Water Resources Management Plan 2019
Annex 6: Options Appraisal

December 2019

Version 1

from Southern Water

Contents

1. Executive summary

Development of the supply-demand balance identifies deficits that may occur within the 50-year planning horizon of this Water Resources Management Plan (WRMP) from 2020 to 2070. These deficits can be met through the introduction of supply-side options to increase supplies or demand management options to reduce demand. Options appraisal is the process by which these options are identified, developed and subsequently assessed against each other to bring together the portfolio of schemes that form the strategy for each of the three Southern Water supply areas: Western, Central and Eastern.

The Water Resources Planning Guideline (WRPG) Environment Agency and Natural Resources Wales, 2017) provides information on how water companies should undertake the options appraisal. We have followed this guidance in developing options and in designing the decision-making modelling processes from which the WRMP area strategies are derived.

The process of options appraisal can also be seen in terms of the gradual screening of a wide array of options to reach an optimum solution with a basket of robust options. The approach to screening and filtering options has been refreshed since the WRMP14 in order to be more transparent and efficient. This technical Annex sets out the way in which we have:

- Identified an **unconstrained list** of options
- Screened and filtered the unconstrained list of options to arrive at a **constrained list of options**, removing options that are impractical or have unacceptable environmental or economic impacts. These options were placed in a register of rejected options, which is summarised in Annex 7
- Screened and filtered the constrained list of options to arrive at a **feasible list of options** that has been tested on grounds of both monetised and non-monetised costs and benefits, including environmental assessment. These feasible options can be taken forward into the decision-making modelling processes (these are detailed in Annex 8)

1.1 Unconstrained list of options

The unconstrained list of options is a high-level list including generic option types as well as taking account of government policy and aspirations. It is populated with options and studies from past WRMPs as well as new option ideas, and has been developed referring to the following:

- The UK Water Industry Research (UKWIR) WR27 Water Resources Planning Tools 2012 project (UKWIR, 2012a)
- The earlier Economics of Balancing Supply and Demand (EBSD) report (UKWIR, 2002)
- The extensive option investigations that underpinned our WRMP14, which in turn built upon the comprehensive study of options conducted during AMP4 for each of our three supply areas
- A list of our existing assets
- Our drought plan (Southern Water, 2013)

To ensure that all relevant options were included in the unconstrained list of options, we engaged with customers and stakeholders (including the Environment Agency (EA) and Natural England (NE)) via pre-draft consultation to elicit their views on the proposed options categories, continued active participation in the Water Resources in South East (WRSE) group, and conducted internal reviews of proposed options.

New options ideas were sought by asking for a standard pro-forma to be populated with information describing the option. This request was advertised on the company website, staff notice board, and on social media, as well as being published in a newsletter to customers and stakeholders. The same question was also raised in the stakeholder panels.

Screening of the unconstrained list of options was undertaken by assessing each option against the following criteria:

- Is the option likely to be technically feasible?
- Does the option help address the water resources planning problem?
- What is the indicative cost and capacity of the option and what is the timing for it becoming available?
- Is the option likely to meet both customer and regulator expectations?
- Is the option likely to be particularly risky to implement, or the output highly uncertain, such that it may fail to be implemented, or implemented in time?

1.2 Constrained list of options

Through this screening process, the constrained list of options was identified. Options on this list were then subject to a further screening process to ascertain whether they should be taken forward as feasible options that could realistically reduce the supply demand deficit in their respective Water Resource Zones (WRZs). Screening of the constrained options list was undertaken by assessing each option against the following criteria:

- **Environmental and social assessment**: A Strategic Environmental Assessment (SEA) and Habitats Regulation Assessment (HRA) have been produced which summarise the environmental and social costs and benefits, and impacts upon European designated sites of each option. The SEA screening criterion illustrates (i) the risk of adverse effects and where available, mitigation measures, and (ii) the opportunity for beneficial effects resulting from the option. This assessment is set out in Annex 14
- **Links to other options** in terms of mutual exclusivities and dependencies
- **Risks**, including vulnerability of the option to future uncertainty relating to climate change impacts and regulatory changes, as well as the sustainability and acceptability of the option

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- **Phasing**, i.e. whether the option can be constructed in a phased or modular way, which would increase its flexibility to be altered in response to future changes in the forecast supply-demand balance
- **Resilience**, which can be described as an indication of the confidence that the option will 'deliver' the required reduction in the supply-demand balance deficit

1.3 Feasible list of options

The feasible list of options is a final screened list that has been tested on grounds of both monetised and non-monetised costs and benefits. It encompasses the option types listed in Table 1. A SEA and HRA was also produced which summarises the environmental and social costs and benefits, and impacts upon European designated sites. This is set out in Annex 14.

The feasible list of options was then used with the WRMP investment model to derive a least cost solution and preferred programme of options to meet a given supply demand balance deficit.

Table 1 Generic option types included in the feasible list of options

Option group	Option category
Demand management	Leakage management
	Metering
	Water efficiency
Drought options	Demand interventions
	Supply interventions
New water	Desalination
	Groundwater abstractions (new)
	Surface water abstractions
Storing water	Aquifer storage and recovery
	Reservoirs
Water reuse	Indirect potable water reuse
	Industrial water reuse
Managing the water environment	Catchment management
Trading water	Bulk imports and exports
	Inter-zonal transfers (between Southern Water WRZs)
	Licence trading
Managing existing assets	Asset enhancement
	Borehole rehabilitation

1.4 Existing assets

To demonstrate we are providing best value in our proposals for balancing supply and demand, we have incorporated all our existing sources and transfers in our decision-making modelling processes. Their continued operation has been selected by the investment model because there will not be any initial capital expenditure to bring existing sources or transfers into production. However, going through this process demonstrates that we are exploring the true least cost solution to balance supply and demand.

1.5 Next steps

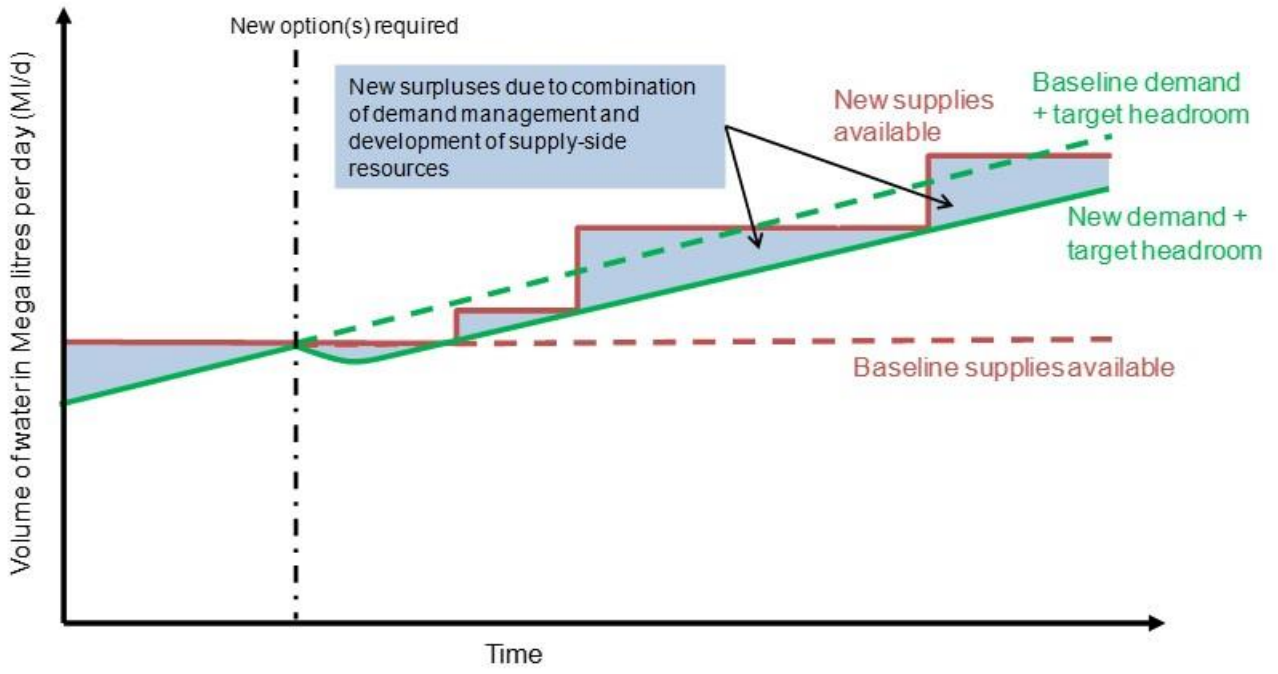
The feasible list of options was taken forward into the investment model which was used to identify the least cost solution in each WRZ and Southern Water supply area. This, and subsequent decision-making processes were used to derive the portfolio of schemes that comprise the strategy for each area. These decision-making processes are detailed in Annex 8.

2. Options appraisal process

2.1 Introduction

Where there are forecast deficits in the baseline supply-demand balance, taking account of target headroom, these can be met through the introduction of supply-side options to increase supplies, or
demand management options to reduce demand. The effect of these two different types of options on the supply-demand balance is shown in Figure 1.

Figure 1 The twin-track approach to meeting a deficit in the supply demand balance

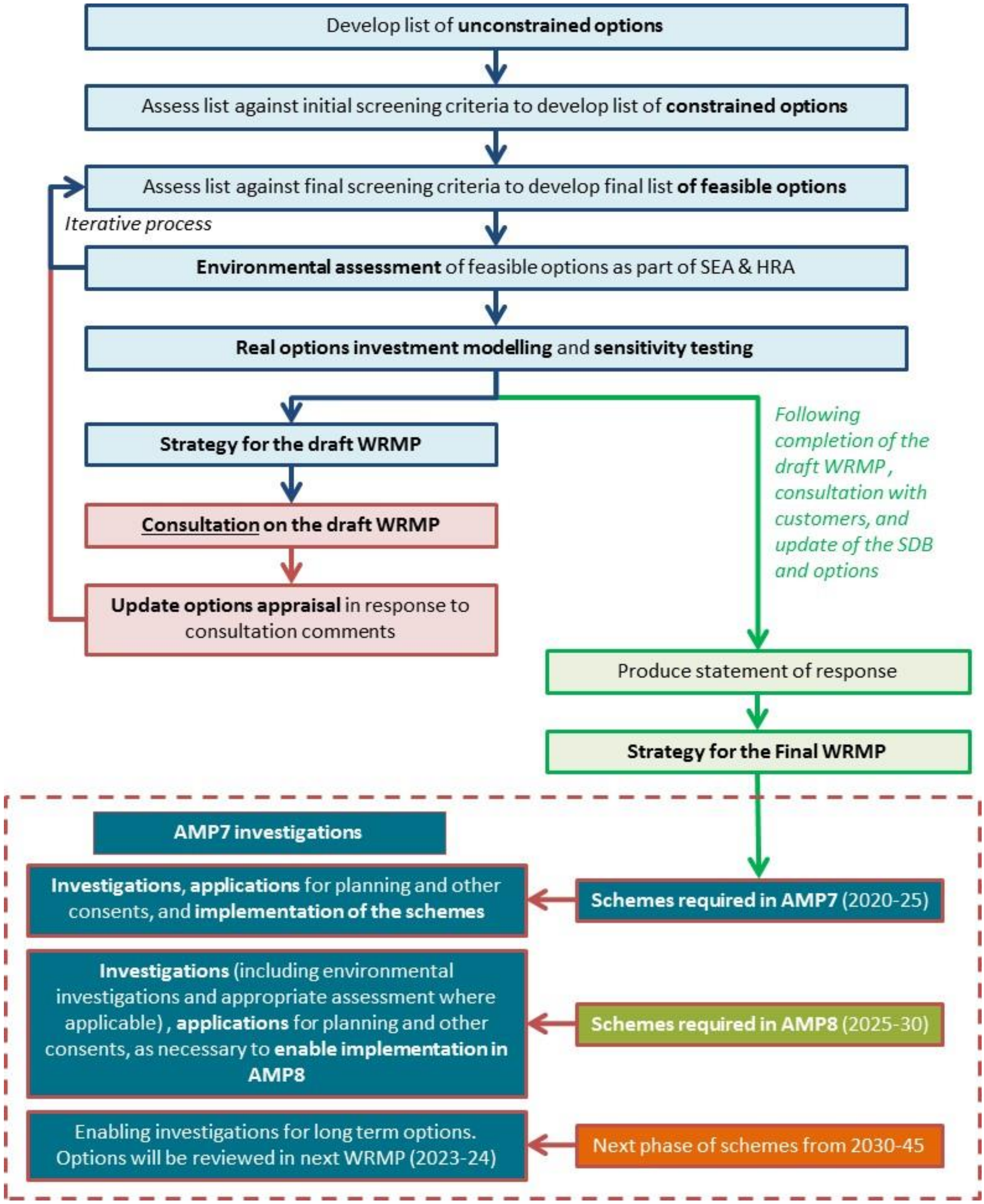


The options appraisal process comprises the following key steps, which are taken from the EA guideline (Environment Agency and Natural Resources Wales, 2017), with reference to UKWIR (UKWIR, 2016) Water Resources Management Plan (WRMP) 2019 Methods – Decision-making process guidance (UKWIR, 2016):

- Stage 1 – Prepare supply-demand balance information
- Stage 2 – Develop a list of unconstrained options that takes account of government policy and aspirations
- Stage 3 – Undertake a problem characterisation and evaluate strategic needs and complexity
- Stage 4 – Decide on a modelling method
- Stage 5 – Identify and define data inputs to model(s)
- Stage 6 – Undertake decision making (options appraisal) modelling
- Stage 7 – Stress testing and sensitivity analysis
- Stage 8 – Produce a final planning forecast. This should include an EBSD (UKWIR, 2002) bench mark if using a different method to select options

This process is summarised in Figure 2.

Figure 2 Process for options appraisal, derivation of area strategies and implementing this plan (SDB in this figure refers to supply-demand balance)



Stages 2 and 5 are described in this Annex, which covers development of the unconstrained list of options, through to the constrained list of options, and finally the feasible list of options, data from which populates our investment model.

Section 3 contains tables summarising the 494 unconstrained options initially considered, and the resulting 118 feasible options following the screening process.

Annex 7 contains all of the unconstrained option that have been screened out and their screening assessments.

The decision-making modelling processes that have informed the strategy for each of Southern Water's three supply areas are detailed in Annex 8.

2.2 Unconstrained list of options

The unconstrained list of options is a high-level list including generic option types as well as taking account of government policy and aspirations. It is populated with previous options and studies from past WRMPs as well as new option ideas and has been developed referring to the following:

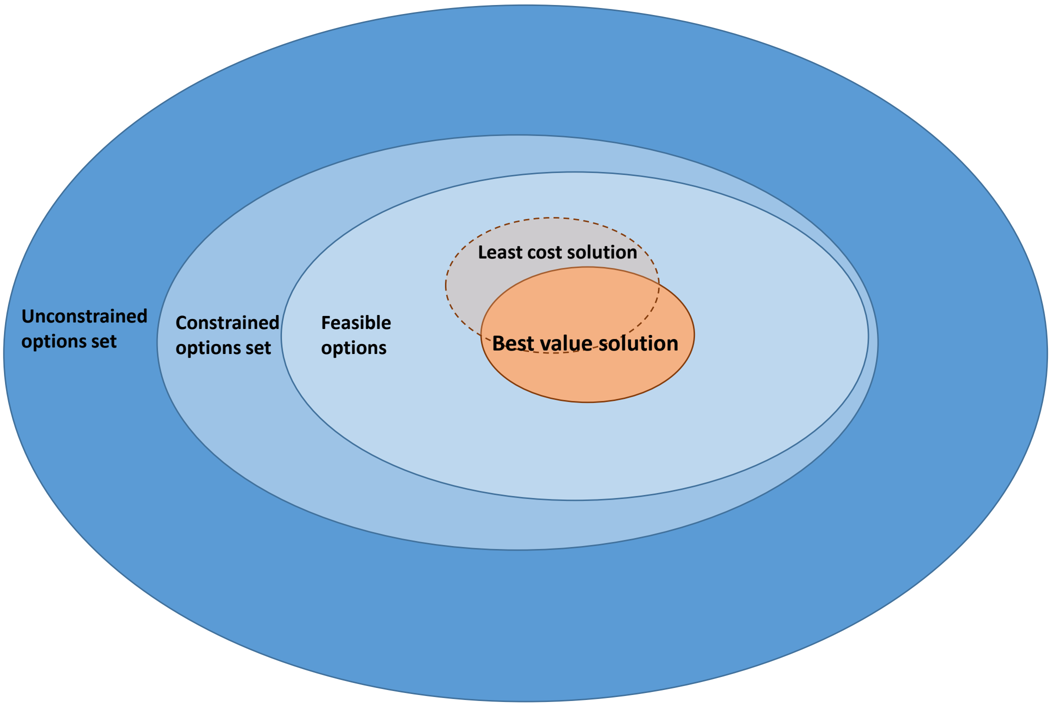
- The UKWIR Water Resources Planning Tools report (UKWIR, 2012a)
- The EBSD report (UKWIR, 2002)
- The extensive option investigations that underpinned our WRMP14, which in turn built upon the comprehensive study of options conducted during AMP4 for each of our three supply areas
- A list of our existing assets
- Our drought plan (Southern Water, 2013)

We have adopted the following approach to ensure that all relevant options were included in the unconstrained options list:

- Engaged with customers and stakeholders via pre-draft consultation (using a scheme preference online survey, willingness to pay research and scheme preference workshops) to elicit their views on the proposed options categories. Outcomes of these are set out in Annex 1
- Published a notice in the Official Journal of the European Union (OJEU) to seek third party supplies
- Continued our active participation in the WRSE group, a grouping of regulators and other water companies whose aim is to identify regional solutions to water resources problems.
- Conducted internal reviews of proposed options as part of the WRMP process
- Consulted on the draft unconstrained list of options with the EA and Natural England (NE), as documented in Annex 1

The process of options appraisal can also be seen in terms of the gradual screening of a wide array of options to reach an optimum solution with a basket of robust options as set out in Figure 3.

Figure 3 Options screening process



We used a standard proforma to compile information on all options at each stage of the options appraisal process to ensure consistency in and comparability of the information gathered.

2.2.1 Demand management options

Demand management options can be effective in controlling what might otherwise be unrestricted growth in demand for water, which could consequently trigger investment in resource developments earlier in the planning period than would otherwise be necessary. The implementation of demand management measures is therefore an important component of our approach to water resources planning. The range of options considered have been categorised according to the naming convention in Table 2. Descriptions of each option type are included in section 2.5.2.

Table 2 Demand management option groups

Option group	Option group code	Option category	Option category code
Demand management	DM	Leakage management	LM
		Metering/tariffs	MET
		Water efficiency	WEF

There are political and environmental reasons for promoting demand management measures, and Southern Water, supported by its customers and regulators, believes that ambitious targets should be set, and is aiming to reduce per capita consumption to 100 litres per head per day by 2040: our Target 100 initiative, described in section 2.5.2. However, the precise role of other demand management measures in a long-term investment plan will depend on the characteristics of the supply-demand balance, in particular:

- The magnitude of any deficits
- The year when deficits occur
- The earliest date at which new supply-side options are available

Where there are large deficits that arise from step changes in the supply side of the supply-demand balance (for example, because of sustainability reductions or reappraisal of deployable output (DO) using more robust and long-term hydrological and operational data), then it is unlikely that demand management measures on their own would be sufficient to maintain the supply-demand balance. Instead they would need to form part of a twin-track approach, as shown in Figure 1.

2.2.2 Supply-side options

A number of supply-side options have been investigated for this plan. The range of options considered can be divided into the option categories shown in Table 3.

Table 3 Supply-side option groups

Option group	Option group code	Option category	Option category code
Drought options	DO	Demand interventions	DI
		Supply interventions	SI
New water	NW	Desalination	DES
		Canal water abstraction	CWA
		Groundwater abstractions (new)	GWA
		Surface water abstractions	SWA
		New technologies	NT
Storing water	STR	Aquifer storage and recovery	ASR
		Reservoirs	RES
Water reuse	WR	Indirect potable water reuse	PWR
		Industrial water reuse	IWR
		Grey water reuse	GRE
Managing the water environment	ENV	Catchment management	CM
		Conjunctive use	CU
		Licence variation	LV
		Supporting river flows	SRF
Trading water	TW	Bulk supplies	BS
		Bulk export	BE
		Inter-zonal transfers (between Southern Water WRZs)	IZT
		Licence trading	LTR
Managing existing assets	ASS	Asset enhancement	AE
		Water treatment works enhancement	WTW
		Borehole rehabilitation	BR

2.2.3 Screening and filtering the unconstrained list of options

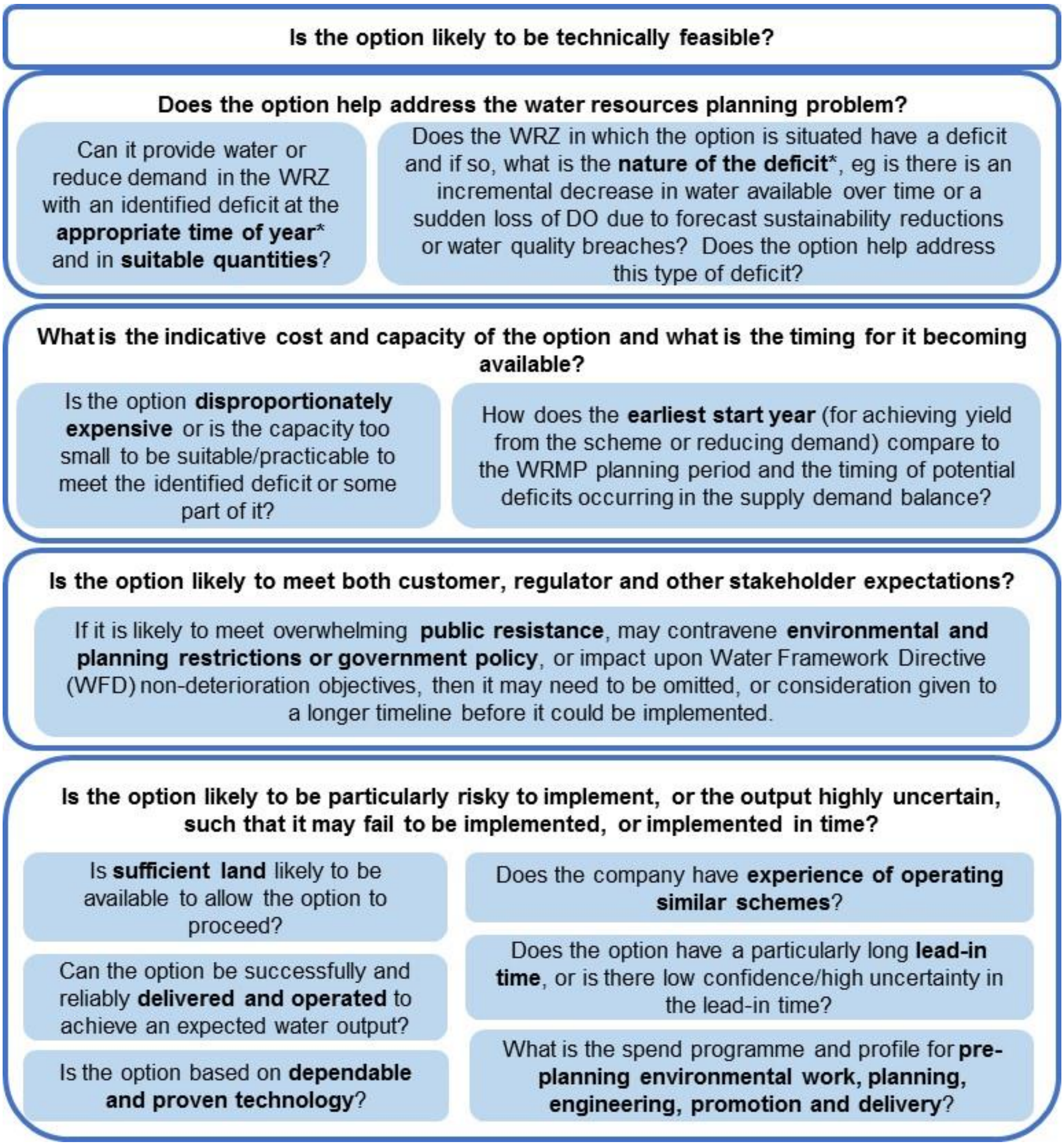
Within the Level 1 fact files, each option is assessed against the first round of screening criteria to identify if it should be taken forward onto the constrained list of options. The screening criteria are presented in

Figure 4. Where an option is screened out, i.e. not taken forward onto the constrained list of options, it is placed on a register of rejected options (reported in Annex 7) along with the screening results that led to its exclusion. In this way, the audit trail of decision-making is retained. At each screening stage, we engaged with the regulators to discuss the options that were being rejected and taken forward.

