounted for under the Metering intervention (Section 2).

## 4.1. Pressure Management

Pressure Management refers to the reduction of excess pressure and better management of pressure fluctuations within the water mains network to reduce the rate of leakage.  To achieve this, Pressure Reducing Valves are installed within a DMA to reduce pressure within the area to a targeted level. This intervention includes the introduction of new Pressure Management areas within specific DMAs.

### 4.1.1. Schemes

A DMA is considered to have potential for pressure management given the following assumptions:

- Average pressure is greater than 30m
- Less than 5% of the DMA is currently pressure managed

Using these assumptions, 544 potential schemes were identified throughout Thames Water's network. However, these assumptions have only been employed to obtain a theoretical level and do not consider topography, hydraulics, network constraints, emergency supply resilience (i.e. for vulnerable customers on dialysis), a true reflection of the number of tall building boosters required or a practical assessment of whether these schemes are deliverable.

Consequently, the number of pressure management schemes currently input into IDM is theoretical and has been used to understand the cost and benefits of pressure management in comparison to other options.

Thames Water is currently assessing the pressure management options available, grouping areas into larger schemes and investigating the feasibility of zonal schemes to develop a practical solution for AMP7 and beyond. This data will be updated in the next IDM model run.

#### 4.1.2. Benefits

Pressure Management provides demand management benefit through reduction in leakage. The assumed benefits are input into IDM to model the total benefit expected from Pressure Management. To calculate the IDM input data, the following assumptions were made:

- DMAs with a current pressure between 30-40m, pressure can be reduced to 25m
- DMAs with a current pressure between 41-50m, pressure can be reduced to 35m
- DMAs with a current pressure between 51-60m, pressure can be reduced to 45m
- DMAs with a current pressure greater than 60m, pressure can be reduced to 55m

- Leakage reduction is proportionate to the percentage pressure drop. That is, a 10% pressure drop = 10% leakage reduction.

The assumption relating to leakage reduction has been developed using the data from Water Net. Water Net holds data for existing average pressure reductions in DMAs and the volume of leakage that pressure management areas are holding back. Waternet is the official corporate system for forecasting, calculating, reporting and monitoring leakage savings and PMA maintenance.

DMAs with a current pressure below 30m have not been considered as there is minimal leakage savings that can be achieved by dropping pressure 1-3m. DMAs are also required to have an average minimum pressure of 25m before they are considered for pressure management. This ensures Thames Water can continue to meet its service levels (ie. 10m pressure and 9l/s flow at the property boundary) without an infeasible number of tall building boosters being installed. Tall building boosters are required in pressure managed areas to feed water to tall buildings (anything above four stories) and avoid customer complaints.

DMA's with current pressure above 40m are not eligible to be reduced to 25m due to:

- high volumes of customer complaints when pressure is reduced by greater than 10%. Customers in particularly high pressure areas are used to that pressure and may be required to alter their own internal systems (i.e. pressure to attic bathrooms) to accommodate lower pressures (even if Thames Water still comply with the minimum level of service).
- network restrictions - areas with significantly higher pressures usually require that level of service.
- new developments in high pressure DMAs usually have undersized pipes. When developers see a high pressure area they can save money by using a smaller bore of pipe. Although this is the developer issue at construction, many customers in Thames Water's area will be unaware of this and a significant reduction in pressure by Thames Water will cause additional costs to these customers.

#### 4.1.3. Costs

The cost of a pressure management scheme is dependent on the:

- Capex and ongoing maintenance opex
- Number and size of pressure reducing valves
- Number of tall building boosters required
- Additional network and valve information systems

The pressure management costs input into IDM have been provided from the Engineering Estimating System Cost model based on the following assumptions:

- PRV sizing is determined according to the size of the largest two metered inlets
- One CPP is required per scheme
- The Number of Tall Building boosters required is based on location. i.e. Thames Valley, South London or North London.

### 4.2. Enhanced Active Leakage Control

Enhanced Active Leakage Control is an innovative solution made up of two interventions, DMA Enhancement and DMA Enhancement Plus.

#### 4.2.1. DMA Enhancement

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

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

Enhanced Active Leakage 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.