The level of detail for some options at the unconstrained options screening stage was relatively high level and/or uncertain. A conservative approach was therefore taken to retain options in cases where the justification to exclude was uncertain. Where there was sufficient justification to exclude an option the reason for rejection has been summarised and reported in Annex 7. To ensure consistent screening each option within a given option group was reviewed by one technical lead.

In any given WRZ, a forecast supply-demand balance deficit may arise under one or more of the conditions defined by the annual average deployable output (ADO), critical period (peak demand, CP) or minimum deployable output (MDO) scenarios. This deficit triggers the need for new investment in demand or supply side options. However, the conditions which drive the need for investment may have a direct bearing on the appropriateness of one option over another. For instance, a deficit under a peak period scenario may be solved through increased treatment capacity or higher meter installation, whereas average or minimum resource period imbalances may require the development of other types of options, such as more storage, the provision of a more reliable supply of water such as water re-use or desalination, increased meter installation or further leakage reduction.

Figure 4 Screening criteria for the unconstrained list of options (DO in the figure refers to Deployable Output)



* Forecast supply-demand balance deficit may arise ADO, CP or MDO

Based on the answers to the above screening questions, a decision was made as to whether the option should be taken forward onto the constrained list.

2.4 Constrained list of options

2.4.1 Screening and filtering the constrained list of options

Further investigations for each option were undertaken to generate more detailed option descriptions. This information was collated within Level 2 fact files to allow a second stage filtering process to be applied to generate the constrained options list.

In some cases, additional options were also identified through this process, and sub-options were developed into discrete options where appropriate. Options on the constrained list were considered against the following criteria to determine whether they should be taken forward as feasible options. As at the unconstrained options screening stage, a conservative approach was taken to retain options in cases where the justification to exclude was uncertain. Where there was sufficient justification to exclude an option, the reason for rejection has been summarised and reported in Annex 7. To ensure consistent screening, each option within a given option group was reviewed by one technical lead. The fact files for the feasible options are presented in Appendix A and also include a discussion of the rationale for including the options.

Environmental and social assessment

Each option was assigned two **grades**, which summarise the findings of the **SEA assessment**, illustrating (i) the risk of adverse effects and (ii) the opportunity for beneficial effects (e.g. improved water quality, reduced flood risk, improved catchment management) resulting from the option. Where **environmental or social impacts** were identified, an assessment was also made as to whether they could be **mitigated**.

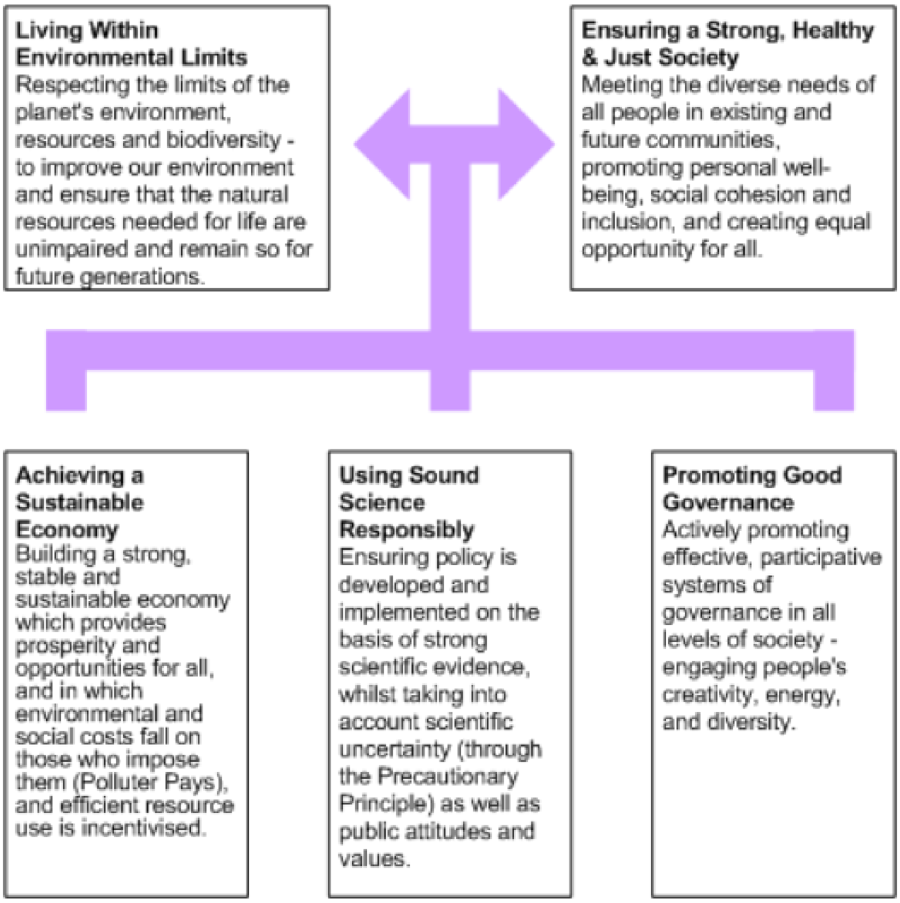
Links to other options

Dependencies and **mutual exclusivities** with other options and, where appropriate, third parties were defined.

Risks

A qualitative assessment was made as to whether the option is at risk of **climate change impacts** or **future uncertainty**, e.g. regulatory changes, acceptability of the option, potential planning constraints or changes in customer behaviour (for some demand management options). To inform this assessment, the **sustainability** of each feasible option was considered with reference to the UK government's guiding principles for sustainable development, as shown in Figure 5.

Figure 5 The five guiding principles of sustainable development (UK government)



The sustainability of each option was informed by answers to the following questions:

- Is the option required to address **societal needs**, e.g. is there a water resource problem that could be addressed by the option?
- Is there an opportunity to minimise **energy** consumption or develop/use renewable energy?
- Does the option use the most **appropriate technology,** and will this technology be supported in the future (i.e. is it a transient technology that is likely to be superseded within its asset lifetime)?

A further risk to the potential feasibility of an option is the **acceptability** of the option. This can relate to customers' views of the option, as well as likely planning risks. Where available, the outcomes of customer consultation undertaken to-date were referred to, and expert knowledge of the existing planning regime formed the basis of the likely risks in terms of planning uncertainty.

Phasing

Each option has been assessed in terms of whether it can be implemented in a **phased** or **modular** way. If this was possible, it would increase the flexibility of the option to be altered in response to future changes in the forecast supply-demand balance.

Resilience

According to the Cabinet Office (Cabinet Office 2011) "resilience is the ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from a disruptive event. Resilience is secured through a combination of activities or components; the four principal strategic components are" presented in Figure 6:

Figure 6 The components of infrastructure resilience (Cabinet Office, 2011)

- *Resistance* is about providing adequate strength or protection to resist a hazard or its primary impact (in this case a supply-demand deficit)
- *Reliability* relates to ensuring the infrastructure components (in this case the portfolio of schemes in each strategy) can operate under a range of conditions
- *Redundancy* is concerned with the capacity of the system to ensure continuity of service in the event of disruption, and essentially refers to the availability of spare capacity in the system
- *Response and Recovery* describes the organisation's ability to respond to and recover from disruptive events quickly and effectively. Good understanding of the system is vital to being able to do this

The contribution of each option to overall resilience has been assessed with reference to the above categories. In particular, different types of sources will react differently to differing hydrological conditions. Hence WRZs may incur differing degrees of stress under the same hydrological conditions due to their different composition of types of source. To develop a system that is as resilient as possible to different types of drought, due consideration must be given to the optimum balance of the type of sources that Southern Water has in any given WRZ and how those sources will respond under a variety of drought conditions. This should be an important consideration in the choice of new resources. The resilience of an option is an indication of the confidence that the option will 'deliver' the required reduction in the supply-demand balance deficit. Where an option depends heavily on assumptions about changes in customer behaviour, or may be significantly impacted by different climatic conditions, it is less reliable than an option that is unaffected by such factors (e.g. water reuse and desalination).

Summary of screening and filtering process

The answers to the above questions formed the basis of the decision on whether each option was considered feasible or not for the purposes of this plan. Where further information was obtained through the option development process that informed the answers to the unconstrained options screening criteria, these answers were updated. In this way, the process was iterative and ensured that options included in the feasible list met all the necessary criteria.

2.5 Feasible list of options

A feasible list of options is defined by the EA in the WRPG (Environment Agency and Natural Resources Wales, 2017) as:

"…a set of options that you consider to be suitable to take forward for assessment as part of your preferred programme of options. As such, it should not include options with unalterable constraints that make them unsuitable for promotion (e.g. unacceptable environmental impacts that cannot be overcome or options which have a high risk of failure).

By applying the systematic, two-stage filtering approach described above, we developed a transparent option selection process from definition of the unconstrained list of options through to determination of the feasible list of options. Feasible options were included in the investment model, the results from which were used to inform selection of the strategy. Summary information for the feasible options is presented in Table 7, Table 8 and Table 9. Information for all feasible options are presented in a standard proforma in Appendix A of this Annex. A summary table of the options rejected through the options screening process is provided in Annex 7. The EA has reviewed the feasible options list.

2.5.1 Information compiled for feasible options

To support, and in addition to the information compiled for the screening and filtering of the constrained list of options, the following information was compiled for each feasible option:

Engineering descriptions

Engineering descriptions of each option and engineering designs appropriate for WRMP costing purposes were prepared for each option/sub-option.

Water quality considerations from a public health perspective were included in the engineering designs, as described in Appendix B.

Earliest start years

The earliest potential start years for schemes were assessed on the basis of scheme and construction complexity, likely planning constraints and risks, and environmental or other investigations likely to be needed to support the implementation of the scheme.

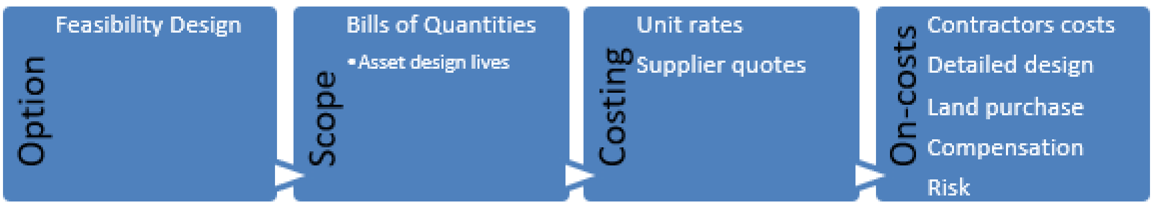
For the majority of new resource developments, the preparatory feasibility and environmental investigations and planning approvals required, as well as the engineering design and construction time, meant that options could generally not be relied upon to start producing yield until the end of AMP7 at the earliest (i.e. until 2024-25), and in some cases not until into AMP8 (i.e. between 2025 and 2030).

Monetised costs

Monetised costs were estimated based on best available information, but it is important to emphasise that they are indicative only and as options are investigated and developed further, the costs will need to be refined. Monetised costs have been prepared covering:

- The **capital costs** (or capital expenditure, or 'capex') for each option were developed from a detailed assessment of project work items required. Asset lives were determined for each project work item, which allowed calculation of their estimated renewal costs. Infrastructure costs were derived using typical water industry unit costs and on-costs

Figure 7 Capital costing development



- Non-infrastructure treatment costs were derived from supplier quotes, known out-turn costs and, in the case of desalination plants, a desk study into typical costs over a range of capacities internationally. The PR19 Business Plan provides detailed cost assumptions specific to the schemes in the preferred plan. These costs were annuitised to take account of renewals after expiry of the asset lives of project work items, e.g. an item with a 10-year asset life would be replaced in year 10, year 20, year 30 etc. of the planning period, with the cost incurred each time assumed to be the same as the initial capex cost (although discounting is applied). The annuitisation method uses a weighted average discount rate (3.23%) to take account of the time-varying Treasury Green Book discount rates required by the WRPG (Environment Agency and Natural Resources Wales, 2017), i.e. 3.5% for years 0–30 of the appraisal period, 3% for years 31–75, and 2.5% for years 76–125. The investment model assumes full annuitised capex from the moment the decision is made to implement an option. An adjustment has therefore been applied to the annuitized values to take account of the build-up of capital expenditure over the lead-in time for each option

- A profile of capex renewals has been provided in WRMP Table 5
- The capex associated with each element of the Target 100 demand management option and other metering options was assumed to be applied linearly over the relevant time period. A total cost profile over the planning period was developed for each option, taking account of all the different cost elements and their anticipated renewal costs
- **Opex**: fixed and variable costs including power, abstraction, treatment, distribution, labour and any other costs, such as business rates where applicable
- **Financing costs**: the cost of capital needed to deliver each option was calculated using an assumed 3.6% average cost of capital, the "vanilla" (in that it does not take account of tax considerations) real wholesale weighted average cost of capital (WACC) in PR14 (Environment Agency and Natural Resources Wales, 2017). The cost of capital has been calculated as an annuitised value, consistent with the capex of each option, using the method below:
  - Each project work item has a Net Book Value (NBV), which contributes to Southern Water's overall Regulatory Capital Value (RCV). For example, the full NBV of an asset is added to the RCV in year 1. If it has an asset life of 10 years, the NBV of that item reduces incrementally in subsequent years 2–10 back to zero as its value depreciates. Upon renewal at the end of the asset life, the full NBV is incurred again and the depreciation recommences. Each year, customers pay the WACC on the total RCV. Hence it is important to account for the depreciation of assets in the calculation of financing costs for this plan
  - For each project work item's asset life, an annuitisation factor was calculated for financing costs taking account of the profile of NBV as described above. This factor was applied to the initial capex of each project work item to derive an annuitised financing cost
  - As for capital costs, an adjustment was made to the annuitised financing cost to take account of the lead-in time of the option, during which the capital expenditure, and hence financing costs, are built up in an assumed linear fashion
  - **Cost confidence:** The costs derived for each feasible option are estimates only at this early stage of the planning process – cost confidence would generally increase as an option evolves toward the detailed design phase. We have explored the impact of uncertainty around the cost estimates derived for each option type. The impacts are examined in sensitivity tests presented in Annexes 9 to 11. Table 4 below shows the cost confidence levels that have been assigned to the various categories of feasible options

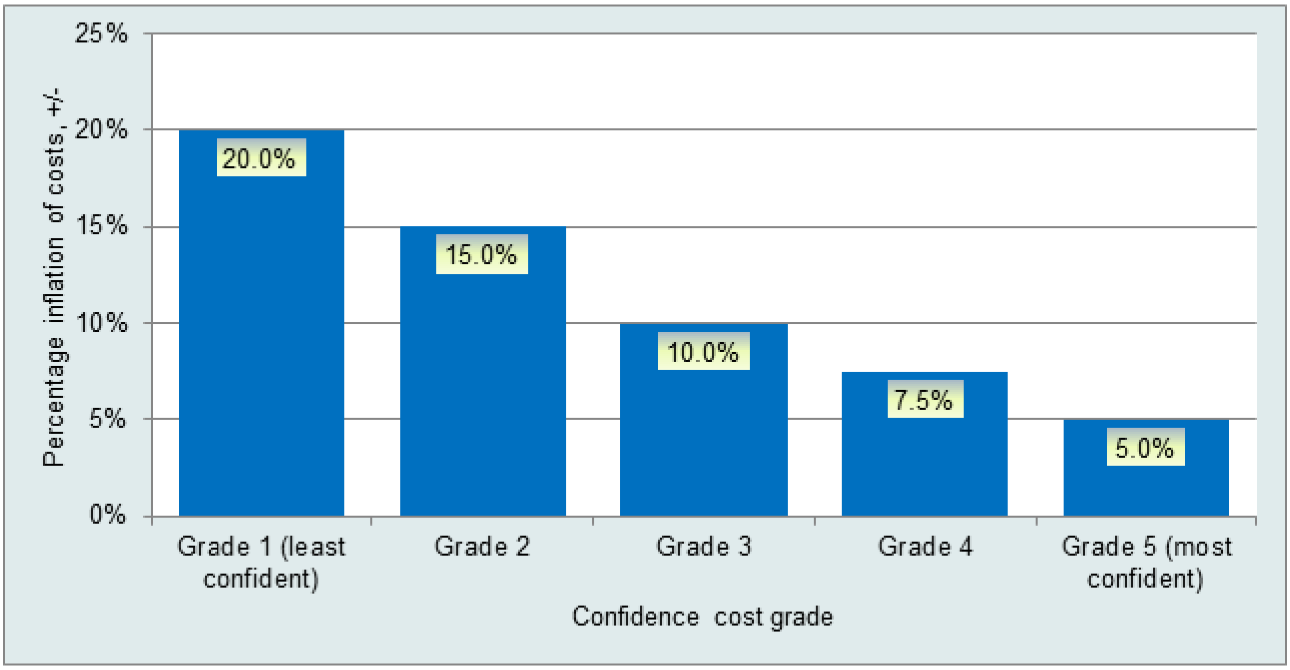
Table 4 Cost confidence by option type

Option type	Cost confidence	Comment
ASR	2	ASR has not previously been implemented by Southern Water, although we have extensive experience in most components within these schemes (e.g. boreholes, mains, pumping stations). Cost data has been compiled from dissimilar projects and non-company sources.
Bulk Supplies	4	Southern Water has considerable experience in developing bulk supply options, with reliable company data available. However, the UTMRD (Upper Thames Major Resource Development) and Honour Oak options have been assigned a score of 4 as they are significantly larger than previous options developed, and therefore have greater uncertainty.
Catchment Management	3	For the nitrate removal catchment management options, there is uncertainty over the scheme benefits and hence these options will be investigated over a long lead time.
Desalination	1	Southern Water has no previous experience of desalination plants, although desalination is a proven technology, so cost data has been compiled from non-company sources and dissimilar projects where possible.
Leakage Management	3	Southern Water is already implementing leakage reduction programmes, has considerable experience in this type of option and reliable cost data is available. However, the scale of leakage reduction being attempted in this plan and the technologies being applied, have reduced the cost confidence score.
Licence Variation	5	Southern Water has prior experience in similar projects.
Reservoirs	3	Southern Water has not developed any new reservoirs recently. Cost data is from non-company sources and previous company projects where applicable.
Surface water abstractions, including bankside storage	5	Southern Water has considerable experience in similar projects with similar scale, and has cost data available.
Transfers (inter-zonal)	4	Southern Water has considerable experience in developing inter-zonal pipeline options, with reliable company data available.
Groundwater abstractions	4	Southern Water has prior experience in similar projects, with specific cost data available.
Water treatment works	3	Southern Water has prior experience in similar projects. Costs have been defined using some company specific data and some non-company source data, however a greater level of investigation will be required to assess water quality at individual sites and therefore the processes required.
Water Reuse	2	Southern Water has no previous experience of specific water reuse schemes. Cost data has been compiled from non-company sources and dissimilar projects. However Southern Water does have extensive experience in some of the components within these schemes (e.g. mains and pumping stations).

Option type	Cost confidence	Comment
Water Efficiency	3	Southern Water is already implementing water efficiency programmes, has considerable experience in this type of option and reliable cost data is available. However, whilst we have relatively high confidence in short- / medium-term costs, the costs that will be incurred later in the journey towards a per capita consumption of 100l/h/d are much more uncertain, and will depend on the success of the earlier demand reduction activities.
Metering	3	Where metering activity comprises replacement of existing meters, cost confidence is high because no excavation or assessment of feasibility is required at each property. However, there remains some cost uncertainty as technology in this area is developing rapidly, and costs may change over the planning period. As our options comprise increased meter penetration, cost uncertainty is higher because it is likely that these properties will not be straightforward to meter – otherwise they would have formed part of the Universal Metering Programme (UMP) and already had a meter installed.

- We have used the estimates of cost confidence in sensitivity analysis of the preferred plan. The costs were inflated/deflated by the percentages set out in Figure 8 below for each confidence grade. The results of the sensitivity analysis do not represent the absolute magnitude of investments – the purpose of the cost sensitivity analysis was to understand how changes in relative costs might impact on the final solution set, and thus to inform commentary on the robustness of the options that form the preferred plan

Figure 8 Percentage inflation of costs based on cost confidence grade



- The criteria on which the cost confidence grades were based is summarised in the table below (Environment Agency, 2012)

Table 5 Cost confidence grade criteria

1	2	3	4	
Cost data is from noncompany sources. Used industry parametric data (e.g. TR61).	Significant use of noncompany sources, costs from dissimilar projects or costs from projects completed more than 8 years in the past.	Company has some company specific data. And some noncompany source data. (e.g. contractors' estimates with limited or no company specific input).	Cost represents activity where reliable company specific cost data is available (a few data points).	Cost represents activity where reliable company specific cost data is available (reasonable number of data points).

Embodied and Operational Carbon

Carbon emissions were calculated for each option, both in terms of embodied carbon (the lifecycle carbon emissions of materials used in construction), and operational carbon (emitted through operation of the scheme over its lifetime). The embodied and operational carbon emissions associated have been quantified in terms of kg CO_2e to allow identification of a least carbon suite of options.

The embodied carbon of each option was calculated using Atkins' Carbon Tool. For this plan the tool was updated to include up-to-date values from literature for the embodied carbon of different construction materials and the for the fuel efficiency of transport/plant. Carbon curves provided by Southern Water were used to calculate the embodied carbon of pipes and concrete tanks.

Operational carbon emissions have been calculated based on the operational energy requirements of each option in kWh and the carbon intensity of energy production using published data.
It should also be noted that high energy options are automatically equated with high carbon emissions. However, opportunities to reduce emissions through the supply the energy from renewable sources has been identified in each option fact file.

Environmental and social considerations

The environmental and social impacts of each feasible option were assessed. The environmental costs and benefits of options have not been quantified in monetary terms, which is in accordance with the EA supplementary guidance note on environmental valuation (Environment Agency, 2016). Depending on the option, impacts were informed by a SEA, more general environmental assessment, HRA, and its ability to meet Water Framework Directive (WFD) objectives. The EA's guidance document on environmental valuation for the WRMP (Environment Agency, 2016) was used in defining the appropriate level of appraisal for each feasible option, e.g. qualitative, quantitative or monetised. The full methodology by which environmental and social impacts have been considered is set out in the SEA, HRA and WFD screening section of Annex 14.

Annexes 8–11 provide a detailed description of how we have used the environmental assessments to inform our selection of the preferred strategy for each of our three supply areas.

It should be noted that comments received during the public consultation on our draft WRMP relating to pipeline routing to avoid designated areas and important habitats have been addressed in this WRMP.

We propose to develop an approach to natural capital accounting which will help us assess whether our future WRMPs are expected to achieve an environmental net gain. This concept will be developed further in our WRMP24.

The climate change impacts on options were assessed as part of the SEA in Annex 14. However, climate change also formed part of the overall assessment of potential future vulnerability of options within the options screening process, as set out in section 2.4.1 above.

Climate change would only affect the few options that are impacted by climatic events. For example, a storage reservoir option would likely be affected by climatic events, whereas desalination and water reuse options would be unaffected.

Output

The yield or water saving associated with each option has been assessed across the range of potential design drought event scenarios that are being considered for this plan. For demand management (metering, tariff and water efficiency) options, water savings have been assessed over an 80-year period, as in many cases the profile of water savings varies over time as customer numbers change and assumptions about baseline per capita consumption (PCC) change upon which demand savings are estimated.

2.5.2 Option descriptions

The sub-sections below provide a general description of the generic options types that comprise the list of feasible options.

Reducing demand: Water Efficiency - Target 100

Water companies have a statutory duty to promote the efficient use of water. In recent years we have carried out water efficiency programmes to save one litre of water per property per day – adding up to 1 million litres or 1 megalitre per day (1Ml/d). This target was formerly mandatory, and although Ofwat has now removed the formal target in line with its lighter touch, outcome-focussed regulatory approach, we have aimed to maintain it because it is the right thing to do on behalf of our customers and the environment. Ofwat has, however, included PCC as one of its 14 Periodic Review 2019 (PR19) common performance commitments against which it will judge companies' performance.

Ongoing baseline water efficiency activity carried out by Southern Water includes, for example:

- Carrying out free water saving home visits, designed to provide specific water saving information, clear advice and bespoke water saving product installation for each of our customers' homes which qualify for such a visit
- Running education programmes in primary and secondary schools
- Providing information on our website about how customers can save water and therefore money
- Offering discounted water-saving products on the company's website
- Working in partnership with Waterwise and the Energy Saving Trust

Annex 2, covering the demand forecast, summarises the household demand savings expected throughout the planning period. Supported by our ongoing baseline water efficiency activity, we estimate that average PCC at company level will fall to around 114 litres/head/day (l/h/d) by 2039/40 and 113l/h/d by 2044/45, which is achieved under normal year annual average conditions including allowance for climate change impacts. This follows on from the trends seen for individual micro-components, and allows for replacement of older devices by newer, more water efficient versions as well as a shift towards more water efficient behaviour modelled through reductions in shower durations.

There is an implicit assumption that the level of water efficiency activity that is included in the base year demand will continue through the planning period. This is built into the demand forecast. It is therefore important to emphasise that the demand management options considered as part of the options appraisal and detailed in this section represent enhanced demand management. They are options which provide additional savings over and above those assumed as part of our baseline water efficiency activity and promotion included within the baseline demand forecast, because they are specific interventions that are proposed to be made by Southern Water to help customers reduce their demand further.

Southern Water has in recent years been a forerunner in the field of demand management among UK water companies, having successfully implemented a Universal Metering Programme (UMP), compulsorily installing around 450,000 Automated Meter Reading (AMR) meters between 2010 and 2015, taking household metering levels across its supply area to around 88%. Reflecting the value placed on conserving water by stakeholders including regulators and our customers (during the public consultation on the draft WRMP14, 92% of customers responded that they would like to see the company continue to save 1 litre/household/day (l/hh/d) until 2040), as well as the need to address environmental pressures, we have assessed a range of demand management options.

Whilst the draft WRMP options appraisal assessed discrete water efficiency and metering options, there is a drive within Southern Water to acknowledge the synergies across the different areas of demand management which collectively contribute to customer-side reductions in consumption. On the back of this, we recently launched our 'Target 100' initiative, which aims to achieve a PCC of 100l/h/d by 2040 (for clarity, this relates to average household PCC under normal year annual average conditions – the options developed for the WRMP show the savings under dry year annual average or dry year critical period conditions). We feel that this is well-aligned with Defra's 25 Year Environment Plan (Defra, 2018) which states that "*We will work with the industry to set an ambitious personal consumption target and agree cost effective measures to meet it*". The Target 100 option developed for the revision of the WRMP supersedes many of the discrete demand management options that were included in the draft WRMP and comprises a basket of measures that we will need to adopt in order to deliver the highly ambitious reduction in PCC we are aiming for.

The ambitious decline in PCC targeted as part of Target 100 is presented in Figure 9 and Figure 10 for normal year annual average (NYAA) and dry year annual average (DYAA) respectively. The total consumption savings that this represents are displayed in Figure 11.

It can be seen that the PCC levels under the DYAA scenario are higher than those under the NYAA scenario. This is because demand is higher in a dry year than a normal year reflecting increases in external consumption (e.g. garden watering) as well as some increases in internal consumption (e.g. increased personal washing) and is explained in further detail in Annex 2: Demand Forecast; as such, more water would need to be saved from a dry year baseline demand to achieve 100l/h/d. Nevertheless, Target 100 still achieves low PCC levels in the DYAA at around 110l/h/d by 2040.

Figure 9 Average per capita consumption in the company of baseline demand forecast compared to the Target 100 option in a normal year

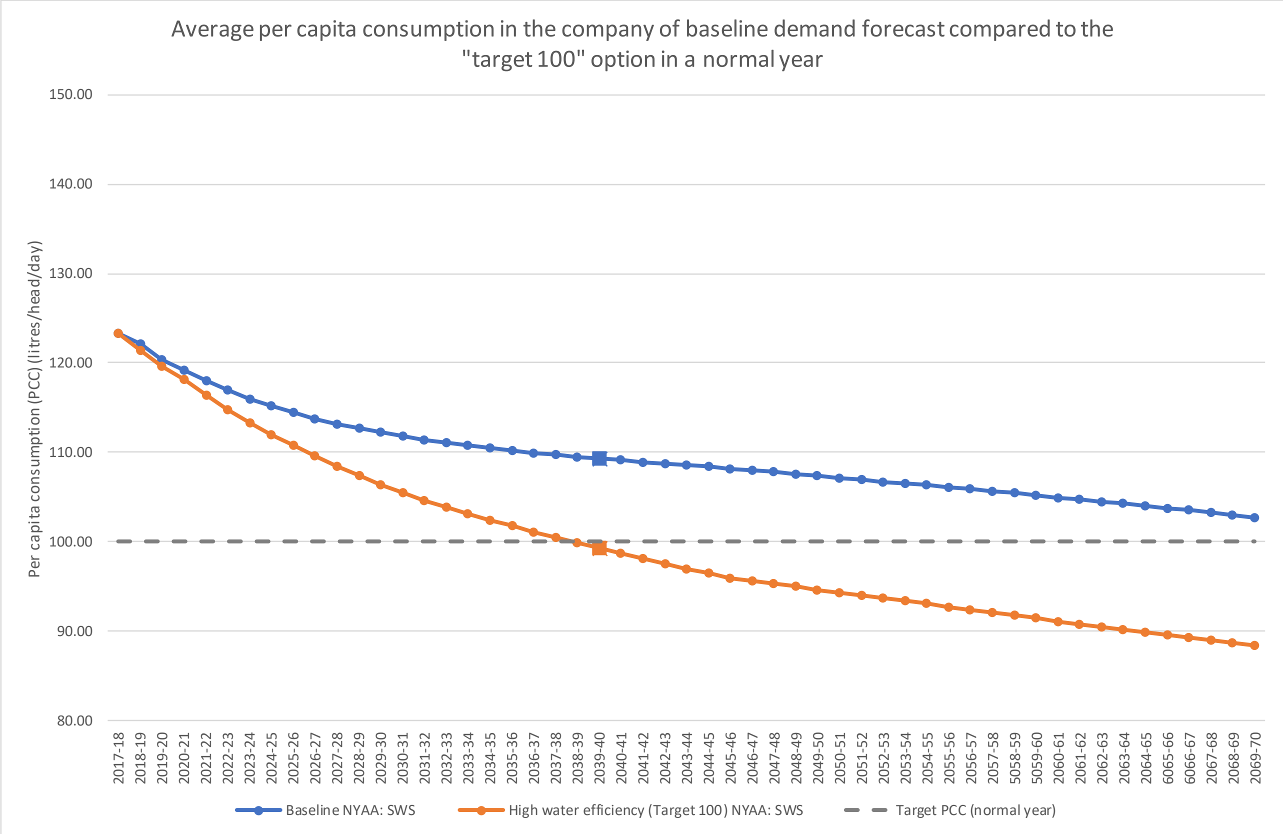


Figure 10 Average per capita consumption in the company of baseline demand forecast compared to the Target 100 option in a dry year

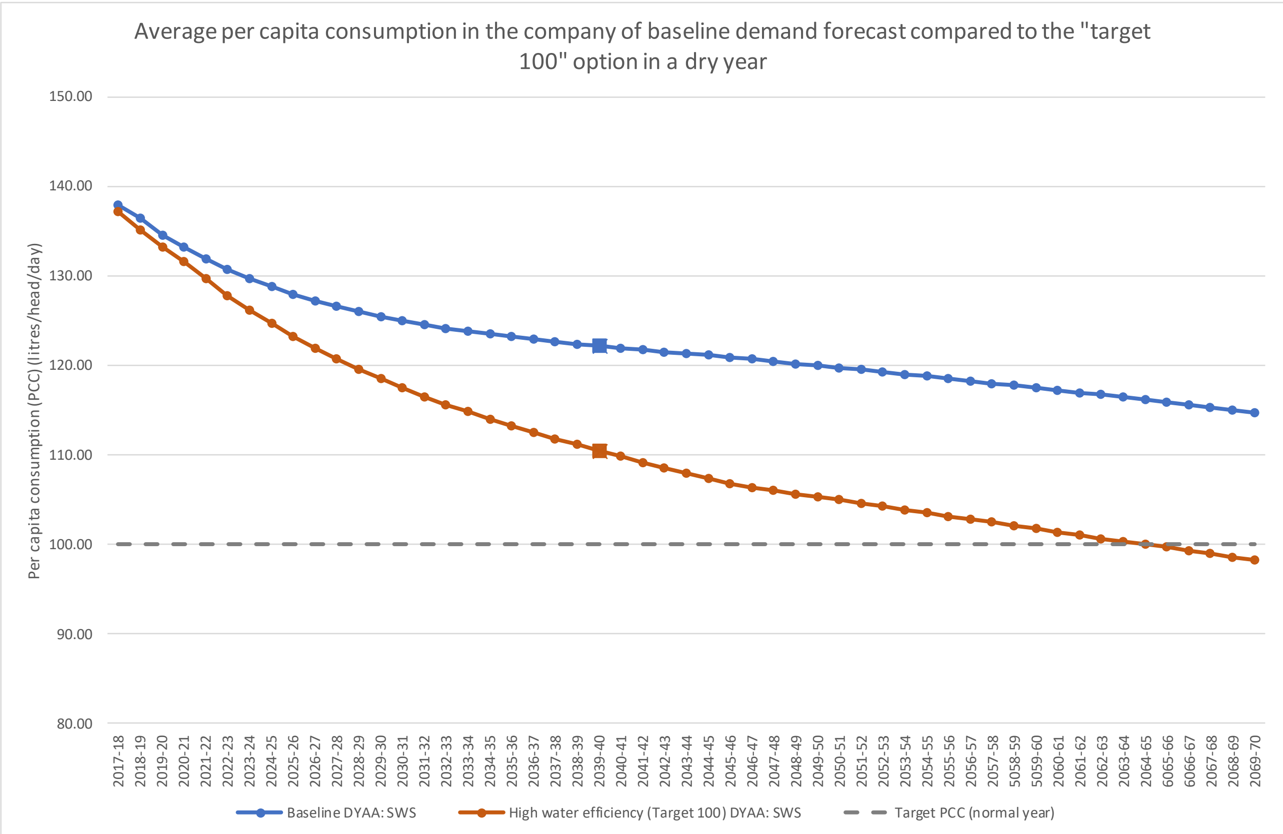
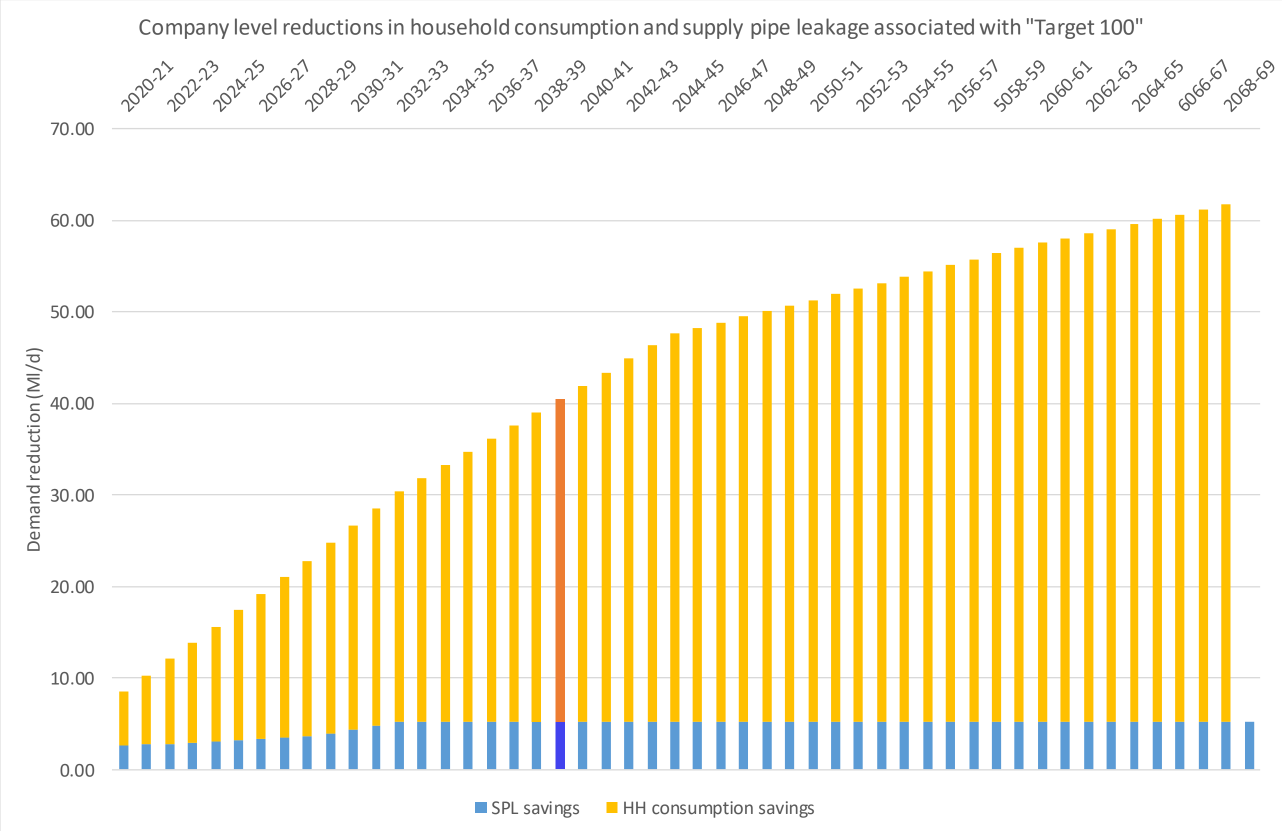


Figure 11 Total household consumption savings aimed for as part of Target 100 option



In order to reflect the costs of the Target 100 policy in the WRMP, it was included in the investment model as an 'option', but selected under all scenarios from 2020 onwards. Consideration was given to including Target 100 demand savings in our baseline demand forecast, but this was discounted because it would mean the costs of implementing the initiative would not be represented in the WRMP, and this is considered important for the transparency of the plan given the significance of the option in terms of its potential contribution to the supply-demand balance.

The overall reduction in PCC required to achieve 100l/h/d by 2040 in normal climatic conditions will rely upon a basket of measures that is expected to include, but not necessarily be limited to, the activities described below. These activities have been separated into those which are planned in the short-term (AMP7), the medium-term (AMP8) and the longer-term (AMP9 and beyond). We recognise and support the view expressed in a recent report for Ofwat (Artesia 2018) that water efficiency requires action from a wide range of society, not only the water companies. For example, significant input from government and product manufacturers is required to establish water labelling for water-consuming products to help consumers select suitably water efficient products, to devise product standards for new toilets, and to update planning rules to require new developments to be water efficient. Then there is a requirement for consumers to change their behaviour in response.

Short -term (AMP7) Target 100 measures

Focused water efficiency activity: We have designed our targeted AMP7 water efficiency activity based on key lessons learned from our recent AMP6 water saving programme, including:

- 'One size doesn't fit all' – we have received positive feedback from customers to our bespoke home visits service
- The link between water saving and affordability issues is very important – by working closely with social housing providers or local authorities we can combine the benefits of targeted

water efficiency measures and the assessment of affordability – something we are already doing in partnership with Brighton and Hove City Council

- Incentives can play an important role in changing customer behaviour, demonstrated by early results from a community incentive scheme we introduced whereby the proceeds of water savings are shared on a community scale, in this case around Cheriton to the east of Winchester
- Customers need to feel more connected with how much water they are using

The activities we propose to undertake during AMP7 include but are not limited to the following:

- We currently undertake *home visits to promote water efficiency*. The programme has a high uptake rate and can result in up to 10% further savings on top the savings achieved through metering. We plan to continue with this programme and combine it with leak detection so that while we offer help and advice on water efficiency, we can also help detect any plumbing losses or supply-pipe leaks
- Since the opening of the non-household market on 1 April 2017 we do not communicate directly with non-household customers, limiting our ability to offer direct water efficiency service to businesses and schools. However, we propose to continue our successful *schools programme*, which was delivered through a partnership approach whereby the school received a free visit and free products in return for helping to educate the children on the importance of water and how to use it wisely. We have suggested a key performance measure in the form of an ODI linked to the number of schools engaged in AMP7
- Our customers and stakeholders have shown little appetite for seasonal tariffs as way of managing demand. As an alternative, we are looking to *reward customers for conserving water*. Given the sustainability reductions that we have implemented in the Western area, the first scheme will be rolled out in Hampshire in partnership with Eastleigh Borough Council. The scheme will offer rewards to residents for recycling waste and reducing water consumption on a monthly basis. The scheme is planned to be introduced in the Central area towards the end of AMP7 and in the Eastern area during AMP8
- We are currently undertaking trials of devices that can read meters and send the reading to the customers using their Wi-Fi. The aim is to *provide customers with near real-time information on their consumption* so that they can see the consumption associated with various water-using activities and take measures to conserve water where they can. If the trial proves successful, we plan to roll out 100,000 devices over AMP7
- We are looking to develop tools and systems that allow us to identify any significant increase in consumption so that we can *proactively engage with our customers* at an early stage to determine if the increase is due to change in circumstances or is due to a leak. This will allow us to specifically target customers or geographical areas for water efficiency messages during periods of high demand
- We are planning to implement a system where every customer being assessed for inclusion on an *affordability scheme* will also be assessed for high consumption and immediately offered water efficiency support
- We are *working with developers* to build more water efficient homes, aiming to boost the long-term resilience of our homes, businesses and infrastructure in accordance with Defra's 25 Year Environment Plan (Defra, 2018). We have introduced a free connection charge for water efficient new properties and we have also agreed to work with key developments within our region to ensure that water efficiency is promoted. We are planning to fund any additional expenditure through the developer services part of our business

Increasing the meter reading frequency from six-monthly to monthly in all supply areas, linked to a programme of rewards or targeted support for customers based on that monthly reading. Each customer will be contacted with information on their usage and how it relates to recent activity on a regular basis. If water usage is high, the customer will be offered a package of support including information and a home visit. If low, the customer will be thanked and rewarded in a scheme similar to a supermarket loyalty card. The rewards will be varied and include personal rewards, for example free coffees and discounts off food shopping right through to gym memberships and other attractions to excite a whole range of customer interests. In addition, community rewards will be linked to the scheme including local good causes and charitable donations. We believe that this combination of a regular 'prompt and reward system' for the right behaviour will make the difference and take water saving to a new level of commitment across communities.

Increasing the frequency of meter readings to monthly would only be feasible if meters are read using drive-by rather than walk-by techniques; therefore, all remaining meters requiring visual-read (VMR) would need to be replaced with automated meter read (AMR) meters as a minimum, although we propose to replace them instead with intermediate smart technology, expected to cost no more per unit than our current stock of AMR meters. There are almost 357,000 VMR meters across our company area. Looking at the age profile of our VMR meters and taking account of their 15-year meter asset life, base expenditure is likely to address the replacement of most these meters during AMP7. However, accelerated replacement will be required during AMP7 for those remaining VMR meters that would not reach the end of their estimated asset life during AMP7: approximately 45,500 meters over the company area. The costs of replacing these meters have been derived from known unit costs from our current meter replacement programme, including meter acquisition, labour for installation (note that this will cost less than an initial installation at each property because the excavation has already been done), and an adjustment to the opex to account for the switch to drive-by rather than walk-by meter readings. The ongoing renewal costs of these meters have not been included because they will eventually be replaced under the roll-out of Next Generation Smart Meters described in the *Medium-term (AMP8) Target 100 measures* section below.

Meter reading costs underpinning this activity are based on a scaling up of existing meter reading costs to allow for a greater frequency of readings to be taken. This increased opex cost has been included from the start of AMP7, and are gradually superseded in AMP8 as smart metering is rolled out and drive-by meter reading is no longer required.

No allowance has been made in this option for an upgrade to our existing meter data management systems to cope with the greater volume of data, as it is assumed that the existing systems will cope with the additional volume of data. Future upgrades will form part of the medium-term smart metering and smart networks proposals described later in this section.

The demand savings achieved by this option relate to the earlier identification of supply pipe leaks (SPL). More regular visibility of consumption data should assist customers in taking greater control over their water use.

Base expenditure domestic metering measures: A central strand to household demand management is the level and type of metering. Metering provides a price signal to customers, which has traditionally proved to be a means of reducing water consumption. The 'easy-wins' of initial metering have now largely been achieved across Southern Water's supply area following the successful implementation of the UMP, where a 12–14% demand reduction has been observed (Southern Water, 2017). There is now, therefore, a need to consider how, in partnership with customers, we can achieve further demand reductions to respond to the water resource pressures identified in the baseline supply-demand balance. The following 'base expenditure' measures will be undertaken during AMP7, the demand savings from which will contribute to the Target 100, although the cost of the measures is not included in the WRMP as they are not considered 'enhancement' measures:

- Replacement of all failing AMR meters and VMR meters (estimated to be around 180,000 meters) with a smart alternative (intermediate smart technology, which is expected to cost no more per unit than an AMR meter)
- We propose to undertake 3 proof of concept smart metering trials during AMP7, to inform selection of the Next Generation Smart Meter (NGSM) stock to be rolled out in AMP8. The technologies to be trialled will be:
  - Narrow-Band/5G

- Sigfox
- LoRA

Rainwater harvesting and grey water recycling technology has the potential to replace the approximately 30% of household consumption that is used in toilet flushing. Despite these significant savings, having analysed the very high unit costs of installing rainwater harvesting at existing properties, it is not currently considered a viable option to roll out across our company area. Although, where feasible and cost beneficial, rainwater harvesting and grey water recycling may be considered on a site by site basis in the short-term. We are proposing to undertake new trials of rainwater harvesting technology at our Testwood Lakes education centre in partnership with the local Wildlife Trust. We also propose to look at both rainwater and greywater recycling options at our own sites to showcase the latest available technology. It is hoped that this will inform future proposals for the potential wider roll-out of this technology.

Medium-term (AMP8) Target 100 measures

We propose to continue the **targeted water efficiency activity** undertaken in AMP7, learning lessons from AMP7 activities in the same way we have learned lessons from AMP6 to inform our AMP7 strategy. The specific water efficiency activities included in the Target 100 basket of measures during AMP8 will therefore be developed through AMP7, taking into account up-to-date unit costs of technologies and potential target household numbers. A cost allowance similar to that included in AMP7 has currently been allowed for.

A company-wide smart metering roll-out will be undertaken in AMP8, using the technology selected following the AMP7 trials. Upgrading Southern Water's meter stock to smart meters and installing the associated infrastructure and systems to transmit and process the daily meter readings would allow both the company and customers to observe daily consumption data with a view to enabling customers (and enabling the company to help customers) to better control their water use. Research suggests that a behavioural demand reduction of 1% could result from this option (UKWIR, 2012b), alongside a reduction in SPL of around 4.8l/hh/d.