### 4.2.2. DMA Enhancement Plus

DMA Enhancement is one part of a larger innovative solution, DMA Enhancement Plus. DMA Enhancement Plus is defined as improving the accuracy of leakage detection by better accounting for demand. This is done by systematically checking all the building blocks that enables a DMA to function and combing through data from these building blocks. This uncovers anomalies in the network, properties and property assignments, assets, systems & data for the selected DMAs. Corrections are made in respect to each task where it will in turn improve data quality for the three components (water supplied, water consumed and leakage). The interaction between these components will either reduce leakage directly or help narrow the search of leaks in reality.

To date, assumptions have been made by Thames Water experts on the expected benefit of DMA Enhancement and DMA Enhancement Plus to enable the comparison of this intervention against other demand management interventions.

## 4.3. Mains Replacement

Mains Replacement is a long term sustainable option that involves water mains and communication pipe replacement and boundary box install activities. Four interventions have been modelled in IDM including 25%, 50%, 75% and full DMA mains replacement (Table 12).

### 4.3.1. Length of Mains Replacement

To date, the approach to mains rehabilitation has been based on results combining national research, Thames Water experience over the last 14 years, experience gathered from other water companies and discussions with manufacturers.

However, since 2011, an approach to target pipe condition as well as performance has been investigated to ensure mains replacement is targeted to deliver sustainable benefits. This means mains replacement 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 the worst can be targeted.

The distribution of mains replacement at pipe level is first modelled in the Distribution Mains Model. The output of this model forms the input to IDM.

### 4.3.2. Cost and Benefits of Mains Replacement

The benefits of mains replacement are derived at DMA level based upon leakage reduction.

The costs of mains replacement are derived at DMA level based upon:

- Size and length of main to be replaced and the split of techniques (open cut, slip lining, pipe bursting and directional drilling)
- For London, costs are based on costed schemes, borough/cost zone cost models where provided or 4 zone cost models. In Thames Valley, costs are based on inner city and outer city cost models.

Data from Thames Water's Engineering Estimating System (EES) is used to develop the cost models for mains replacement. The output of the EES cost model is input into IDM.

The specific benefit and cost assumptions used in IDM are summarised in Table 13.

| Risk Component | Intervention Benefit |
|---|---|
| Distribution Mains Leakage and Communication (comms) Pipe Leakage | Leakage is split into 2 components; background leakage and burst based leakage. The benefits of mains replacement is a 97% reduction in potential background leakage savings, i.e. difference between background leakage ad residual leakage. The reduced value then exponentially deteriorates at 1.12%. The other benefit of mains replacement is a reduction in burst based leakage associated with mains bursts which deteriorates at 1.26%. |
| ALC Detection Opex | 80% reduction in ALC detection opex.<br>This reduced leakage value then deteriorates through time based on the burst based leakage deterioration rate of 1.26% |
| ALC Repair Opex | 80% reduction in ALC detection opex.<br>This reduced leakage value then deteriorates through time based on the burst based deterioration rate of 1.26% |

**Table 13 - Cost and Benefit Assumptions for Mains Replacement**

# 5. Next Steps

This paper has detailed the benefits and assumptions input into IDM for each demand management intervention.

The first run of IDM has produced potential benefits and costs for each intervention under a maximum investment scenario. This will be available for presentation at the Technical Stakeholder Meeting on 19th June, 2017.

The second run of IDM will, by a process of optimisation, produce a number of Constrained Optimised Programmes of Demand Management. The output of this model run will include a mix of demand management interventions to be conducted over each AMP, the total cost of that programme and the expected water demand reduction (broken down into leakage, usage and wastage). The second run of IDM is scheduled for July 2017.

Post the IDM modelling, the Constrained Optimised Demand Management Programmes are able to be appraised together with the Constrained Supply Options in the Economics of Balancing Supply (EBSD) Model to develop the least cost solution to the assessed water supply / demand deficit the WRMP19 is to meet.

# 6. References

Arup (2017), 'Thames Water, Non-potable Water Reuse Strategy', Summary Paper, March 2017

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