We propose to replace 780,000 meters during AMP8. The costs for this option have been built up from estimated per household unit cost rates for the smart meters themselves, plus an allowance for labour and programme management costs.

Significantly expanded and upgraded 'back office' systems (e.g. data management, analytics and billing) would be required for us to be able to analyse the vastly increased data volumes resulting from smart metering and to provide consumption information to customers in a format that is useful to them, e.g. with benchmarking, and analysis of consumption relative to their historic levels. These data management / analytical platforms / signals costs are accounted for in the AMP7 upgrade of our systems (notably the network management platform) and enable a number of other key performance improvements across our networks. The costs of these upgrades are therefore not included in the Target 100 costs in this WRMP.

Improved meter reading capability through smart metering would allow us to potentially bill customers differently: more accurately based on their consumption, and potentially more frequently.

As during AMP7, where feasible and cost beneficial, **rainwater harvesting and grey water recycling** may be considered on a site by site basis in the medium-term.

Longer-term (AMP9 and beyond) Target 100 measures

We will continue with our **targeted water efficiency programme** throughout the planning period to 2040 at the same rate of expenditure as forecast for AMP8. Thereafter, it is assumed that ongoing (i.e. beyond 2040) maintenance of the demand savings expected to be delivered by the targeted water efficiency elements of the Target 100 initiative may cost around a third of the costs of the intensive scheme.

Later in the planning period (e.g. from AMP9 onwards), **rainwater harvesting and grey water recycling** may form a larger part of the basket of measures comprising Target 100. The need for large scale roll-out of these technologies (which are expected to become cheaper over time) will be reviewed once there is greater certainty around the savings that will be achieved through the metering and water efficiency options proposed to be undertaken in the short to medium term. They may therefore form part of the basket of measures and initiatives that are needed in order to drive PCC down to 100l/h/d.

As mentioned above, the roll-out across our company area of the selected smart metering technology will allow us to provide customers with the information required to proactively monitor and reduce their consumption. We expect to **complete our smart meter roll-out over the early years of AMP9**, reaching a total of 1.1m smart meters across our company area by 2032. Thereafter, we will monitor and review the technologies available to ensure that our customers are being provided with beneficial information in a reliable way.

A key benefit of enhanced metering, particularly smart metering, is the flexibility it could offer to both Southern Water and our customers in managing future demand. Gaining an increased understanding of demand, as enabled by enhanced metering, would form a stronger basis on which to engage with customers, and potentially consider the benefits of different charging mechanisms that could allow customers to save money and water, particularly during times of water stress. It is possible that **tariffs** may be feasible, and indeed required, in future to achieve Target 100. Work in AMP7 will focus on incentives, but it may be that once customers feel better able to control their consumption following the early stages of the Target 100 initiative, their views of tariffs may change.

Supply pipe leakage savings associated with Target 100

It is widely recognised that improvements to metering technology can bring about demand savings resulting from improved identification of customer-side leakage: more frequent reading of meter data allows faster identification of leak alarms that are triggered by continuous flow through the meter (often signifying a leak) therefore reducing leak run times. The leak may be on the customer's supply pipe or in the customer's property, e.g. a leaking toilet. The demand savings are reliant upon the customer taking action to fix the leak, which metered customers have the incentive to do. Our policy for 2018 was that we will fix one identified SPL per property throughout the year free of charge to customers, to assist customers in saving water.

An SPL option has been developed for each relevant demand management option included in the WRMP, i.e. Target 100, and the two options that extend compulsory metering across parts of our company area (see *Reducing demand: Extension of our compulsory metering programme* section below). This SPL option is dependent on the associated 'metering' option, and will automatically be selected by the investment model when the 'metering' option is selected.

The cost of undertaking the meter readings through which leak alarms are identified and the costs of analysing the data are incorporated in the dependent metering option. Our leak repair policy will determine the number of leak repairs that we will need to pay for as opposed to those that will need to be paid for by customers. We have assumed for the WRMP that our leak repair policy will remain as it currently is, with costs assumed entirely incurred by Southern Water (very few properties are assumed to have a second supply pipe leak identified in any one year). The number of bursts per day per property has been estimated for the baseline and each metering scenario. From this, the per property cost of supply pipe repairs has been estimated, and is subsequently factored up to the number of properties benefiting from the option.

The SPL reductions associated with each option that incorporates metering has been incorporated in the investment modelling as a dependent option that is selected when the associated 'metering' option is implemented. It should be noted that the SPL savings associated with metering improvements do not count towards PCC targets, but would provide additional leakage reduction benefits over and above what has already been assumed as part of the leakage reduction policy.

The SPL savings and assumptions associated with the Target 100 initiative are set out below:

- During AMP7, the SPL savings from increasing meter readings to monthly from six-monthly have been estimated as 4.0l/hh/d. This has been estimated from modelling the impact of the reduced leak run times that are believed to result from monthly instead of twice-yearly meter readings. This saving has been applied to all properties that were already metered at the start of AMP7, and is applied during AMP7 only. The base expenditure reactive replacement of meters with intermediate smart meter technology that is expected to be implemented during AMP7 is not considered to result in any significant SPL savings over and above the estimated 4.0l/hh/d because it is not envisaged that the data management and customer engagement systems that will truly help drive these additional savings will be fully in place until late in AMP7
- During AMP7, the SPL savings associated with the increases in meter penetration are taken into account. When properties were metered under the UMP, a 57% reduction in SPL was observed. This percentage reduction has been applied to the current baseline unmeasured SPL value of 11.5l/hh/d, giving a reduction in SPL of 5l/hh/d, applied to the number of properties metered and with the assumption that the saving is sustained over the entire planning period
- From AMP8 onwards, the SPL savings from meter data provision associated with smart meters are estimated to increase from the AMP7 values of 4.0l/hh/d to 4.8l/hh/d. This has been estimated from modelling the impact of the reduced leak run times that are believed will result from daily instead of twice-yearly meter readings. From AMP8 this saving has been applied to all properties whose existing meters are replaced with smart meters, with the savings sustained over the rest of the planning period

Risks and uncertainties associated with Target 100

There is considerable uncertainty over a number of factors influencing the long-term effectiveness of water efficiency and metering measures, including the long-term savings associated with many water efficiency devices, how customers use and maintain the devices, and how customer behaviour may change in future. As a result, Target 100 cannot be considered a fully resilient option because the potential saving cannot be guaranteed at all times of the year under all types of dry year conditions, and the options in themselves cannot guarantee that supplies will be available during drought events.

However, demand management schemes in general are likely to enhance the resilience of supply side options, because they act to generally reduce demand, which will be beneficial in the run up to a potential or actual drought event.

As discussed earlier, the success of customer reduction also relies on and requires action from a wider section of the society, not only the water companies, particularly including government and regulatory actions. If there is little action from government and product manufacturers to establish water labelling for water-consuming products to help consumers select suitably water efficient products, to devise product standards for new toilets, and to update planning rules to require new developments to be water efficient, etc. then there is a greater risk that the demand savings will not be achieved or sustained.

A key influence on the long-term success and financing of metering as part of our Target 100 initiative is the issue of the potential introduction of competition into the household water market. Should the UK water industry undergo a household market split into wholesale and retail operations, as occurred for the non-household market in 2017, the role of wholesalers like Southern Water in determining metering strategies and their ability to influence customer demand will become highly uncertain. Ofwat recognises there is a risk that "*retailers adopt a short-term mind-set which sits at odds with the long-term approach needed to manage the environment and water network*" (Ofwat, 2017b), and goes on to state that "*Wholesalers and retailers need the right incentives to work together to maintain resilience and plan over the long-term, so customers of the future have the water services they need at a fair price.*" However, the structure and effectiveness of these incentives in managing demand, plus the uncertainty over the timing of any household market split means if metering options form part of the company's strategy, there will be significant uncertainty surrounding the long-term costs and benefits of the metering options as developed in this plan. Furthermore, the nature of any potential investment in metering infrastructure by Southern Water and its customers under the current regulatory regime should be considered with reference to its adaptability to future uncertainties.

Target 100

Basket of measures that aim to achieve a PCC of 100l/h/d by 2040, comprising:

Enhanced water efficiency activities

Operational enhancements to meter reading regimes, moving from 6-monthly to monthly meter readings in the short-term

Smart metering of existing metered households in the medium-term

Pros	Raises awareness of consumption, and therefore water saving and reduces demand for water
Cons	Expensive for the amount of water saved and does not secure supplies during droughts

Reducing demand: Extension of our universal metering programme

Our baseline position at WRMP19

Prior to implementing our UMP in AMP5, we undertook a cost effectiveness analysis which demonstrated that universal metering was the most cost-effective way of significantly increasing meter penetration and achieving the demand reductions required to meet our supply-demand balance deficit. The analysis that formed the basis for the justification for our UMP in our WRMP09 is presented in Table 6. The analysis showed that optant metering and change-of-occupier metering did not have the potential to reach the high levels of household meter penetration that could be achieved through universal metering during the WRMP09 25-year planning period, because they take longer to implement. Furthermore, optant and change of occupier metering were, as can be seen from Table 6, less cost effective than universal metering when both costs and benefits were taken into account.

Table 6 Relative costs and benefits of different types of metering (from WRMP09, 2007/08 prices)

Scenario	Difference in present value relative to optant-only baseline (£m)	Increase in total annual average demand saving (from the baseline) over WRMP09 25-year planning period (Ml/d)
Baseline - optant only (including selective metering of high water-using properties) reaching 87% overall household meter penetration	n/a (baseline)	n/a (baseline)
Change-of-occupier metering reaching 93% overall household meter penetration	£25.3	120.9
Universal metering reaching 100% overall household meter penetration	-£3.7	400.8
Universal metering reaching 93% overall household meter penetration	-£37.9	322.4

Reasons for the greater cost effectiveness of universal metering included the following:

- Efficiencies could be gained from the geographically targeted (i.e. street-by-street) installation programme. It was considered unlikely for any geographical pattern to be present in optant meter requests or change-of-occupier metering, meaning the travel time between properties would likely be greater, adding to labour and vehicle costs
- The timing of when the meters would need to be purchased and installed would be known in advance with a universal metering programme, enabling economies of scale in the purchasing of the assets, and greater cost certainty
- Optant and change-of-occupier metering would take longer than compulsory metering to achieve a certain level of meter penetration, as they rely on customers either opting for a meter or moving house, respectively. The benefits are therefore not gained as quickly
- Change-of-occupier metering is the most expensive because it requires proactive customer contact initiated by the company which adds another cost element, as opposed to optants whereby the customer contacts the company in the first instance

Our UMP has resulted in sustained demand reductions of approximately 13% (including SPL savings). The scale of the metering programme that we have already implemented means that there is a relatively small residual number of unmeasured properties (approximately 140,000, 12% of our domestic customer base) across our three supply areas.

Options to increase household metering in our WRMP19

Subject to technical feasibility in each case, metering the remaining unmetered households may be possible, although investigations as part of the UMP have indicated that the costs are likely to be significant and potential demand saving benefits uncertain and/or limited. Whilst we recognise the importance of complying with our statutory duties as a water undertaker, including compliance with the WRMP Directions, we consider that our already high level of household meter penetration reduces the practicality of relying on certain types of metering (e.g. optant or change-of-occupier) to achieve further meaningful increases in meter penetration above our already high levels, in a timely manner.

However, our view remains that the relative cost effectiveness of the different metering types that we assessed as part of our WRMP09 remains valid for this WRMP. In fact, we consider that the following points, which are relevant to our baseline situation for this WRMP, further strengthen the case for universal metering being more cost effective than other types of metering:

- In terms of water saving benefits, when starting out on a metering programme from initially low levels of meter penetration (as was the case when doing the calculations for our WRMP09), it is likely that optants would have shown greater water savings than those who were metered compulsorily, because they chose to opt for a meter - either because they expected to be able to save money, or they were driven by environmental considerations. Therefore, while the costs may have been higher than universal metering, so might the benefits - although the aggregate result overall (once both costs and benefits were taken into account) still showed universal metering to be more cost effective. However, as we are starting from a much higher baseline level of meter penetration for this WRMP (88%), it is likely that most of those potential optant customers from WRMP09 who had the potential to save the most water will have already been metered. Therefore, the future potential demand savings from optant metering are likely to be lower overall than they were at WRMP09. This means the relative cost-benefit ratio is likely to be lower for optants than that shown in Table 6 above, increasing the relative benefit of universal metering
- Optant metering relies on uptake, i.e. customers proactively opting for a meter. Given the extensive publicity that surrounded our UMP while it was being implemented, and the fact we targeted 93% of our customer base, it is expected that most customers who would otherwise have opted for a meter will have already had a meter installed, where it was technically feasible to do so. Therefore, the uptake of optants is likely to be lower than it was in 2009, further reducing the relative cost-benefit ratio of optant metering
- The time taken to achieve higher levels of meter penetration and their associated demand reduction benefits becomes an issue as the baseline unmetered population decreases. Even if the same proportion of unmetered customers opt for a meter or move house in any one year as was assumed in our WRMP09 cost effectiveness analysis (which, as discussed above is unlikely), it would take a much longer period of time for the demand reduction benefits to be achieved from optant and change-of-occupier metering when compared to universal metering. It is also far more uncertain because people opting for a meter and moving house are both outside the control of the company

In conclusion, this analysis demonstrates that universal metering remains the most cost-effective way that we can meter our remaining unmeasured customers in a timely manner, achieving the associated demand reductions as soon as possible in the planning period. As such, we have progressed the following options in this WRMP:

- MAMR1: Installing AMR meters to take household meter penetration from current levels up to a minimum of 92% in each WRZ by the end of AMP7
- MAMR2: Extending this programme to install AMR meters for all remaining unmeasured households, also by the end of AMP7

We have assumed that this would be a universal metering programme, implemented over one AMP. However, we have made an assumption that extending our universal metering campaign will generate some optant requests, as it did during the UMP, which we will deliver and which will be counted towards the overall meter penetration goal of 92% (option MAMR1) or 100% (option MAMR2).

Through our investment modelling process, detailed in Annex 8, we assess the cost effectiveness of these options against other options, as part of the development of our preferred plan. Annexes 9-11 set out how these options have been taken forward as part of the strategy for each of our supply areas.

Evidence from the UMP suggests that a demand saving of around 12–14% could be achieved when customers are provided with an AMR meter, and also include around a 57% reduction in SPL, achieved (as described earlier) by more frequent reading of meter data allowing faster identification of leak alarms that are triggered by continuous flow through the meter (often signifying a leak) therefore reducing leak run times. However, of the remaining unmeasured properties in our supply area, a higher portion of shared supplies is expected than under the UMP (one of the reasons why they were not metered under the UMP), many of which will be purpose-built blocks of flats. From the UMP analysis (Southern Water, 2017), customers in such groupings are expected to show lower demand savings.

The capex costs for these options that look at extending our compulsory metering programme have been built up from unit costs of both meter acquisition and labour required for installation (including estimated civils costs of excavation), based on our experience of the costs incurred during our UMP plus an estimate of the increased costs of installing meters at properties that have not previously been considered economic to meter for a range of reasons, e.g. difficult access. An allowance has also been made per property of the opex costs of drive-by meter readings.

These options are available for selection by the investment model in 2020, with completion by the end of AMP7. For the purposes of this plan, we have assumed that if a metering option is selected by the investment model in a particular WRZ, then the same metering option should be simultaneously selected in the other WRZs in that area. This is in order that customers within each of the three supply areas are subjected to the same demand management arrangements. The renewal costs of these meters have not been included because they will eventually be replaced under the roll-out of Next Generation Smart Meters described above.

Metering remaining unmeasured customers

Extension of the Universal Metering Programme to cover the remaining households that could not be economically metered during 2010–15

Pros	Reduced demand and all household customers paying a metered tariff
Cons	Proportionately very expensive to install meters in remaining unmeasured households for a relatively small reduction in demand

Reducing demand: Leakage reduction

Since the water industry was privatised in 1989, we have reduced leakage to such an extent that the amount of water abstracted each day has reduced, despite an increase in population being supplied by Southern Water.

In 2017-18, Southern Water's total leakage was 88.1Ml/d, which was slightly above our target for the year (87.6Ml/d). However, our total leakage in the previous two years was much lower than target: 81.7Ml/d in 2014-15 against a target of 88.0Ml/d, and 83.9Ml/d in 2015-16 against a target of 88.0Ml/d. The WRPG (Environment Agency and Natural Resources Wales, 2017) recommends using the average of the last three years' actual leakage as base-year leakage. Accordingly, the company's base-year leakage is 84.6Ml/d. For the baseline supply-demand balance forecast, we have kept leakage constant over the planning period at our 2019-20 target of 86.2Ml/d.

To maintain our baseline level of leakage, our team of leakbusters works around the clock to find and repair leaks on the company's 13,753km of water mains, delivering one of the lowest levels of leakage per property of all water and wastewater companies. Over 20,000 leaks have been repaired during each of the last six years.

The set of leakage reduction options developed for this plan incorporates the following, which all have the potential to reduce leakage below the baseline levels reported above:

- Improved active leakage control (ALC), which includes achieving efficiencies through new technologies and practices
- A mains renewals programme
- Additional future savings from emerging technologies to account for technologies not yet on the market (available from 2035 onwards)

Note that SPL savings from the Target 100 and any other enhanced metering options that may be selected by the investment model have not been counted towards achieving our leakage target, but they nonetheless provide additional benefits.

In its latest update to the leakage methodology for this plan (Environment Agency, 2017), the EA refers to Ofwat's PR19 guidance that requires companies to deliver ambitious leakage reductions, achieving the following minimum reductions in 2020-25 or justify why not:

- At least a 15% reduction in leakage from baseline levels
- Largest actual percentage reduction achieved by a company since PR14

This means that the level of leakage reduction we are committing to is higher than the sustainable economic level of leakage (SELL) and does not form part of the least-cost outputs from the investment model.

In this WRMP, our commitment to leakage reduction is demonstrated by our policy to achieve a 50% reduction from our end of AMP6 target by 2050 in addition to committing to the 15% reduction in AMP7. As part of our strategy to meet these ambitious targets in the long term we have allowed for future opportunities from technological innovations. These are represented by the 'additional' leakage reduction activities in our plan and are available from 2035 onwards. In the short-term we also recognise there may be market limitations to reducing leakage (e.g. a limited number of qualified personnel) particularly if all water companies in the area undertake significant leakage reduction activity.

In response to an initiative by UK water companies, Water UK has developed a methodology for calculating leakage to ensure that it is reported in a consistent manner across the industry. We have calculated, using the new method, the expected impact on our leakage total to increase our end of AMP leakage target from 86.2Ml/d to 105.4Ml/d. We have also based our leakage reduction percentages on the higher new methodology leakage value, equating to a higher percentage of leakage reductions required against our current leakage levels.

Appendix C provides a detailed overview of our leakage reduction strategy including the activities we are proposing to meet our targets up to 2050.

Finally, whilst leakage reduction can generally contribute to reduced demand and hence reduced need for abstractions, the level of leakage is a function of climatic conditions. If there is, for example, a very cold winter, then leakage will increase due to increased pipe bursts. As a result, it is not possible for companies to guarantee the level of leakage that they can achieve in any given year. Ofwat recognises this when it sets leakage targets for companies, requiring them to meet the target as an average over a three-year period.

Improved active leakage control

Increased efficiency in the repair of water mains and connection pipes which leak water. Including the use of new technologies and changes in practice

Pros	Reduces need to abstract water
Cons	Can be relatively expensive and does not help secure supplies during droughts

Mains renewals

Replacement of non-polyethylene (non-PE) pipes

Pros	Reduces need to abstract water
Cons	Very expensive for relatively small savings in leakage (although cost benefit is improved if other drivers are taken into account)

Drought options: Demand and supply interventions

The WRPG (Environment Agency and Natural Resources Wales, 2017) requires water companies to align their WRMPs and Drought Plans as closely as possible. For the options appraisal, this means incorporating Drought Plan interventions as feasible options in the investment model, such that they are made available to contribute to reducing a supply-demand deficit in appropriate design drought events. However, it should be noted that in reality, drought interventions are temporary measures that Southern Water may be able to implement during a drought event, but they would not be available as a permanent measure to reduce a supply-demand deficit. That said, it is likely that in order to balance supply and demand during the most severe drought events, it is more appropriate and cost effective to rely upon short-term drought interventions than develop alternative supply-side or demand management options, as they may not be needed for a long period of time.

Following the changes that have been agreed with the EA to our abstraction licences on the rivers Test and Itchen in our Western area, we will have to rely on Drought Order and Drought Permit applications to meet a deficit until approximately 2027. We would have to do so more frequently than in the most severe droughts.

Drought demand interventions in this plan include the following types of scheme:

- Temporary bans on water use
- Drought Orders to restrict the non-essential use of water
- Emergency Drought Orders

Drought supply interventions in this plan include the following types of scheme:

- Maximising river abstractions
- Maximising pumping from groundwater sources
- Intra-company transfers
- Enhancing abstraction at existing sources
- Inter-company transfers
- Re-commissioning unused sources
- Drought Orders and Permits, which can include:

- Licence variations
- Supporting river flows using groundwater

- Emergency tankering
- Emergency desalination

Each drought intervention is assigned a DO in the investment model, and is made available under the relevant drought scenario (e.g. drought, severe drought, and extreme drought) and the relevant time of year, i.e. minimum DO (MDO)/average DO (ADO) and Critical Period (CP).

Drought options

Temporary demand and supply interventions that can help reduce the supply demand deficit during drought events

Pros	Options will restrict demand or provide additional water during drought events
Cons	Reliability of demand savings is low and assurance that water will be available for abstraction during drought events is uncertain

New water: Desalination

Desalination options seek to make use of saline groundwater or coastal and tidal river waters which cannot be exploited by traditional treatment techniques. This is an approach that is widely practised in arid countries. It has become less expensive in recent years as the cost of the technologies has reduced. The potential sources of saline water are:

- Coastal waters
- Tidal rivers
- Offshore waters
- Deep groundwater
- Coastal aquifers

The first two sources, coastal waters and tidal rivers, are the two most commonly utilised, and are probably the easiest to design and manage from an operational viewpoint. A number of environmental factors were taken into account when considering desalination:

- Construction and the subsequent abstraction and brine discharge may have adverse environmental impacts on coastal and marine habitats and wildlife
- Treatment works may have significant visual impacts, especially in residential, tourist and designated areas along the coastline. These impacts can be mitigated to some extent; however, the mitigation measures clearly attract additional costs
- Significant supporting infrastructure (roads, power, pipelines) is required, which may have social and environmental impacts
- Tidal rivers in the South and South East of England are considered a valuable habitat and many of those within or near the company's supply area are subject to one or more environmental designation
- Groundwater aquifers, given that they are likely to be non-renewable (i.e. fossil aquifers), when subject to abstraction may deplete adjacent aquifers
- Extraction from coastal aquifers may result in saline intrusion into fresh groundwater sources.
- The potential requirements in terms of energy are high, although these can be reduced if the plant is only used intermittently, and modern design includes the facility for much enhanced energy recycling and the use of green energy sources

Owing to the environmental designations that apply to large stretches of the southern coastline within the Southern Water area of supply, potential locations for desalination were considered in existing industrial areas where there was the possibility of combined abstraction or wastewater discharge, to minimise the environmental impact.

The exact location of desalination plants was selected within existing or potential industrial developments where the visual and environmental impacts could be minimised. Consultation on our draft WRMP resulted in removal of two of our proposed desalination options, as there are sites available whose discharges of brine would result in less environmental impact. One site was moved on to land partially owned by Southern Water owing to the unavailability of the original site.

Wherever possible, modular/phased construction of desalination plants were considered, to provide as flexible a solution as possible to potentially be better able to respond to future changes in the supply-demand balance.

New water: Groundwater abstractions
A range of potential new groundwater abstractions have been considered, including:

- Reinstating former groundwater sources for which licences remain and providing additional treatment
- Aggregating existing licences
- Recommissioning existing or old licences
- Augmenting surface water flows with new groundwater sources

These options may involve drilling of new boreholes and construction of new treatment works and associated pipework to get the water into distribution.

New water: Surface water abstractions
A range of potential surface water abstraction options have been considered, including new abstraction locations, amending the volumes taken at existing abstractions, and the relocation of existing abstractions.

The resilience of these options is limited, as abstraction licences may contain conditions that restrict abstractions during periods of low flow, so that sufficient residual flows remain in the river for environmental purposes. The effect of a drought in reducing river flow is therefore absorbed entirely by the water abstraction in order to protect the environmental flow requirements. Flows are also affected by licensed abstractions upstream (for instance for agricultural use).

Desalination

Saline water is abstracted and turned into drinking water

Pros	Reliable water supply in drought, can be switched on and off
Cons	High energy use, costs and carbon footprint. Brine by-product to dispose of

Groundwater abstraction

New groundwater abstraction, licence aggregation, recommissioning old licences or augmenting surface flows with new groundwater boreholes

Pros	Could provide reasonable volume of water
Cons	Likely to be governed by licence conditions limiting abstraction to certain times. May conflict with WFD status

Surface water abstraction

New surface water abstraction, additional volume from an existing abstraction or relocation of existing abstraction

Pros	Could provide reasonable volume of water
Cons	Can only abstract when river levels exceed the minimum residual flow, so not considered to provide much system resilience without associated storage. May conflict with WFD status

Storing water: Aquifer Storage and Recovery

The principle of Aquifer Storage and Recovery (ASR) is that either potable water, or raw water that could be used for potable purposes, is injected into a confined aquifer to create a 'bubble' of fresh water than can be re-abstracted when required, generally in summer or autumn.

Detailed investigations of potential ASR options have been carried out in previous AMPs as part of a programme of wider water resources investigations. However, very few applicable sites were identified in the Southern Water region as there are constraints in terms of the appropriate confined aquifers, sources for providing the potable or raw water to be stored, and proximity to existing water supply infrastructure and abstraction boreholes.

The environmental applicability of ASR essentially relates to the impacts such a scheme could have on unconfined parts of aquifers that either affect surface water bodies or sources that are currently used for potable water.

We are currently investigating a potential ASR scheme in Sussex Worthing WRZ to pump water from the River Arun during winter for storage in the Lower Greensand aquifer and subsequent use in droughts. This scheme would pump water from the river when flows are high and store it underground in a confined aquifer ready to be pumped back to the surface and put into supply when needed.

Storing water: Reservoirs

Reviews of potential options covered impounding reservoirs, pumped bankside storage, enlargement of existing water storage facilities and use of quarries or sandpits for new sources, in addition to enlarging existing reservoirs.

Reservoirs can provide flexibility to meet peak demands, as water can be abstracted for short periods at high rates without significant environmental impact.

Storage reservoirs rely on rain in the winter to guarantee supplies for the following year. They provide some degree of resilience, although after one or two dry winters they can become depleted. However, abstraction from reservoirs may be maximised during the winter to rest groundwater sources and maximise the benefits of recharge.

Storage reservoirs have some significant risks and uncertainties associated with them, not least the potential time associated with planning applications and the long lead-in time to build the schemes. There are also potentially significant environmental impacts, although once a reservoir is built, it generally provides other amenity and recreational benefits.

Aquifer Storage and Recovery (ASR)

Pumping water from rivers or groundwater in winter to store in underground aquifers

Pros	Improves storage to provide extra water in summer and droughts, and makes use of the natural environment
Cons	There are few suitable locations in the south east

Storage reservoirs

Building a new storage reservoir or enlarging an existing one

Pros	Improves storage for extra water in summer and provides longer term artificially created habitat
Cons	Lengthy planning and long lead-in times, and impacts on the environment

Water reuse: Indirect potable water reuse

The indirect reuse of wastewater effluent discharges currently discharged to estuaries or the sea for potable uses to reduce pressure on existing water abstractions and further resource development options can comprise:

- Recharge of groundwater aquifers
- Supplementing river flows and surface water storage

The focus of the options development has been on indirect reuse to augment river flows and surface water storage. Direct potable reuse is generally unacceptable due to the higher levels of risk and the recharge of groundwater using wastewater is not permitted under European legislation. No direct potable reuse options have therefore progressed to the constrained list of options.

There are many considerations with indirect water reuse if it is to be widely adopted in the future. These relate to the environmental impact of wastewater discharge, public health, public perception and cost. In addressing these issues, schemes have been developed taking on board current UK legislation in respect of the environment and human health; and have utilised as supporting information additional published guidance from the USA (primarily California State) and Australia where water reuse is more widely adopted to support potable water abstractions.

The advantages of water reuse schemes are that they tend to be resilient to climate change and different drought events, and offer flexibility in implementation and operation. Wherever possible, modular/phased construction of water reuse schemes was considered, to provide as flexible a solution as possible to potentially be better able to respond to future changes in the supply-demand balance. However, there could be concerns regarding the energy needs of such schemes, as there would likely be significant pumping and treatment requirements.

Water reuse: Industrial water reuse
A variant of water reuse is to supply industry directly with treated wastewater for non-potable uses. This can be a relatively costly option, so would only be advocated as an approach where it was assessed to be economically viable. Schemes that are considered so have been included in the feasible list of options.

Water reuse: Greywater reuse
Greywater reuse could comprise rainwater capture or dual supply schemes to allow households to reuse grey water for non-consumption uses (e.g. garden watering, toilet flushing) alongside their standard potable supply. We have considered options for grey water reuse as part of our unconstrained list of options. During the screening process, it was concluded that the options were not suitable for inclusion in this plan because the company is not responsible for installing supplies in new properties. However, there may be scope for Southern Water to support changes in legislation in this area or developers in implementing grey water reuse on suitable sites because it would reduce reliance on potable water.

Indirect potable water reuse

Reusing wastewater to a river for downstream abstraction for drinking water

Pros	Reliable supply of water, even in drought, and extra water in the environment
Cons	May require relatively expensive treatment processes

Water for industry

Treating wastewater to a higher standard and using for industry

Pros	Avoids using drinking water for industrial processes (which is the standard practice at present)
Cons	Can be relatively expensive

Managing the water environment: Catchment management
Catchment management schemes have the potential to provide significant benefits to the environment, in terms of biodiversity and water quality, at relatively low cost, whilst potentially reducing treatment costs and increasing water available for abstraction. Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and by delivering permanent environmental improvements in our rivers.

There are two main categories of relevance to water resources and there is some overlap between the two:

- *Water quality* – Water companies are delivering actions for Drinking Water Protection Areas (DrWPAs) under the WFD. By controlling upwards trends or short term peaks in pollutants catchment management can help meet drinking water obligations and avoid risks to DO and/or the need to invest in alternative supplies in the future
- *Water quantity* – Water companies are required under the Water Industry National Environment Programme (WINEP) to investigate and implement schemes to address

abstraction impacts. Ecological impacts are often uncertain and catchment or in-channel measures may complement flow recovery where it is not cost-beneficial to fully restore flows

Focusing on DrWPAs and water quality first, during AMP6 we have been investigating catchment management solutions with the EA and under our commitments to the Drinking Water Inspectorate (DWI). These investigations have focused on the impacts of diffuse sources of pollution on drinking water supplies, primarily in relation to nitrates in groundwater sources and pesticide pressures at surface water sources. Where these investigations have shown that diffuse pollution poses a risk to drinking water supplies, then catchment management action plans have been developed and agreed with the regulators.

Although catchment management provides a cost-effective and sustainable contribution to reducing pollution, experience across Europe and elsewhere has shown that it takes time to deliver water quality improvements. The Blueprint for Water, a coalition of environmental organisations, emphasised in their report Blueprint for PR14 (Blueprint, 2012): "*Catchment management is long-term, taking many years before the full range of benefits are realised. Patience and continuing monitoring efforts are needed.*" Where pressures are more immediate, catchment management therefore needs to be combined with measures to blend water with other sources and/or with treatment options. In these situations, catchment management still provides a cost-effective benefit by reducing pollution at source and thereby reducing operational costs for blending and treatment.

Nitrate pressures affect the largest number of individual sources and, for these, two levels of catchment management actions are included. For sources with a lower level of nitrate pressure, we will engage catchment officers to give advice on nutrient management and support farmers to maximise benefits from existing government schemes. For sources where there is greater need, or potential, for nitrate reduction, we will provide capped financial incentives for farmers to implement nutrient management measures that go beyond existing government requirements. This is in line with the 'payment for ecosystem services' approach that is promoted by Defra and has been adopted across the water industry.

For pesticides, the most widespread issue faced by the water industry comes from metaldehyde. Through industry working groups and co-operation, a range of catchment management measures have been developed including advice and incentives. For pesticides, incentives are targeted at changes in agricultural practice or where appropriate, changes in cropping or the substitution of metaldehyde with more environmentally benign control measures. In addition, 'smart abstraction' (in which abstraction avoids periods of high pesticide risk) may be applicable where reservoir storage is available to maintain supply. As pesticide concentrations can be very variable, frequent monitoring is required as part of catchment management solutions.

In addition to improve the environmental resilience of catchments, we are proposing 'Instream Catchment Resilience Schemes' as part of our Catchment First initiative, which will include potential schemes being delivered on the rivers Test, Itchen, Medina and Eastern Yar in Western area as well as catchments where we abstract in Central and Eastern areas. In AMP7 the River Test is proposed to be a pilot catchment where we will undertake monitoring and investigations to identify opportunities to implement instream solutions (this is a separate initiative to the monitoring, mitigation and compensation measures agreed for the Test, Itchen and Candover under the s20 agreement). We will need to work closely with the EA and other stakeholders during all stages of these schemes if they are to be successful. Catchment First also encompasses the catchment schemes we are delivering to improve the raw water quality of water sources, impacted particularly by nitrates and pesticides.

These schemes provide a means of improving ecological resilience under low flow conditions where options appraisal had indicated that it was not cost-beneficial to fully restore flows. For the purposes of this plan, an indicative quantitative DO benefit has been assigned on the basis of potential mitigation of unconfirmed sustainability reductions at sources in the vicinity of the rivers.

The large-scale river restoration project for the River Test included in scenarios in the draft WRMP has been removed, as have the original mitigation measures linked to the rivers Test and Itchen Drought Permit and Order options. They have been replaced by the package of monitoring, mitigation and compensation measures agreed under the Section 20 Operating Agreement for the Test, Itchen and Candover (discussed in greater detail in Annex 3) and a smaller scale 'Instream Catchment Resilience Scheme' for the Test, Itchen, Eastern Yar and/or Medina if selected by the investment model for this WRMP. Catchment schemes to improve raw water quality remain in this WRMP.

In addition to these source-specific schemes, larger-scale initiatives aiming to achieve multiple benefits are also being encouraged by regulators and developed by the water industry. We are progressing these initiatives through our integrated water cycle management (IWCM) programme in our PR19 business plan.

Catchment management

Working in partnership with landowners and river guardians to better manage the flow and quality of rivers

Pros Both water quality and water quantity catchment management measures are relatively low cost compared with developing new water supplies and they provide multiple environmental and societal benefits

Cons Schemes to address diffuse pollution require a long-term commitment and can take time to deliver water quality benefits. River restoration to improve ecological resilience may not be accepted by some stakeholders as an alternative or complement to reducing abstraction

Managing the water environment: Licence variations

Licence variations could apply to remove certain licence constraints or revise any minimal residual flow (MRF) constraints, enabling greater DOs to be achieved. We applied for and were granted a licence variation for the River Medway scheme during AMP6. The variation of this abstraction licence will maximise the supplies of water that can be derived from the River Medway scheme while causing no adverse environmental impacts. At present, there are no further licence variations which we are considering, apart from those classified as drought interventions.

Licence variations

Changing an abstraction licence with the EA to allow the abstraction of different volumes of water from existing sources such as rivers or groundwater. This is only possible where there would be no significant impact on the environment

Pros Maximises supplies of water from sources which are not under pressure

Cons The extra water may not always be available all year round or in droughts

Trading water: Bulk imports and exports and inter-zonal transfers

The Southern Water area of supply is complex in nature due to the fragmented geographical areas of supply and the inter-connections between its own supply areas, as well as those with a number of other water companies. Bulk transfers (imports and exports) are a means of supplying additional water to a WRZ with a supply-demand balance deficit from a WRZ with a surplus. The range of possible transfer options open to Southern Water includes:

- Enabling transfers (inter-zonal transfers between Southern Water WRZs)
- Inter-company bulk transfers within the South East region
- Termination of existing bulk supplies to other water companies
- Transfers from outside the South East region

The transfer of water from areas of surplus to those of deficit has always been a fundamental part of our water resources strategy, as demonstrated by our participation in the WRSE group. It forms a key component of our current approach to providing security of water supplies. However, a key consideration is the availability of surplus supplies in potential donor WRZs or other companies in the future. Consideration also needs to be given to other factors such as the magnitude of the surplus available, the timing of availability and the duration for which it is available.

The water supply system within south east England is complex. There are a number of water companies, each sharing boundaries with a number of other companies. It is also the area with the most environmental and resource pressures in the country, being not only classified as an area of serious water stress, but also likely to be at the forefront of the effects of climate change. Given the dynamics of the situation, there are a number of benefits arising from the development of a regional strategy which is reflected through the harmonisation of the strategies of the neighbouring companies. This can help to progress regional solutions that limit unnecessary developments which could result in greater environmental impact, a sub optimal solution (for the region as a whole) and customer bills that are higher than they need to be.

The work of the WRSE group has focused on sharing resource developments to create the building blocks for a regional solution. As members of the WRSE group, Southern Water and its neighbouring water companies submitted their feasible options to the regional modelling group at PR14. The aim of this work was to derive a least cost ‘regional solution’, which could provide the water companies in the region with a view of potential bulk import requirements and bulk export availabilities. It is then the responsibility of the companies to identify, investigate and agree on the potential bulk supply and/or shared resource schemes. We have always adopted the bulk supplies that have been derived through the WRSE process and confirmed by the recipient/donor company. The options within our WRMP therefore include potential transfers between the water companies identified through the WRSE process, above those that are currently in place, with the aim of facilitating the trading of water in the most cost-effective manner.

All regional transfers were reviewed in discussions between the water companies during pre-consultation on this plan.

Whilst the work of the WRSE group helps to facilitate appropriately integrated solutions across the region, each company remains responsible for developing its own strategy. There are a number of instances where the company-preferred strategy might differ from that proposed by modelling undertaken by the WRSE group. For example:

- Where a solution proposed by the WRSE group might result in higher bills to Southern Water’s customers than might have been the case were an alternative solution to be pursued
- Where a solution might lead to a reduction in the security of supplies to Southern Water’s customers
- Where the WRSE model results in Southern Water having to undertake further demand management measures in order to facilitate an export to a neighbouring company that has made less progress in these key areas of demand management. In such cases, we would clearly wish to resist its customers having to subsidise less stringent demand management activities in other companies

We continue to actively support the WRSE group as it moves towards building a regional plan for the south east that takes into consideration other sectors and wider resilience issues. Our WRMP has considered the latest WRSE modelling outcomes and many of the proposed solutions are consistent with our plan and provide building blocks for future resource sharing and trading opportunities. We also attend the West Country Water Resources group to support the consideration and investigation of schemes from this region which could benefit Southern Water and other companies in the South East.

Following the submission of our Statement of Response, we wrote to other water companies in the country to explore potential future transfer options that were not identified at the time of the draft WRMP submission. In this regard, we held a meeting with Wessex Water on 13 May 2019 to discuss possibilities of future transfers from the Wessex region.

We have liaised closely with Portsmouth Water to ensure alignment between our WRMPs. In addition to e-mail exchanges and phone calls, we met Portsmouth Water on 24 April 2019 to share information and agree a common position to address points raised within Defra's letter of 19 March 2019. We have made a commitment to meeting on a regular basis to discuss ongoing investigations and the delivery of schemes in order to keep each other informed of emerging risks to each company's respective water resources strategies. Since publishing our respective Statement of Response Addendums in June 2019 we have subsequently met Portsmouth Water in July, September and November 2019 to progress dialogue on these issues. We also signed a contract with Portsmouth Water in July 2019 for the new bulk supply scheme allowing us to import up to 15Ml/d from Portsmouth Water's Lower Itchen source.

Trading water: Licence trading

In addition to contacting neighbouring water companies and participating in the WRSE group to investigate potential bulk supply options, the company also considered other means of investigating licence trading or third-party supplies:

- Publication of a notice in the OJEU to seek third party supplies
- Publication of a 'statement of need' on our website to seek third party supplies, including from neighbouring companies
- Contacting large abstraction licence holders within our supply area with a view to initiating water trading discussions

As we develop our implementation plans for the Target 100 initiative in more detail we will give due consideration to third party demand side interventions.

We follow a transparent options appraisal process that gives equal weight to third-party options as well as in house options. The same screening criteria are applied and costs are compared on a consistent basis to ensure there is no bias towards a particular set of options. Details of the third party options, as for all other options, are summarised in the feasible option summary tables (section 3 of this Annex) and in Annex 7 (the register of rejected options) as applicable.

Bulk imports and exports and inter-zonal transfers

Buying and selling large supplies of water from or to neighbouring water companies, or transferring water between Southern Water WRZs

Pros	Moves water around the south east to where sources are under pressure and helps deliver a 'regional grid'
Cons	Not producing any 'new water'

Southern Water

Licence trading	
Buying existing abstraction licences to abstract water from industry or agriculture	
Pros	Uses a water allowance which is already available for abstraction
Cons	The water traded might not be available if there is a conflict, for example, with the 'no deterioration' commitment in the WFD

Managing existing assets: Asset enhancement

This includes any options that Southern Water is able to implement to potentially increase the existing DO within a WRZ, and for which no external permissions are required. Such options could include:

- Re-introduction of existing resources (under existing licences) through enhanced treatment or pump alterations
- Improvements to and replacement of existing mains
- Increases to pump size or capacity
- Lowering of borehole pumps or lower low-level 'cut-outs'
- Re-introduction of well and adits at certain groundwater sources
- Re-lining of existing boreholes
- Altered operation of an existing source
- Increased use of an existing (and under-utilised) licence or new boreholes under existing licences

However, these asset enhancements are dependent on the current assessment of DO for each site. We review our existing asset sites on a regular basis to identify practicable schemes where there is a realistic, reliable opportunity for increasing the DO. Where these are identified, then any resultant DO increase is reflected in the DO assessments, rather than the options appraisal process.

One key option in this category relates to network constraints which result in 'locked-in' DO, whereby the combined DO of sources in an area cannot be utilised in full in some WRZs. Options have been included to release 'locked-in DO' that has been identified in the Hampshire Kingsclere and Sussex Brighton WRZs.

Managing existing assets: Water treatment works enhancement

Options under this category include any upgrades to Southern Water's existing water treatment works, e.g. addition of iron treatment, or increases in capacity. Enhancements would be limited to those which maintain operations within existing licence constraints, therefore no external permissions would be required.

Managing existing assets: Borehole rehabilitation

Schemes typically involve the refurbishment or rehabilitation of disused groundwater sources for which abstraction licences remain. They may also include drilling new boreholes and new onsite treatment of water. In some cases, reconfiguring groundwater sources on a site may improve seasonal management flexibility without increasing the annual abstraction volume.

Asset enhancement

Improvements to Southern Water's existing assets to maximise the DO available within existing licence constraints, particularly addressing network constraints to release 'locked-in' DO

Pros Does not require licence changes or external permissions and makes best use of existing infrastructure

Cons Southern Water regularly reviews its existing asset sites to identify potential for DO increases so there may not be many options available

Water treatment works enhancement

Upgrades to treatment processes or capacity at Southern Water's existing water treatment works

Pros Does not require licence changes or external permissions

Cons Southern Water regularly reviews its existing asset sites to identify potential for DO increases so there may not be many options available

Borehole rehabilitation

Bringing back online disused groundwater sources for which abstraction licences remain.

Pros Does not require licence changes or external permissions

Cons May require significant additional infrastructure such as treatment or drilling of new boreholes

Existing sources and transfers

To demonstrate it is providing best value in its proposals for balancing supply and demand, we have incorporated all our existing sources and transfers into the investment model to be considered alongside all other feasible options. For each of these sources, the annuitised capital cost of maintaining these assets and the cost of operating them has been estimated from Southern Water cost databases. The output assigned to each existing source is the stated DO as set out in Annex 3, and for existing transfers, the maximum capacity is stated.

It is expected that because there will not be any initial capital expenditure to bring existing sources or transfers into production, their continued operation will be selected by the investment model. However, going through this process demonstrates that we are exploring the true least cost solution to balance supply and demand.

3. Feasible options summary tables

Table 7 Summary of options lists by category

Option group	Option group code	Option category	Option category code	Company-wide		Western area		Central area		Eastern area	
				Unconstrained options	Feasible options	Unconstrained options	Feasible options	Unconstrained options	Feasible options	Unconstrained options	Feasible options
Drought Options	DO	Demand Interventions	DI	3	1	0	0	0	0	0	0
		Supply Interventions	SI	1	0	4	3	4	1	6	6
Demand Management	DM	Leakage Management	LM	14	7	0	0	0	0	0	0
		Metering/tariffs	MET	20	2	0	0	0	0	0	0
		Water Efficiency	WEF	9	1	0	0	0	0	0	0
New Water	NW	Desalination	DES	4	0	17	4	6	3	9	6
		Canal Water Abstraction	CWA	0	0	1	0	0	0	0	0
		Groundwater Abstractions (new)	GWA	2	0	5	1	5	0	4	1
		Surface Water Abstractions	SWA	0	0	6	0	4	0	7	1
		New Technologies	NT	1	0	0	0	0	0	0	0
Storing Water	STR	Aquifer Storage and Recovery	ASR	0	0	7	0	11	1	11	0
		Reservoirs	RES	5	0	4	1	28	1	13	1
Water Reuse	WR	Indirect Potable Water Reuse	PWR	4	0	11	6	6	3	11	5
		Industrial Water Reuse	IWR	1	0	4	1	0	0	2	1
		Grey Water Reuse	GRE	3	0	0	0	0	0	0	0
Managing the Water Environment	ENV	Borehole Rehabilitation	BR	0	0	2	1	3	2	2	1
		Catchment Management	CM	19	0	14	8	22	11	18	16
		Conjunctive Use	CU	1	0	0	0	1	0	1	0
		Licence Variation	LV	0	0	5	1	6	1	3	0
		Supporting River Flows	SRF	0	0	2	0	0	0	0	0
Trading Water	TW	Bulk Supplies	BS	8	0	16	4	25	0	13	2
		Bulk Export	BE	0	0	0	0	3	0	14	0
		Licence Trading	LTR	1	0	0	0	1	0	4	0
Managing Existing Assets	ASS	Asset Enhancement	AE	2	0	9	1	6	1	4	0
		Enabling Transfers (Inter-Zonal)	IZT	0	0	15	7	16	2	7	2
		Water Treatment Works Enhancement	WTW	1	0	9	1	2	0	6	1
		Borehole Rehabilitation	BR	0	0	2	1	3	2	2	1
Existing Sources	EXI	Existing Sources	EXI	0	0	0	0	0	0	0	0
Totals				99	11	133	40	152	28	137	44

- Only one of each DM option type is included per area, i.e. where each DM option has been split into WRZs, or where there are numerous steps of ALC in each WRZ, these have not all been counted
- Only one Drought Option Demand Intervention (Non Essential Use (NEU) ban)) has been included per area
- Where desalination and reuse options have multiple size variants or are modular, only one option has been counted for each location.
- Bi-directional transfers that have the potential to supply two WRZs have only been counted as one option
- Where generic scheme types were included in the unconstrained list of options across the company area, these have been replaced with the specific options developed (where appropriate) in each area

Table 8 High level summary of options lists

High level summary	Company-wide		Western area		Central area		Eastern area	
	Unconstrained options	Feasible options	Unconstrained options	Feasible options	Unconstrained options	Feasible options	Unconstrained options	Feasible options
Resource developments	45	0	102	29	108	26	103	40
Bulk supplies	8	0	31	11	44	2	34	4
Total supply-side options	53	0	133	40	152	28	137	44
Total demand management options	46	11	0	0	0	0	0	0
Total existing sources	0	0	0	0	0	0	0	0
Grand total options	99	11	133	40	152	28	137	44

Table 9 Summary table of feasible options

Option category code	Option name	Option description	Area	WRZ	Screening criteria: unconstrained to constrained									Screening criteria: constrained to feasible							
					Beneficial environmental outcomes?	Increased resilience?	Phased/Modular implementation?	Technically feasible?	Addresses water resources planning problem?	Meets customer and regulator expectations?	Avoids disporionate costs and/or delivers appreciable water resource?	Confidence in implementation/output?	Include in constrained option list?	Scheme SEA grade: risk of adverse effects	Scheme SEA grade: opportunity for beneficial effects	Are there mitigation measures to address potential impacts?	Are there dependencies or mutual exclusivities with other options or third parties?	Is option at risk of climate change impacts or future uncertainty?	Can option be implemented in a phased or modular way?	Does option contribute to overall resilience?	Include in feasible option list?
AE	Newbury WSW	The scheme is located within the Hampshire Kingsclere resource group (which is served by WSWs in Newbury and near Basingstoke). The scheme will increase the yield of the Newbury source within the existing licence by removing the present constraint imposed by mains leaving the site.	Western	HK	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	No	Yes	Yes
AE	Lewes Road	Increase pump capacity and WSR connectivity. Current demand constraint is approximately 2.3Ml/d (PDO). If the scheme is introduced, the constraint becomes pump capacity; approximately 3.9Ml/d for both MDO and PDO under severe drought conditions. Assume available in AMP6.	Central	SB	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	No	No	Yes	No	Yes	Yes
ASR	Sussex Coast – Lower Greensand	Because of the uncertainty over the scope for development within the Lower Greensand in a given area, two alternative schemes have been assessed under this option; a 4Ml/d output using two boreholes (scheme 1) and an 8Ml/d output using four boreholes (scheme 2). The option will take potable mains water and inject it into the aquifer within the Lower Greensands formation during winter and abstract it over the summer months. The abstracted water is then treated and then sent into supply via Tennants Hill WSR	Central	SW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	1	No	Yes	Yes	No	Yes	Yes
BR	Re-commissioning of Test valley WSW	This option involves the re-commissioning of unused Test valley WSW. Test valley WSW was abandoned for environmental reasons, however, in severe drought conditions and with the Itchen sustainability reductions in place, the source could be considered for temporary re-introduction. Could also be considered as a Drought Option	Western	HR	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	No	Yes	No	Yes	Yes
BR	Recommission Meopham groundwater source	Meopham Borehole 3 UGS is currently out of service. This option involves recommissioning this groundwater source.	Eastern	KMW	-	-	-	-	-	-	-	-	-	1	0	No	No	Yes	No	Yes	Yes
BR	Transfer excess water for enhanced treatment at Midhurst with refurbishment of Petersfield and BH rehabilitation.	Refurbishment of Petersfield. Modification of the existing pipeline to allow this to be used in reverse to release locked in DO that refurbishing Petersfield would create – may just require new pumps.	Central	SN	-	-	-	-	-	-	-	-	-	1	0	No	Yes	No	No	Yes	Yes
BR	Scheme to bring West Chiltington back into service	Scheme to bring back into service. Would need headworks (and flood works to protect headworks) and possible re-drill. Then transfer to Pulborough for treatment.	Central	SN	-	-	-	-	-	-	-	-	-	1	0	No	No	Yes	No	Yes	Yes
BS	Honor Oak (London Water Ring Main) to near Rochester WTW	This option involves the transfer of up to 45Ml/d of treated water from Thames Water's Honor Oak reservoir in Lewisham London to Kent Medway West WRZ near Rochester Water Treatment Works, through a new bulk transfer pipeline. There is the potential that this option may be developed jointly with South East Water.	Eastern	KMW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	No	Yes	Yes

					Screening criteria: unconstrained to constrained									Screening criteria: constrained to feasible							
Option category code	**Option name**	**Option description**	**Area**	**WRZ**	**Beneficial environmental outcomes?**	**Increased resilience?**	**Phased/Modular implementation?**	**Technically feasible?**	**Addresses water resources planning problem?**	**Meets customer and regulator expectations?**	**Avoids disporpionate costs and/or delivers appreciable water resource?**	**Confidence in implementation/output?**	**Include in constrained option list?**	**Scheme SEA grade: risk of adverse effects**	**Scheme SEA grade: opportunity for beneficial effects**	**Are there mitigation measures to address potential impacts?**	**Are there dependencies or mutual exclusivities with other options or third parties?**	**Is option at risk of climate change impacts or future uncertainty?**	**Can option be implemented in a phased or modular way?**	**Does option contribute to overall resilience?**	**Include in feasible option list?**
BS	Bournemouth Water supply	New bulk transfer from Bournemouth Water's WSW on the River Avon at Christchurch across the New Forest to Hampshire Southampton West WRZ.	Western	HSW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	No	Yes	Yes
BS	Transfer from UTMRD to Itchen WSW	(1) 30Ml/d bulk transfer from Thames Water to Itchen WSW, reliant on the development of the Abingdon Reservoir, Upper Thames Major Resource Development (which is not currently part of Thames Water's plan). Requires advance water treatment located next to the reservoir or on the Hampshire border. This would allow potable water transfer into the Hampshire Andover and Kingsclere WRZs and avoid the need for additional treatment at Itchen WSW. (2) 80Ml/d bulk transfer from Thames Water to Itchen WSW, reliant on the development of the Abingdon Reservoir, Upper Thames Major Resource Development (which is not currently part of Thames Water's plan). Requires advance water treatment located next to the reservoir or on the Hampshire border. This would allow potable water transfer into the Hampshire Andover and Kingsclere WRZs and avoid the need for additional treatment at Itchen WSW.	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	No	Yes	Yes
BS	Additional import from Portsmouth Water	Option 1) Additional 9Ml/d bulk import from Portsmouth Water to Itchen WSW distribution network using spare capacity of existing 30Ml/d main, dependent on resource development (World's End WTW) by Portsmouth Water. Could also be considered as a Drought Option	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	Yes	Yes	Yes	Yes	Yes
BS	Additional import from Portsmouth Water	Option 2) Additional 21Ml/d using a new pipeline to Itchen WSW, dependent on an additional import from Portsmouth Water (Havant Thicket reservoir development). Could also be considered as a Drought Option	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	Yes	Yes	Yes	Yes	Yes
BS	South East Water Kingston to Kent Thanet WRZ (near Canterbury)	2Ml/d import from South East Water Kingston to Kent Thanet WRZ near Canterbury WSW	Eastern	KT	-	-	-	-	-	-	-	-	Yes	2	0	Yes	Yes	Yes	No	Yes	Yes
CM	Pesticide Option – River Arun	The River Arun pesticide catchment management scheme is designed to reduce the issues caused from metaldehyde entering into surface water reservoirs via streams and rivers. This is done through metaldehyde treatment and implementing a catchment management scheme.	Central	SN	-	-	No	-	-	-	-	-	-	0	1	-	Yes	Yes	No	Yes	Yes
CM	Nitrate Option – Chilbolton	Option to address nitrate risk using both conventional treatment and catchment management together to ensure successful reduction of nitrates in limited timeframe.	Western	HA	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Pesticide Option – Darwell Reservoir	The Darwell pesticide catchment management scheme is designed to reduce the issues caused from metaldehyde entering into surface water reservoirs via streams and rivers. This is done through metaldehyde treatment at WSWs and implementing a catchment management scheme.	Eastern	SH	-	-	No	-	-	-	-	-	-	0	1	-	Yes	Yes	No	Yes	Yes

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Option category code	Option name	Option description	Area	WRZ	Screening criteria: unconstrained to constrained									Screening criteria: constrained to feasible							
					Beneficial environmental outcomes?	Increased resilience?	Phased/Modular implementation?	Technically feasible?	Addresses water resources planning problem?	Meets customer and regulator expectations?	Avoids disporpionate costs and/or delivers appreciable water resource?	Confidence in implementation/output?	Include in constrained option list?	Scheme SEA grade: risk of adverse effects	Scheme SEA grade: opportunity for beneficial effects	Are there mitigation measures to address potential impacts?	Are there dependencies or mutual exclusivities with other options or third parties?	Is option at risk of climate change impacts or future uncertainty?	Can option be implemented in a phased or modular way?	Does option contribute to overall resilience?	Include in feasible option list?
CM	Nitrate Option – Deal	The Deal catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction towards government incentives only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Winchester	The Winchester catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Western	HW	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	Yes	Yes	Yes
CM	Nitrate Option – West Sandwich	The West Sandwich catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction towards government incentives only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	Yes	Yes	Yes	Yes	No	Yes	Yes	-	0	1	-	Yes	No	No	Yes	Yes
CM	Pesticide Option – Pulborough Surface	The Pulborough pesticide catchment management scheme is designed to reduce the issues caused from metaldehyde entering into surface water reservoirs via streams and rivers. This is done through metaldehyde treatment and implementing a catchment management scheme.	Central	SN	-	-	No	-	-	-	-	-	-	0	1	-	Yes	Yes	No	Yes	Yes
CM	Nitrate Option – North Falmer A	The North Falmer catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant and by Southern Water assisting land owners with improvements to nitrate management.	Central	SB	-	Yes	Yes	Yes	Yes	No	Yes	Yes	-	0	1	-	No	No	No	Yes	Yes
CM	River Itchen catchment management options & river restoration pilot	Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and in delivering permanent environmental improvements in our rivers. Catchment management solutions have, to date, proved difficult to quantify in sufficiently robust and certain terms that can meet the requirements of a WRMP process that focuses on achieving a supply-demand balance. However, Southern Water is committed to exploring with other stakeholders the potential for catchment management not only as part of the Western Area strategy needed to meet the challenges posed by the notified River Itchen sustainability reductions, and/or in response to any potential future sustainability reductions that may be considered, but also as part of more integrated management of the water environment. The Company believes that such solutions may well provide the best outcomes for both customers and the environment.	Western	HA	-	-	-	-	-	-	-	-	Yes	N/A	N/A	No	No	No	No	No	Yes

					Screening criteria: unconstrained to constrained									Screening criteria: constrained to feasible							
Option category code	Option name	Option description	Area	WRZ	Beneficial environmental outcomes?	Increased resilience?	Phased/Modular implementation?	Technically feasible?	Addresses water resources planning problem?	Meets customer and regulator expectations?	Avoids disporionate costs and/or delivers appreciable water resource?	Confidence in implementation/output?	Include in constrained option list?	Scheme SEA grade: risk of adverse effects	Scheme SEA grade: opportunity for beneficial effects	Are there mitigation measures to address potential impacts?	Are there dependencies or mutual exclusivities with other options or third parties?	Is option at risk of climate change impacts or future uncertainty?	Can option be implemented in a phased or modular way?	Does option contribute to overall resilience?	Include in feasible option list?
CM	River Itchen catchment management options & river restoration pilot	Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and in delivering permanent environmental improvements in our rivers. Catchment management solutions have, to date, proved difficult to quantify in sufficiently robust and certain terms that can meet the requirements of a WRMP process that focuses on achieving a supply-demand balance. However, Southern Water is committed to exploring with other stakeholders the potential for catchment management not only as part of the Western Area strategy needed to meet the challenges posed by the notified River Itchen sustainability reductions, and/or in response to any potential future sustainability reductions that may be considered, but also as part of more integrated management of the water environment. The Company believes that such solutions may well provide the best outcomes for both customers and the environment.	Western	HR	-	-	-	-	-	-	-	-	Yes	N/A	N/A	No	No	No	No	No	Yes
CM	Nitrate Option – Manston	The Manston catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction towards government incentives only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – North Arundel	The North Arundel catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Central	SW	-	Yes	Yes	Yes	Yes	No	Yes	Yes	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – North Dover	The scheme will require: catchment walkovers, farmer engagement, delivery of good practice advice on nutrient management and, where appropriate, cost-effective additional measures to reduce nitrate leaching, as informed by site assessments and landowner discussions. - these approaches will be targeted to both prevent poor management practices that could lead to future deterioration of water quality, but additionally where strong seasonality is seen in water quality data, appropriate measures will be targeted at reducing the magnitude and frequency of these peaks.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Pesticide Option – River Medway Scheme	The Medway pesticide catchment management scheme is designed to reduce the issues caused from metaldehyde entering into surface water reservoirs via streams and rivers. This is done through metaldehyde treatment and implementing a catchment management scheme.	Eastern	KMW	-	-	No	-	-	-	-	-	-	0	1	-	Yes	Yes	No	Yes	Yes
CM	Nitrate Option – Ramsgate B	The Ramsgate B catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction towards government incentives only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes

					Screening criteria: unconstrained to constrained									Screening criteria: constrained to feasible							
Option category code	**Option name**	**Option description**	**Area**	**WRZ**	**Beneficial environmental outcomes?**	**Increased resilience?**	**Phased/Modular implementation?**	**Technically feasible?**	**Addresses water resources planning problem?**	**Meets customer and regulator expectations?**	**Avoids disporportionate costs and/or delivers appreciable water resource?**	**Confidence in implementation/output?**	**Include in constrained option list?**	**Scheme SEA grade: risk of adverse effects**	**Scheme SEA grade: opportunity for beneficial effects**	**Are there mitigation measures to address potential impacts?**	**Are there dependencies or mutual exclusivities with other options or third parties?**	**Is option at risk of climate change impacts or future uncertainty?**	**Can option be implemented in a phased or modular way?**	**Does option contribute to overall resilience?**	**Include in feasible option list?**
CM	Nitrate Option – North Falmer B	The North Falmer catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Central	SB	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Long Furlong B	The Long Furlong catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Central	SW	-	Yes	Yes	Yes	Yes	No	Yes	Yes	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Brighton A	The Brighton A catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Central	SB	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Pesticide Option – Powdermill Reservoir	The Powdermill pesticide catchment management scheme is designed to reduce the issues caused from metaldehyde entering into surface water reservoirs via streams and rivers. This is done through metaldehyde treatment and implementing a catchment management scheme.	Eastern	SH	-	-	No	-	-	-	-	-	-	0	1	-	No	Yes	No	Yes	Yes
CM	Nitrate Option – near Canterbury A	The Canterbury A area catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction towards government incentives only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Steyning	The scheme will require: catchment walkovers, farmer engagement, delivery of good practice advice on nutrient management and, where appropriate, cost-effective additional measures to reduce nitrate leaching, as informed by site assessments and landowner discussions. - these approaches will be targeted to both prevent poor management practices that could lead to future deterioration of water quality, but additionally where strong seasonality is seen in water quality data, appropriate measures will be targeted at reducing the magnitude and frequency of these peaks.	Central	SN	-	Yes	Yes	Yes	Yes	No	Yes	Yes	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Strood	The scheme will require: catchment walkovers, farmer engagement, delivery of good practice advice on nutrient management and, where appropriate, cost-effective additional measures to reduce nitrate leaching, as informed by site assessments and landowner discussions. - these approaches will be targeted to both prevent poor management practices that could lead to future deterioration of water quality, but additionally where strong seasonality is seen in water quality data, appropriate measures will be targeted at reducing the magnitude and frequency of these peaks.	Eastern	KMW	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes

Southern Water

Option category code	Option name	Option description	Area	WRZ	Screening criteria: unconstrained to constrained									Screening criteria: constrained to feasible							
					Beneficial environmental outcomes?	Increased resilience?	Phased/Modular implementation?	Technically feasible?	Addresses water resources planning problem?	Meets customer and regulator expectations?	Avoids disporionate costs and/or delivers appreciable water resource?	Confidence in implementation/output?	Include in constrained option list?	Scheme SEA grade: risk of adverse effects	Scheme SEA grade: opportunity for beneficial effects	Are there mitigation measures to address potential impacts?	Are there dependencies or mutual exclusivities with other options or third parties?	Is option at risk of climate change impacts or future uncertainty?	Can option be implemented in a phased or modular way?	Does option contribute to overall resilience?	Include in feasible option list?
CM	Nitrate Option – Sandwich A	The Sandwich A catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	River Test catchment management options & river restoration pilot	Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and in delivering permanent environmental improvements in our rivers. Catchment management solutions have, to date, proved difficult to quantify in sufficiently robust and certain terms that can meet the requirements of a WRMP process that focuses on achieving a supply-demand balance. However, Southern Water is committed to exploring with other stakeholders the potential for catchment management not only as part of the Western Area strategy needed to meet the challenges posed by the notified River Itchen sustainability reductions, and/or in response to any potential future sustainability reductions that may be considered, but also as part of more integrated management of the water environment. The Company believes that such solutions may well provide the best outcomes for both customers and the environment.	Western	HA	-	-	-	-	-	-	-	-	Yes	N/A	N/A	No	No	No	No	No	Yes
CM	River Test catchment management options & river restoration pilot	Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and in delivering permanent environmental improvements in our rivers. Catchment management solutions have, to date, proved difficult to quantify in sufficiently robust and certain terms that can meet the requirements of a WRMP process that focuses on achieving a supply-demand balance. However, Southern Water is committed to exploring with other stakeholders the potential for catchment management not only as part of the Western Area strategy needed to meet the challenges posed by the notified River Itchen sustainability reductions, and/or in response to any potential future sustainability reductions that may be considered, but also as part of more integrated management of the water environment. The Company believes that such solutions may well provide the best outcomes for both customers and the environment.	Western	HR	-	-	-	-	-	-	-	-	Yes	N/A	N/A	No	No	No	No	No	Yes
CM	Nitrate Option – Romsey	The Romsey catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Western	HR	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Twyford	The Twyford catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Western		-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes

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					Beneficial environmental outcomes?	Increased resilience?	Phased/Modular implementation?	Technically feasible?	Addresses water resources planning problem?	Meets customer and regulator expectations?	Avoids disporionate costs and/or delivers appreciable water resource?	Confidence in implementation/output?	Include in constrained option list?	Scheme SEA grade: risk of adverse effects	Scheme SEA grade: opportunity for beneficial effects	Are there mitigation measures to address potential impacts?	Are there dependencies or mutual exclusivities with other options or third parties?	Is option at risk of climate change impacts or future uncertainty?	Can option be implemented in a phased or modular way?	Does option contribute to overall resilience?	Include in feasible option list?
CM	Pesticide Option – Weir Wood Reservoir	The Weir Wood pesticide catchment management scheme is designed to reduce the issues caused from metaldehyde entering into the surface water reservoirs via streams and rivers. This is done through metaldehyde treatment and implementing a catchment management scheme.	Central	SN	-	-	No	-	-	-	-	-	-	0	1	-	No	Yes	No	Yes	Yes
CM	Nitrate Option – Gravesend	The Gravesend catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KMW	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – near Canterbury B	The Canterbury B area catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction from Southern Water only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Nitrate Option – Sandwich B	The Sandwich B catchment management scheme is designed to offset the issues caused from rising levels of nitrates in the groundwater. This is done through the construction of a nitrate treatment plant to address high nitrate levels, and through advice and direction towards government incentives only, no financial incentives proposed. This aims to address deterioration in the longer term.	Eastern	KT	-	-	-	-	-	-	-	-	-	0	1	-	Yes	No	No	Yes	Yes
CM	Arun and Western Stream in-channel catchment management	The Arun and Western Stream in-channel catchment management options will provide ecosystem resilience. There are currently limitations on the biological functioning of waterbodies within the Arun catchment with known pressures from surface water run-off, urbanisation, barriers and morphology. In-channel catchment measures will provide solutions to enable future resilience targeting achieving or maintaining good ecological status/potential, providing sustainable water and seeking naturalised river form and function, in line with other wider catchment management initiatives.	Central	SN	-	-	-	-	-	-	-	-	-	-	-	Yes	No	-	No	-	Yes
CM	Arun and Western Stream in-channel catchment management	The Arun and Western Stream in-channel catchment management options will provide ecosystem resilience. There are currently limitations on the biological functioning of waterbodies within the Arun catchment with known pressures from surface water run-off, urbanisation, barriers and morphology. In-channel catchment measures will provide solutions to enable future resilience targeting achieving or maintaining good ecological status/potential, providing sustainable water and seeking naturalised river form and function, in line with other wider catchment management initiatives	Central	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	-	Yes

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CM	Medway - instream catchment management options	Southern Water is committed to exploring with other stakeholders the potential for catchment management as an integral part of more integrated management of the water environment. The Company believes that such solutions may well provide the best outcomes for both customers and the environment. Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and in delivering permanent environmental improvements in our rivers. Catchment management solutions have, to date, proved difficult to quantify in sufficiently robust and certain terms that can meet the requirements of a WRMP process that focuses on achieving a supply-demand balance. Why in-channel catchment management? Southern Water have a responsibility to manage water resource sustainably within the catchment. Major pressures from urbanisation including increases in flood risk, unnatural flow regimes and direct impacts to ecological functioning can be improved by in-channel interventions. Southern Water is a key partner in water resource management and resilience	Eastern	KME	-	-	-	-	-	-	-	-	-	-	-	Yes	No	No	Yes	Yes	Yes
CM	Medway - instream catchment management options	Southern Water is committed to exploring with other stakeholders the potential for catchment management as an integral part of more integrated management of the water environment. The Company believes that such solutions may well provide the best outcomes for both customers and the environment. Catchment management solutions can contribute to making our water environment more resilient to changing climatic conditions, and in delivering permanent environmental improvements in our rivers. Catchment management solutions have, to date, proved difficult to quantify in sufficiently robust and certain terms that can meet the requirements of a WRMP process that focuses on achieving a supply-demand balance. Why in-channel catchment management? Southern Water have a responsibility to manage water resource sustainably within the catchment. Major pressures from urbanisation including increases in flood risk, unnatural flow regimes and direct impacts to ecological functioning can be improved by in-channel interventions. Southern Water is a key partner in water resource management and resilience	Eastern	KMW	-	-	-	-	-	-	-	-	-	-	-	Yes	No	No	Yes	Yes	Yes
DES	Tidal River Arun Desalination	This option proposes a desalination plant to treat estuarine water from the tidal River Arun to supply treated water to the Sussex Worthing WRZ. It is assumed that the water could be used during drought conditions to meet demand in Sussex Worthing WRZ. There is bi-directional transfer between Sussex Worthing WRZ and Sussex North WRZ which means this option could have result in additional benefit to Sussex North WRZ. An investigation in AMP4 indicated that land adjacent to Littlehampton WwTW showed the greatest potential for a new desalination site because of the existing land use, the availability of services (access roads, power, etc.) and the potential savings if it is possible to use Littlehampton's existing long-sea outfall.	Central	SW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes

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DES	Camber Desalination near Rye Bay	Previous work in AMP4 and AMP5 indicated that the most appropriate location for a desalination plant in the vicinity of the Camber is an area of land to the south of Rye and next to Rye WwTW. This is an industrial area where further development may raise less objections than other nearby locations, and the presence of a cement works indicates power supplies may be available.	Eastern	SH	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	3	0	Yes	No	Yes	Yes	Yes	Yes
DES	Emergency Desalination	This option is to install emergency desalination plants for use during drought events to maintain supply. Mobile desalination equipment would be installed at each site using purchased or leased plant from specialist suppliers of RO systems. Potential site locations have been identified at Sandown, Sheerness and Littlehampton. It has been assumed that the permanent pipework infrastructure for each scheme including the seawater intake and brine discharge pipelines, pumping stations and treated water outlet main connections would be installed as a first phase of construction, such that temporary desalination plants could then be connected when required. This would significantly reduce the time required to commission the scheme during a drought event. Power supplies would be provided either as permanent connections to the local supply grid or through use of mobile generators as required.	Western	IOW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	1	No	Yes	No	Yes	Yes	Yes
DES	Emergency Desalination	This option is to install emergency desalination plants for use during drought events to maintain supply. Mobile desalination equipment would be installed at each site using purchased or leased plant from specialist suppliers of RO systems. Potential site locations have been identified at Sandown, Sheerness and Littlehampton. It has been assumed that the permanent pipework infrastructure for each scheme including the seawater intake and brine discharge pipelines, pumping stations and treated water outlet main connections would be installed as a first phase of construction, such that temporary desalination plants could then be connected when required. This would significantly reduce the time required to commission the scheme during a drought event. Power supplies would be provided either as permanent connections to the local supply grid or through use of mobile generators as required.	Central	SN	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	1	No	Yes	No	Yes	Yes	Yes

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DES	Emergency Desalination	This option is to install emergency desalination plants for use during drought events to maintain supply. Mobile desalination equipment would be installed at each site using purchased or leased plant from specialist suppliers of RO systems. Potential site locations have been identified at Sandown, Sheerness and Littlehampton. It has been assumed that the permanent pipework infrastructure for each scheme including the seawater intake and brine discharge pipelines, pumping stations and treated water outlet main connections would be installed as a first phase of construction, such that temporary desalination plants could then be connected when required. This would significantly reduce the time required to commission the scheme during a drought event. Power supplies would be provided either as permanent connections to the local supply grid or through use of mobile generators as required.	Eastern	KME	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	1	No	Yes	No	Yes	Yes	Yes
DES	Fawley	This option involves construction of a desalination plant on a site within the New Forest NP adjacent to a disused power station. The power station has two large diameter outfall tunnels (nominally 5,500Ml/d) which subject to agreement of the landowner could be used by a desalination plant. With distribution enhancements treated water could be supplied to the following customers/areas: 1. Nearby large industrial user: currently Southern Water supply 10Ml/d but could be increased to 36Ml/d; 2. The Isle of Wight: the IOW is supported by transfer through the Cross-Solent main with a current capacity of up to 18Ml/d, but it is proposed to increase capacity to 30Ml/d; 3. Testwood WSW: the current daily licence limit of 136Ml/d is reduced to 80Ml/d following Hampshire Licence Inquiry. Risk of no abstraction under low flows conditions. 4. Otterbourne WSW: currently supplies approx. 90Ml/d, but is at risk of low flow reductions to 0Ml/d, the Southampton Grid main is currently proposed to supply 45Ml/d should a 200Ml/d desalination option be required.	Western	HSW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes
DES	Isle of Sheppey Desalination Plant	This option proposes a 10Ml/d desalination plant to meet demand on the Isle of Sheppey. Locating a desalination plant on the Isle of Sheppey has a clear advantage: it would meet local demand while significantly reducing the need for transfers along the main from Deans Hill BPT. This option could be enhanced to transfer treated water from the Isle of Sheppey to the wider Kent-Medway WRZ.A number of sites for a desalination plant were investigated and the most suitable would be located on land south of Sheerness Docks, currently used for storage of car imports. Water treated at this site would then be pumped to Southdown WSR and Kins Borough WSR on the island for distribution to customers. This site will be investigated further in the feasibility appraisal.	Eastern	KME	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes

Southern Water

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DES	Test Estuary desalination	This option would supply up to 200Ml/d of desalinated water into the Western Area distribution network. Poor mixing in Southampton Water means the hypersaline effluent will be discharged into the Solent via an existing sea outfall. This will require the construction of a discharge pipe through the New Forest National Park. Lower volumes could be utilised within the local network; larger volumes would need additional infrastructure. With distribution enhancements treated water could be supplied to the following customers/areas: 1. Large industrial user, currently Southern Water confirm supply of 10Ml/d but could be increased to 36Ml/d; 2. The Isle of Wight is supported by transfer through the Cross-Solent main, currently up to 18Ml/d, but it is proposed to increase capacity to 30Ml/d; 3. Testwood WSW currently supplies approx. 105Ml/d (proposed increase to 160Ml/d) but is at risk of low flow reductions to 0Ml/d; 4. Otterbourne WSW currently supplies approx. 90Ml/d, but is at risk of low flow reductions to 0Ml/d, the Testwood to Otterbourne Link Main is currently proposed to supply 45Ml/d.	Western	HSW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	3	0	Yes	No	Yes	Yes	Yes	Yes
DES	River Medway Desalination, up as far as Allington Lock	This option proposes abstraction of brackish water from the Tidal River Medway. The most feasible location for the desalination plant would be on or adjacent to Medway WwTW, although other locations have merit. The discharge of hyper-saline effluent is assumed to be through the existing discharge for Medway WwTW.	Eastern	K	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes
DES	Sandown Coastal desalination IOW	Installation of a new coastal seawater desalination plant at Sandown on the Isle of Wight which would be capable of producing a range of outputs between 3Ml/d and 22.5Ml/d. The proposed location is at the site of the Sandown WwTW. Outputs above 8.5Ml/d (local demand) require the construction of a transfer pipeline to High Alvington WSR for distribution to the rest of the island. Due to the extensive coverage of designated areas on the Isle of Wight, Sandown WwTW was identified as the only industrial site with potential for a coastal desalination plant. For this option to be technically viable, a pumping station would need to be located on the seafront. Sensitive location selection and design of this facility would be necessary.	Western	IOW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
DES	Coastal Desalination – Shoreham Harbour	A site in Shoreham Harbour was identified as the most feasible location for a coastal desalination plant that could supply the Central area WRZs. The new desalination plant would be constructed within the site of an existing power station and make use of its abstraction and discharge structures. The treated water would be supplied to the Sussex Brighton WRZ distribution network.	Central	SB	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes

Southern Water

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DES	River Thames Desalination: Desalination plant adjacent to the abandoned Swancombe WwTW with abstraction from the Thames Estuary and transfer to Singlewell WSR	This option proposes the development of a desalination plant adjacent to Britannia Refined Metal on the Swanscombe Peninsula, which would be capable of producing 10Ml/d, and would combine discharge with Swanscombe WwTW's existing outfall. Treated water would be transferred to Singlewell WSR for distribution to the Kent Medway WRZ.	Eastern	KMW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes
DES	Desalination in Thanet	This option would see a desalination plant constructed near to the North Thanet Coast, and would supply potable desalinated water to the Kent Thanet WRZ.	Eastern	KT	-	-	-	-	-	-	-	-	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes
DI	Restriction to non-essential use	Drought Option: The Company has recourse to a range of restrictions to Non-Essential Use. However, it can take a significant time to apply for and then implement a Drought Order. The Company might decide not to exercise all its powers until severe drought conditions are reached. Can be applied on a WRZ basis. Level of intervention for this option: Severe drought conditions.	Southern Water		No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	1	-	-	-	Yes	-	Yes
GWA	Near Cowes WSW	The groundwater source has been disused since 1989. The source is located in Cowes west of the River Medina on the Isle of Wight. The abstraction is sourced from a 220m deep well and borehole connected via an adit to another well. This option would involve bringing this source back online. Groundwater is abstracted from the highly confined source, which is only some 20m thick at the base of the deep borehole. The source would only yield 0.4Ml/d and due to the high iron levels would require treatment prior to bringing it into supply.	Western	IOW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	No	No	Yes	No	Yes	Yes
GWA	West Sandwich and Sandwich WSW licence variation	West Sandwich and Sandwich are borehole sources which abstract from the chalk aquifer. They are located in close proximity to each other. This option is to aggregate the licence for the sources, in order to allow the overall Deployable Output to be increased.	Eastern	KT	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	1	0	No	No	Yes	Yes	No	Yes
IWR	Test Estuary WWTW Industrial Reuse – 9Ml/d	Test Estuary WwTW has a Dry Weather Flow (DWF) of c.13Ml/d in a dry year (2011). This option proposes tertiary treatment of 9Ml/d wastewater to a standard suitable for industrial use by a nearby large industrial user. This would free up supply from Test Surface Water that would otherwise be required to be available.	Western	HSW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	No	Yes	No	Yes	Yes
IWR	Sittingbourne Industrial Water Reuse	This option is to use the reuse scheme to free up additional volume in the borehole licence to increase the scope of the licence trading. It has been assumed at this stage that the RO wastewater can be discharged through Sittingbourne WwTW existing outfall.	Eastern	KME	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	Yes	Yes	No	Yes	Yes
IZT	Romsey Town and Broadlands valve (HSW to HR).	Modelling suggests a new WBS with a flow-rate of 10Ml/d is viable. 6.9Ml/d increase in transfer capacity to 10Ml/d – not necessarily 6.9Ml/d DO. (Bi-directional)	Western	HR	-	-	-	-	-	-	-	-	-	0	1	Yes	Yes	Yes	No	Yes	Yes

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IZT	Pulborough Winter transfer	During the winter there is surplus water available at Pulborough WSW. Pulborough Winter Transfer involves four stages, each of which provides cumulatively increasing benefit in terms of DO. Implementation of all stages would enable transfer from Pulborough WSW to Tenants Hill WSR in Sussex Worthing, which would then gravitate to Sussex Brighton. This option considers the potential for excess surface water that may be available within the River Rother during the winter to be used (either within the existing licence, or using an extended winter licence at Pulborough WSW) to supply Sussex Coast. This would allow coastal groundwater sources to be rested, which would help Southern Water's Source Drought Management Strategy (SDMS) and hence increase groundwater capabilities during the summer and autumn of a drought year. (1) This stage addresses turbidity and sludge handling issues at Pulborough which would otherwise constrain the DO that can be achieved following the implementation of the transfer (ASS_IZT_Wei). Improvements at Pulborough WSW would allow increased transfer capacity to 7Ml/d, providing a DO benefit of 2Ml/d for the Brighton Block (SB). Constrained by V6 Worthing-Brighton transfer main. To achieve further DO benefit to Brighton, it would be necessary to alleviate pressures in the V6 main.	Central	SB	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
IZT	Pulborough Winter transfer	During the winter there is surplus water available at Pulborough WSW. Pulborough Winter Transfer involves four stages, each of which provides cumulatively increasing benefit in terms of DO. Implementation of all stages would enable transfer from Pulborough WSW to Tenants Hill WSR in Sussex Worthing, which would then gravitate to Sussex Brighton. This option considers the potential for excess surface water that may be available within the River Rother during the winter to be used (either within the existing licence, or using an extended winter licence at Pulborough WSW) to supply Sussex Coast. This would allow coastal groundwater sources to be rested, which would help Southern Water's Source Drought Management Strategy (SDMS) and hence increase groundwater capabilities during the summer and autumn of a drought year. (2) New main between Shoreham WSW/North Shoreham WSW and Brighton A WSR. This would allow 7Ml/d to be pumped via a different route and relieve pressure issues in the existing V6 main. Additional water from Pulborough is only available during winter, so the benefit comes from resting groundwater sources in the Brighton Block during winter. The 7Ml/d capacity increase would only result in a 4Ml/d DO increase.	Central	SB	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
IZT	Itchen WSW to Crabwood WSR to Andover to near Basingstoke	Transfer from Itchen WSW to Andover to near Basingstoke. This scheme is designed to support network improvements needed for UTMRD transfer to Hampshire and/or the strategic scheme from IoW/South Hampshire	Western	HW	-	-	-	-	-	-	-	-	Yes	1	0	-	No	Yes	No	Yes	Yes

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IZT	Itchen WSW to Crabwood WSR to Andover to near Basingstoke	Transfer from Itchen WSW to Andover to near Basingstoke. This scheme is designed to support network improvements needed for UTMRD transfer to Hampshire and/or the strategic scheme from IoW/South Hampshire	Western	HSE	-	-	-	-	-	-	-	-	Yes	1	0	-	No	Yes	No	Yes	Yes
IZT	Itchen WSW to Crabwood WSR to Andover to near Basingstoke	Transfer from Itchen WSW to Andover to near Basingstoke. This scheme is designed to support network improvements needed for UTMRD transfer to Hampshire and/or the strategic scheme from IoW/South Hampshire	Western	HA	-	-	-	-	-	-	-	-	Yes	1	0	-	No	Yes	No	Yes	Yes
IZT	Itchen WSW to Crabwood WSR to Andover to near Basingstoke	Transfer from Itchen WSW to Andover to near Basingstoke. This scheme is designed to support network improvements needed for UTMRD transfer to Hampshire and/or the strategic scheme from IoW/South Hampshire	Western	HSE	-	-	-	-	-	-	-	-	Yes	1	0	-	No	Yes	No	Yes	Yes
IZT	Itchen WSW to Crabwood WSR to Andover to near Basingstoke	Transfer from Itchen WSW to Andover to near Basingstoke. This scheme is designed to support network improvements needed for UTMRD transfer to Hampshire and/or the strategic scheme from IoW/South Hampshire	Western	HK	-	-	-	-	-	-	-	-	Yes	1	0	-	No	Yes	No	Yes	Yes
IZT	Romsey Town and Broadlands valve (Hampshire Rural WRZ to Hampshie Southampton West WRZ).	Modelling suggests a new WBS with a flow-rate of 10Ml/d is viable. 6.9Ml/d increase in transfer capacity to 10Ml/d – not necessarily 6.9Ml/d DO. (Bi-directional)	Western	HSW	-	-	-	-	-	-	-	-	-	0	1	Yes	Yes	Yes	No	Yes	Yes
IZT	Faversham4–Fleete	Conditioning of existing Faversham4–Fleete main to enable bi-directional transfers (and specifically from Kent Thanet to Kent Medway). It is not thought that any additional pipeline would be required, although this is dependent on the existing main being structurally sound. A new 25Ml/d pumping station is required at Fleete WSR along with a possible booster pumping station to reduce the pressure head along the main. (Option TT3 in AMP5). Minimum engineering requirements: new 25Ml/d pumping station at Fleete Reservoir, modifications to pipework at Near Broughton Bypass Break Pressure Tank or alterations to pipework and construction of a new Near Broughton Bypass Break Pressure Tank, installation of energy dissipation measures at Faversham4.	Eastern	KT	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	No	Yes	Yes	Yes	Yes	Yes
IZT	Faversham4–Fleete	The operational transfer is limited to the output from Faversham4. This option enables flows from the Faversham3 source to be directed, via an existing main, towards Faversham4 WSW. A soakaway is installed at Faversham4 to allow for reconditioning of the existing main and the addition of UV treatment at Faversham4 permits disinfection of the Faversham3 flows. (Option TT1a in AMP5). Main scheme components are: 13Ml/d soakaway at Faversham4, increased pumping capacity at Faversham4, new UV treatment at Faversham4 WSW.	Eastern	KT	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	No	Yes	Yes	Yes	Yes	Yes

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IZT	Triplicate Cross Solent Main: bi-directional transfer	A third cross-Solent main would be installed to permit further bulk transfer of water resources from the mainland to the Isle of Wight. Although it is possible that the transfer may be from the Isle of Wight to the mainland (should a large-scale desalination plant be selected on the IoW for example) it is most likely that the transfer will be from the mainland to the IoW. As Test Surface Water WSW is the key resource for this transfer, the option includes a new 450 mm diameter main between Test Surface Water and Blackfield on the mainland. A new dual main (300dia each) that would be laid under the Solent sea bed is included between Blackfield and a pumping station near Cowes. A new 450 diameter main is included between Cowes and a new 20 Ml WSR at High Alvington in order to distribute flows to the IoW. A new booster pumping station would also be required at Newport. Engineering requirements: - New main between Test Surface Water WSW and Blackfield Booster Station; - New pumping station at Test Surface Water WSW; - New pumps, pump housing and M&E for the Blackfield booster station and for the booster pumping station near Cowes; - New dual high pressure pipelines between Blackfield pumping station and a pumping station near Cowes; - New pipeline from near Cowes to Alvington High Level WSR); - 20 Ml additional service reservoir adjacent and connected to the existing Alvington High Level WSR (based on a 24hr retention time); and - Connection to mains electricity supply (should be minimal cost).	Western	IOW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	3	0	No	Yes	Yes	No	Yes	Yes
IZT	Woodside transfer valve (HSW to HR)	Modelling suggests a new WBS at the Woodside Transfer with a flow-rate of 25Ml/d is viable. This is approximately 10Ml/d more than the existing transfer capacity. 10Ml/d increase in transfer capacity to 25Ml/d – not necessarily 10Ml/d DO.	Western	HR	-	-	-	-	-	-	-	-	Yes	1	0	No	No	Yes	No	Yes	Yes
LM	Acoustic loggers	This option involves installing acoustic loggers in DMAs to assist with identification of leaks. There are two sub-options, one where loggers are installed in 75% of DMAs and the second where loggers are installed in 100% of DMAs.	Southern Water	NZS	Yes	-	-	Yes	Yes	Yes	Yes	Yes	Yes	1	0	-	No	Yes	No	Yes	Yes
LM	Mains renewal	Leakage-driven mains renewal scheme (replacement of non-PE pipes)	Southern Water		Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	1	1	-	No	No	No	Yes	Yes
LM	Leakage reduction – range of values	Range of leakage reduction activity through find and fix approaches in each WRZ. Can also be a drought option to increase find and fix activity during drought periods	Southern Water		Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	1	1	-	Yes	Yes	Yes	Yes	Yes
LM	Improved active leakage control and smart network technologies.		Southern Water		-	-	-	-	-	-	-	-	Yes	-	-	-	No	No	Yes	Yes	Yes

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LM	Supply pipe leakage reduction associated with option MET_MAMR1	This option accounts for the supply pipe leakage reductions that are assumed to result from the installation of AMR metering equipment for domestic customers to take meter penetration from estimated current 88% up to a minimum of 92% in each WRZ, the original proposition of the 2010–15 Universal Metering Programme (UMP).	Southern Water		Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	0	1	-	Yes	Yes	No	Yes	Yes
LM	Supply pipe leakage reduction associated with option MET_MAMR2	This option accounts for the supply pipe leakage reductions that are assumed to result from the extension of the UMP to cover installation of AMR metering equipment for the remaining approximately 8% of households that could not be economically metered during the UMP and that are not covered by option MET_MAMR1, to achieve 100% metering by the end of AMP7.	Southern Water		Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	1	-	Yes	Yes	No	Yes	Yes
LM	Supply pipe leakage reduction associated with option WEF_Tgt100	This option accounts for the supply pipe leakage reductions that are assumed to result from the basket of measures that comprises Target 100.	Southern Water		Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	0	1	-	Yes	Yes	No	Yes	Yes
LV	Eastern Yar	Modification of operational rules for the Eastern Yar scheme (reduce MRF and change operation) to increase water available for abstraction at Sandown	Western	IOW	No	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	3	0	-	-	-	Yes	-	Yes
LV	Pulborough	Pulborough groundwater licence variation	Central	SN	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	1	-	Yes	Yes	No	Yes	Yes
MET	Meter customers from current metering level (c.88%) to 92%	Installation of metering equipment for remaining unmeasured domestic customers, to take meter penetration up to a minimum of 92% in all WRZs (which was the original amount proposed and envisaged in WRMP14, but not achieved as part of the Universal Metering Programme).	Southern Water		Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	0	1	-	Yes	Yes	Yes	Yes	Yes
MET	Meter all remaining customers (i.e. remaining 8%)	Extension of the UMP to cover installation of AMR metering equipment for the remaining approximately 8% of households that could not be economically metered during the UMP or under option MET_MAMR1.	Southern Water		Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	0	1	-	Yes	Yes	Yes	Yes	Yes
PWR	Medway WWTW Indirect Potable Water Reuse – Medway	This option involves the transfer of approx. 18Ml/d of treated effluent from Medway WWTW to the River Medway upstream of Springfield abstraction. This would be used to supplement flows within the Medway during low flow periods, thus reducing the releases from Bewl Water and conserving storage.	Eastern	KMW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Portsmouth Harbour WwTW to River Itchen Indirect Potable Reuse	Treat wastewater from Portsmouth Harbour WwTW in the Central Area and pump to the River Itchen to support abstractions at Itchen WSW in the Western Area.	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes

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PWR	Combine Portsmouth Harbour and Fareham WwTWs to River Itchen Indirect Potable Reuse (90Ml/d)	This option requires the treatment of wastewater streams at both Portsmouth Harbour WwTW and Fareham WwTW with tertiary treatment to a quality suitable to discharge in to the River Itchen for later abstraction. The treated effluent will be pumped in separate pipes from the WwTWs to a meeting point then pumped in a single pipe to the proposed discharge on the River Itchen.	Western	HSE	-	-	Yes	-	-	-	-	-	Yes	3	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Hastings WWTW effluent to augment storage in Darwell Reservoir	This option proposes the transfer of treated effluent from Hastings WWTW, currently being discharged to sea at Pebsham Gap, in order to augment storage in either the Darwell reservoir. This option includes tertiary treatment of Hastings wastewater, this may include Membrane Bio Reactors and Reverse Osmosis. Additional GAC and UV treatment may be required at Rye WSW.	Eastern	SH	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Medway WWTW Indirect Potable Water Reuse – Eccles Lake (18Ml/d)	This option involves the transfer of 18Ml/d of treated effluent from Medway WWTW to near Rochester WSW's raw water storage reservoir Eccles Lake.	Eastern	KMW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Littlehampton WWTW Indirect Potable Water Reuse	This scheme proposes the transfer of treated effluent from Littlehampton WwTW to a new discharge point to the western River Rother upstream of the Pulborough WSW abstraction. This would support flows over the weir as the MRF is approached, therefore prolong production at Pulborough during a drought. 20Ml/d represents the upper end of the reliable flow that could be expected from Littlehampton WwTW. Once abstracted at Pulborough WSW this water would be used to meet demand in the Sussex North WRZ.	Central	SN	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Medway estuary WWTW Indirect Potable Water Reuse	Medway estuary WwTW has a consented DWF of 44Ml/d which is currently discharged to the sea. This option proposes advanced treatment and transfer of this effluent to support the flows in the River Medway upstream of the Springfield Abstraction that supplies near Rochester WSW with raw water. Two alternative locations for the discharge location have been identified, both of which are small streams that flow into the River Len, a tributary of the Medway.	Eastern	KMW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes

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PWR	Sandwich WWTW Indirect Potable Water Reuse	This scheme proposes the transfer of treated effluent from Sandwich WwTW to a new discharge point to the Great Stour at Ferry Grove. The additional water would be abstracted downstream from an existing abstraction point at Stourmouth. There is an existing 10Ml/d capacity WSW at Stourmouth which is constrained by an MRF in the summer. It was constructed in the 1970s as a temporary measure and in AMP5 was reported to be in disrepair but may be operable if required in a drought. The last recorded use was during 2006. This scheme proposes that the existing WSW at Stourmouth be relocated out of the 1 in 100-year flood plain approx. 2.5 km north of its current location. Raw water storage would also be constructed to provide two days storage. As the works would be on the flight path of Kent International Airport the reservoir would need to be covered to mitigate the risk of bird strikes. There are two sub-options: (1) 11Ml/d treated effluent discharge to support 10Ml/d capacity WSW at Stourmouth, with 20Ml of covered raw water storage. (2) 18Ml/d treated effluent discharge to support 20Ml/d capacity WSW at Stourmouth (reducing to 16.2Ml/d when the MRF is reached), with 40Ml of covered raw water storage.	Eastern	KT	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Portswood WwTW Indirect Potable Water Reuse	Portswood WwTW has a consented DWF of approximately 28Ml/d, although there are reports that the true minimum flow is closer to 20Ml/d. There is little room for expansion at Portswood WwTW therefore it is proposed to pump the effluent to a new tertiary treatment plant at Portsmouth Water WTW. Two options have been identified for the treated effluent discharge and abstraction: (1) The treated effluent from the new tertiary treatment plant at Portsmouth Water WSW will be pumped to a discharge location immediately downstream of the Itchen WSW abstraction point. Discharges would be used offset abstractions at Itchen WSW when sustainability reductions would otherwise restrict abstraction. (2) The treated effluent from the new tertiary treatment plant at Portsmouth Water WSW will be pumped to a discharge location upstream of Portsmouth Water WSW abstraction point. Discharges will be used when abstraction would otherwise be limited due to low flow and will be treated at the existing Portsmouth Water WSW plant. The treated water will be transferred to Southern Water by a recently constructed bulk transfer main from which has capacity to transfer an additional 15Ml/d.	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes

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PWR	Sandown WwTW Indirect Potable Reuse	This option proposes the transfer of treated effluent from Sandown WwTW (currently discharged to sea), to support flows in the Eastern River Yar upstream of the Sandown WSW abstraction at Alverstone. Treated water in excess of the local demand will be transferred through a new transfer pipeline to the Alvington High Level WSR, near Newport, for supply to much of the island. This option is reliant on the WSR enlargements carried out in IZT_CSM Cross-Solent upgrade. (2) Option 2 also includes upgrades to Sandown WSW to achieve the extra flow.	Western	IOW	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Woolston WwTW Indirect Potable Reuse	This scheme makes use of the treated effluent from Woolston WwTW. It is proposed that up to the DWF (15Ml/d) would be pumped to discharge location just downstream of the Itchen WSW abstraction in order to replace flows abstracted at Itchen WSW. Due to space constraints at Woolston WwTW, additional treatment plant would need to sited en route to the proposed Itchen WSW discharge location, potentially Portsmouth Water or Itchen WSW.	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Combined Woolston and Portswood WWTW Indirect Potable Reuse	This scheme makes use of the treated effluent from Woolston WwTW and Portswood WwTW. It is proposed that up to the combined DWF (43Ml/d) would be pumped to discharge location just downstream of the Lower Itchen abstraction in order to replace flows abstracted at Lower Itchen. Due to space constraints at Woolston WwTW and Portswood WwTW, additional treatment plant would need to sited en route to the proposed Lower Itchen discharge location, potentially at Portsmouth Water or Lower Itchen.	Western	HSE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	Yes	Yes	Yes	Yes	Yes
PWR	Brighton WTW	The preferred location has been chosen based on the availability of wastewater for reuse from Brighton WwTW. The new tertiary treatment plant would be constructed at Brighton WwTW. The proposed discharge point on the River Ouse is upstream an existing South East Water WSW abstraction to augment flows in the river and allow for increased abstractions. If the discharge is upstream of the South East Water abstraction, then treatment works upgrades will be required. The proposed potable water pipeline from SEW's WSW to the Sussex Brighton WRZ will utilise the same route as the treated effluent pipeline and minimise impact and costs by being will be installed in the same trench.	Central	SB	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	0	Yes	No	Yes	Yes	Yes	Yes
RES	River Adur offline Reservoir	The option involves the construction of an earth embankment reservoir with a proposed storage capacity of up to 4,600 Ml. The option will allow treated water to enter the distribution network to supply either the Sussex coastal block or the Pulborough area. The reservoir will be filled with water pumped from the eastern branch of the river Adur. The abstraction of raw water from the river to the reservoir would have a maximum flow of 30Ml/d.	Central	SN	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	No	Yes	No	Yes	Yes

Southern Water

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RES	Test Lake	Purchase Test Lake and use for additional raw water storage capacity for Test Surface Water WSW. Sub-option 1 comprises using the Lake at its current capacity whilst sub-option 2 includes deepening the lake and the construction of embankments so that water levels can be raised. The reservoir would be filled by the Test Surface Water SWA within the existing licence and would provide additional operational flexibility and resilience during low flow periods.	Western	HSE	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	No	No	Yes	No	Yes	Yes
RES	Raising Bewl by 0.4m	The scheme involves the raising of Bewl Water to increase storage and yield. The major works for raising Bewl to higher TWL levels will include: • Raise the dam crest and build new wave wall; • Raise overflow and valve chamber shafts; and • Many ancillary works around the perimeter of the reservoir.	Eastern	KMW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	3	0	No	No	Yes	No	Yes	Yes
SI	Bewl water increased filling	Bewl Water is a pumped storage reservoir with abstractions from the River Teise at Smallbridge and the River Medway at near Maidstone. The Permit may take the form of authorisations to allow increased re-filling and conservation of existing storage of Bewl. The precise conditions applied for will depend upon the severity and timing of each drought.	Eastern	KMW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	3	0	-	-	-	No	-	Yes
SI	Drought order to use the Candover Augmentation scheme	To enable operation of Preston Candover river augmentation scheme boreholes. Abstraction would be increased over a period of several days up to the full required discharge rate so as to prevent a sudden increase in flow in the River Itchen. Abstraction and discharges will only be permitted when flows in the River Itchen at Allbrook and Highbridge are at or below a trigger flow of 220Ml/d.	Western	HSE	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	Yes	No	Yes	No	Yes	Yes
SI	Darwell – reduce MRF	Drought Option: The Drought Order involves a proposed reduction in the statutory Minimum Residual Flow (MRF) as gauged at the Robertsbridge flow gauging weir on the River Rother. MRF would be reduced to 10Ml/d to enable abstraction to take place when flows are sufficiently high. The proposed Drought Order reduction varies depending on the time of year. The Drought Order would be sought in order to increase the volume of water available for abstraction at the Robertsbridge intake to pump up to Darwell Reservoir to augment the remaining storage. The Drought Order will influence flows in the watercourses downstream of Robertsbridge.	Eastern	SH	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	3	0	-	-	-	No	-	Yes

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SI	Pulborough – reduce MRF	Drought Option: This Drought Permit is concerned with the surface water off-take from the River Rother. The Permit allows a reduction in the MRF at Pulborough, which effectively allows greater abstraction from the Pulborough Surface water intake once abstraction in the river becomes constrained by the existing licensed MRF. Typical Permits are in the order of 10–30Ml/d reduction in MRF, although larger Permits may be sought under more extreme conditions. This option allows both increased supplies and can also be used to maintain storage in Weir wood and groundwater sources during drought conditions. This remains a viable option for both summer and winter conditions, as it allows more water to be taken from the river when abstraction is constrained by the MRF	Central	SN	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2	1	-	-	-	Yes	-	Yes
SI	Faversham1, Faversham2 and Millstead	Drought Option: Faversham1, Faversham2 and Millstead groundwater sources. These boreholes within the Kent Medway area are all licence-constrained and prevented from abstracting water outside the summer period in order to protect groundwater resources in the Faversham–Sittingbourne area. This option would involve the removal of these seasonal constraints in order to pump at the daily licensed amount throughout the year through the application for and implementation of a Drought Permit or Order. Daily license limit of 5Ml/d maximum abstraction from each of KH, HH, TW.	Eastern	KME	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	-	-	-	No	-	Yes
SI	Itchen WSW – increase licensed volumes	Increase current licensed quantity	Western	HSE	No	-	-	Yes	Yes	Yes	Yes	Yes	Yes	3	0	-	-	-	-	-	Yes
SI	Stourmouth – reduce MRF (Summer/Winter)	Drought Option: This Drought Permit is concerned with abstraction for public water supply to allow increased abstraction from the River Great Stour at Stourmouth. This option involves a reduction in the Minimum Residual Flow (MRF) at Stourmouth from 145Ml/d to 100Ml/d (maximum daily abstraction 9Ml/d), allowing abstraction to continue when the flow in the river is below 145Ml/d.	Eastern	KT	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	1	0	-	Yes	-	No	-	Yes
SI	Powdermill – reduce MRF	Drought Option: A Drought Permit/Order may be applied for to reduce the MRF controlling abstraction from the River Brede to refill Powdermill Reservoir. This is currently 6.2Ml/d, and a reduction to as low as 2Ml/d would be considered, depending on environmental and other constraints	Eastern	SH	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	-	-	-	No	-	Yes
SI	Test surface water abstraction	Relax the hands–off flow condition in the proposed new abstraction licence from 355Ml/d to 200Ml/d	Western	HSW	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	0	0	-	No	Yes	No	Yes	Yes

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SI	Sandwich – increase licensed volumes	Drought Option – The proposed drought option involves increasing groundwater abstraction at Sandwich PS through the application for and implementation of a Drought Permit/Order. This source is constrained by the daily licence and the drought action would seek to increase the licensed daily abstraction rate by 1.27Ml/d to 4.0Ml/d, which is the peak output achieved during the 1992 drought period when a drought action was introduced to relax the daily peak licence.	Eastern	KT	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	3	0	-	-	-	No	-	Yes
SWA	Stourmouth WSW	There is an existing 10Ml/d capacity WSW at Stourmouth which is constrained by an MRF in the summer. It was constructed in the 1970s as a temporary measure and in AMP5 was reported to be in disrepair but may be operable if required in a drought. The last recorded use was during 2006. This scheme comprises the construction of a new water treatment works at Stourmouth including two days' worth of covered storage to replace the existing temporary works in a location c. 2.5 km to the north, outside of the 1 in 100 yr floodplain. Sub-options 2 and 3 include additional open, raw water bankside storage which would be filled during winter (Oct-Mar) from the Great Stour. Sub-option 4 comprises abstraction of water at Stourmouth and transfer to a new 'super WSW' located near the existing Ramsgate B source. (Note that this options does not include water (effluent) reuse from Sandwich WTW – this is covered by option WR-PWR-Plu)	Eastern	KT	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	No	Yes	Yes	No	Yes	Yes
WEF	Reducing per capita consumption to 100l/h/d during AMP8 and AMP9	Southern Water would undertake extensive education and media campaigns as well as water efficiency audits and installation of grey water recycling systems in properties for non-potable uses where possible during AMP8 and AMP9 with the aim of driving down per capita consumption to 100l/h/d from baseline levels.	Southern Water		Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	0	1	-	Yes	Yes	Yes	Yes	Yes
WTW	Increase turbidity capability at near Rochester WSW	Process loss recovery – increase in ADO	Eastern	KMW	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	0	0	No	No	No	No	No	Yes
WTW	Southampton link main	This option is a transfer from Test Surface Water WSW to the areas served by Itchen WSW. The option involves a 21.5 km 60mm HPPE pipeline and a new high-lift pumping station at Test Surface Water WSW.	Western	HSE	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	2	0	-	Yes	No	No	Yes	Yes

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Water Resources Management Plan 2019

Annex 6: Options Appraisal

Appendix A: Feasible Options Fact Files

December 2019

Version 1

RESTRICTED INFORMATION IN SEPARATE PDF, AVAILABLE UPON REQUEST

Water Resources Management Plan 2019

Annex 6: Options Appraisal

Appendix B: Water Quality Considerations in Options Appraisal

December 2019

Version 1

from Southern Water

Water quality considerations in options appraisal

Introduction

In developing schemes for the 2019 Water Resource Management Plan, consideration has been given to water quality both in the context of public health implications and the impacts on the environment. In respect of public health considerations, the following sections summarise the approach, including standards / guidelines used, in respect of specific scheme types.

Water reuse schemes

These schemes involve the transfer of treated secondary effluents from wastewater treatment works (WwTW) to water courses (rivers/lakes) upstream of abstractions for potable water treatment to increase the amount of water available for abstraction. The primary hazards considered include:

- A source of microbiological contamination
- A source of chemical contamination
- A source of organic chemicals that could increase tri-halomethane (THM) potential

There are currently no UK/EU specific guidelines for indirect or direct potable reuse; as a result, the following existing standards/guidelines have been utilised to define the treatment needs and technological solutions:

- Water Framework Directive (WFD) - Directive 2000/60/EC of the European Parliament
- Water Supply (Water Quality) Regulations 2106 (England) as implemented by the Drinking Water Inspectorate (DWI)
- Australian Guidelines for Water Recycling
- California State interim criteria for indirect and direct potable reuse (Olivieri et al. 2016)

Design of treatment requirements for schemes have been based on the following principles:

- 'No deterioration' with respect to environmental standards in receiving waters
- 'No deterioration' with respect to UK and Australian potable water chemical quality standards
- 'No deterioration' with respect to UK potable water microbiological standards

For those schemes not discharging to the rivers Test and Itchen, the following generic treatment trains have been proposed:

- Ferric dosing and tertiary Membrane Bio-reactors (MBR) – primarily to achieve 'no deterioration' against phosphorus, ammonia, BOD and suspended solids
- UV Advanced Oxidation Processes (UV AOP) to reduce concentrations of organic compounds
- Granular Activated Carbon (GAC) to remove residual peroxides and potential by-products from the process (including THMs)
- Inclusion in the existing Water Treatment Works (WTWs) treatment train of UV AOP and GAC – in respect of the former, upgrading to AOP if UV already in place; in respect of the latter new systems if not already in place.

Overall the treatment train (effluent plus WTW upgrades) have been designed to achieve a 12-log10 reduction for enteric virus, 10-log10 reduction for Giardia cysts, and 10-log10 reduction for Cryptosporidium oocysts (referred to as "12/10/10" Log Reduction Value (LRV) criteria) between raw sewage and treated drinking water. The inclusion of upgrades in the WTW are not only to provide microbiological protection but also to provide resilience against any issues in the tertiary effluent treatment train. Both the LRV and resilience elements are as per recommendations in the California State interim criteria.

For those schemes discharging to the rivers Test and Itchen, reverse osmosis (RO – including remineralisation) has been included as an additional element of the effluent treatment train to achieve the very low levels of phosphorus required in the discharge. RO also provides additional organics and microbiological control with the result that to provide and maintain LRVs and resilience only UV disinfection (rather than UV AOP) has been included in the WTW treatment train (where none already exists).

Should reuse schemes require implementation, the final design and requirements will be discussed and agreed with the DWI.

Desalination schemes

All the desalination schemes have been designed on principles required to achieve compliance with the Water Supply (Water Quality) Regulations 2106 (England) as implemented by the DWI. These are early stage schemes and, as such, allowance has been made in respect of:

- Remineralisation – to take account of the potentially aggressive nature of the treated water and to match existing quality of water, in any blend, with a view to avoiding taste issues and chemical reactions that could cause issues in-pipe. The exact nature of remineralisation will need to be defined during detailed design and will require extensive analysis of existing water quality and pilot trials of the proposed treatment trains.
- Disinfection – allowance has been made for marginal chlorination.

Additional requirements will be discussed with the DWI when implementation of such schemes becomes a necessity.

Nitrate schemes

As identified within relevant Drinking Water Safety Plans, several schemes (outside of those subject to existing DWI Undertaking SRN3687) have been included in the options appraisal on the basis that rising nitrate concentrations could lead to a loss in deployable output (DO). Catchment management combined with additional treatment (primarily ion exchange) have been proposed as options to recover the loss in DO and address water quality issues. Flows were required to be treated to achieve, when blended, the standard (50mg/l). Ion Exchange has been selected as current best practice. The exact nature of the additional treatment will need to be defined during detailed design and will require extensive analysis of existing raw and treated water quality; this may require pilot trials of the proposed treatment trains.

Pesticide schemes

As a function of a current DWI Undertaking (DWI Ref No: SRN 3294) several schemes have been included in the options appraisal on the basis that pesticide concentrations could lead to a loss in DO. Catchment management combined with additional treatment (at this stage UV AOP has been selected) have been proposed as options to recover the loss in DO and address water quality issues through achieving concentrations as per existing standards (0.1µg/l per individual pesticide). The exact nature of the additional treatment will need to be defined during detailed design and will require extensive analysis of existing raw and treated water quality; this may require pilot trials of the proposed treatment trains.

Other ground and surface water schemes

A range of other ground and surface water schemes have been included as options in the WRMP process. In all cases water quality requirements have been considered and, where there is data lacking, a precautionary approach has been taken. For example, for the Sittingbourne licence trading scheme, whereby Southern Water would seek to take up an unused part of an existing groundwater abstraction licence, little is known about the quality of the water. Based on understanding of the location and surrounds it has been proposed that GAC, UV disinfection and marginal chlorination be included in the treatment process prior to feed of the treated water into the existing distribution system in order to meet water quality standards. In practice, such a system may not be required but this demonstrates that water quality is fundamental to the options appraisal process.

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Appendix C: Leakage Options

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from Southern Water

Contents

Southern Water

1. Executive Summary

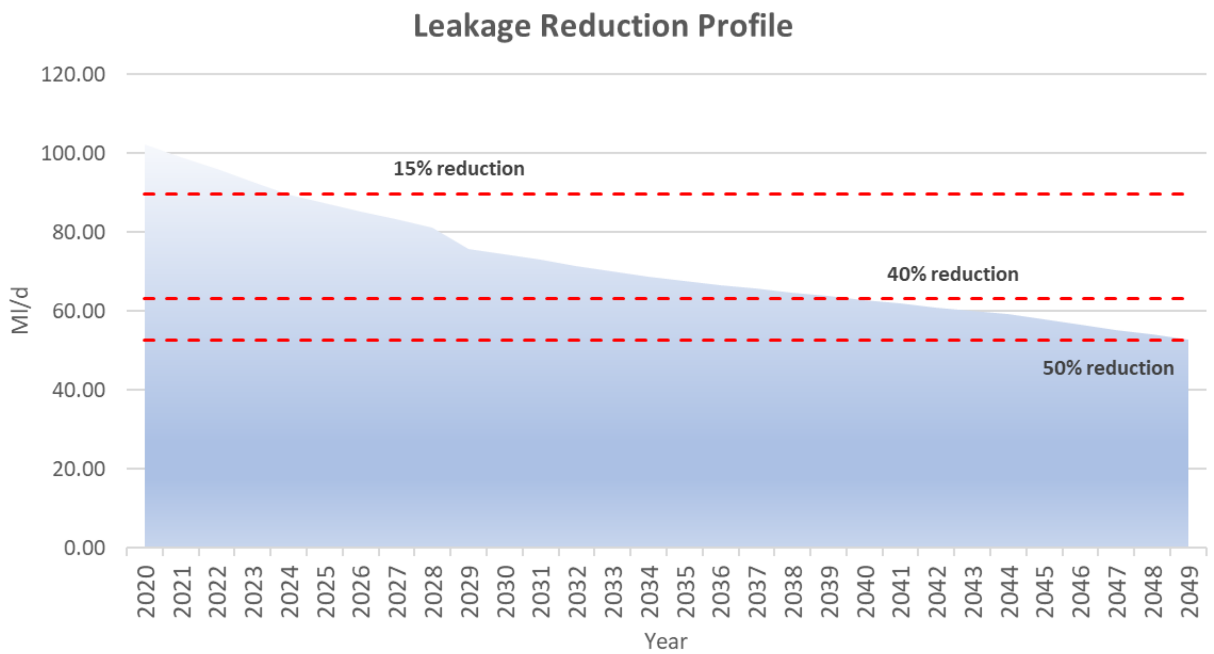
Historically our leakage performance has been among the best in the UK. We have one of the lowest leakage per property across the country, a position that we have maintained for a number of years. On a per km basis we were just outside upper quartile performance in 2016-17 but achieved upper quartile in the previous 3 years.

However, changes in the leakage reporting methodology are causing an increase in our reported leakage with our end of AMP6 target expected to increase from approximately 86Ml/d up to 105Ml/d. Whilst the changes have not yet been embedded into the supply demand calculations, to maintain our industry leading position we have set ambitious leakage reduction commitments against our new methodology leakage value of 105Ml/d. These commitments are to achieve:

- 15% reduction from end of AMP6 level by 2025
- 40% reduction from end of AMP6 level by 2040
- 50% reduction from end of AMP6 level by 2050

Figure 1 shows our leakage reduction profile to meet these targets in 2025, 2040 and 2050.

Figure 1 Leakage reduction profile (from new methodology leakage value)



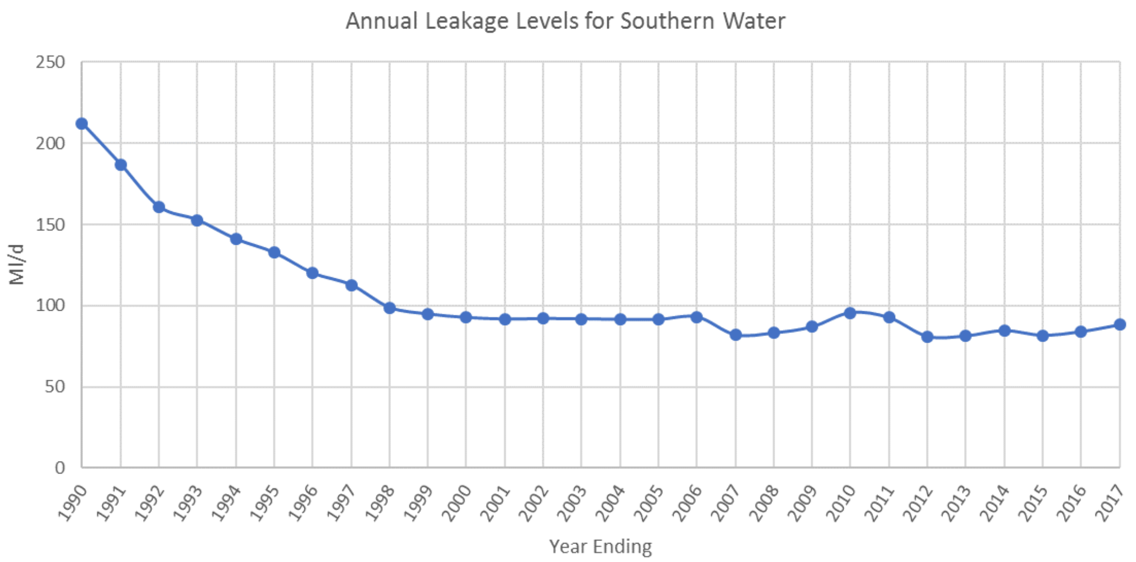
We are proposing a range of approaches to achieve these ambitious targets. It represents a diversified strategy to deliver reductions in the most efficient way and to best guarantee the delivery of our leakage targets. We have included options to improve active leakage control (ALC) efficiency through new technologies and practices, mains renewal programmes and future additional leakage reduction activities to account for potential future savings that cannot yet be fully quantified.

We compare our leakage reduction commitments to our calculated sustainable economic level of leakage (SELL) which shows that we are planning to exceed our SELL by as much as 40.7Ml/d by 2050 depending on the future supply-demand balance.

2. Introduction

Since privatisation in 1989 we have reduced leakage by over 60% (see Figure 2) and have historically been among the best water companies in England and Wales in terms of total leakage. We have maintained the lowest leakage level per property across the country for several years.

Figure 2 Annual reported leakage for Southern Water from 1989-90 to 2016-17



In response to an initiative by UK water companies, Water UK has developed a methodology for calculating leakage to ensure that leakage is reported in a consistent manner across the industry. The new methodology will be formally applied from 2020 onwards but we are already preparing for the change and have calculated the impact on our reported leakage (referred to as 'shadow reporting'). The new methodology is resulting in an increase to our reported leakage with our end of AMP leakage target expected to rise from approximately 86Ml/d up to 105Ml/d. Appendix A1 summarises the background to the new leakage methodology.

To maintain our industry leading position, we have set ambitious leakage reduction commitments:

- 15% reduction from end of AMP6 level by 2025
- 40% reduction from end of AMP6 level by 2040
- 50% reduction from end of AMP6 level by 2050

While the changes in the leakage calculation have not yet been embedded into the supply-demand calculations, our leakage reductions have been based on the new leakage value of approximately 105Ml/d. This equates to a much greater percentage reduction against our current leakage levels.

In its latest update to the leakage methodology for this plan (EA, 2017), the EA refers to Ofwat's final PR19 methodology 'Delivering Water 2020' (Ofwat, 2017), which challenges companies to set stretching leakage performance commitment levels relative to several measures. These are outlined in Table 1 with reference to the section of this report that demonstrates how we are meeting these challenges.

Table 1 Ofwat leakage reduction commitments

Set stretching leakage performance commitment levels to…	Section of report
Achieve forecast upper quartile performance (in relation to l/prop/day and l/km/day) – or justify why this is not appropriate	Section 1.1
Achieve a least a 15% reduction in leakage – or justify why this is not appropriate	Section 2
Justify leakage performance commitments relative to the minimum level of leakage achievable	Section 2.1

The guidance also asks for a comparison with SELL which is presented in Section 4.

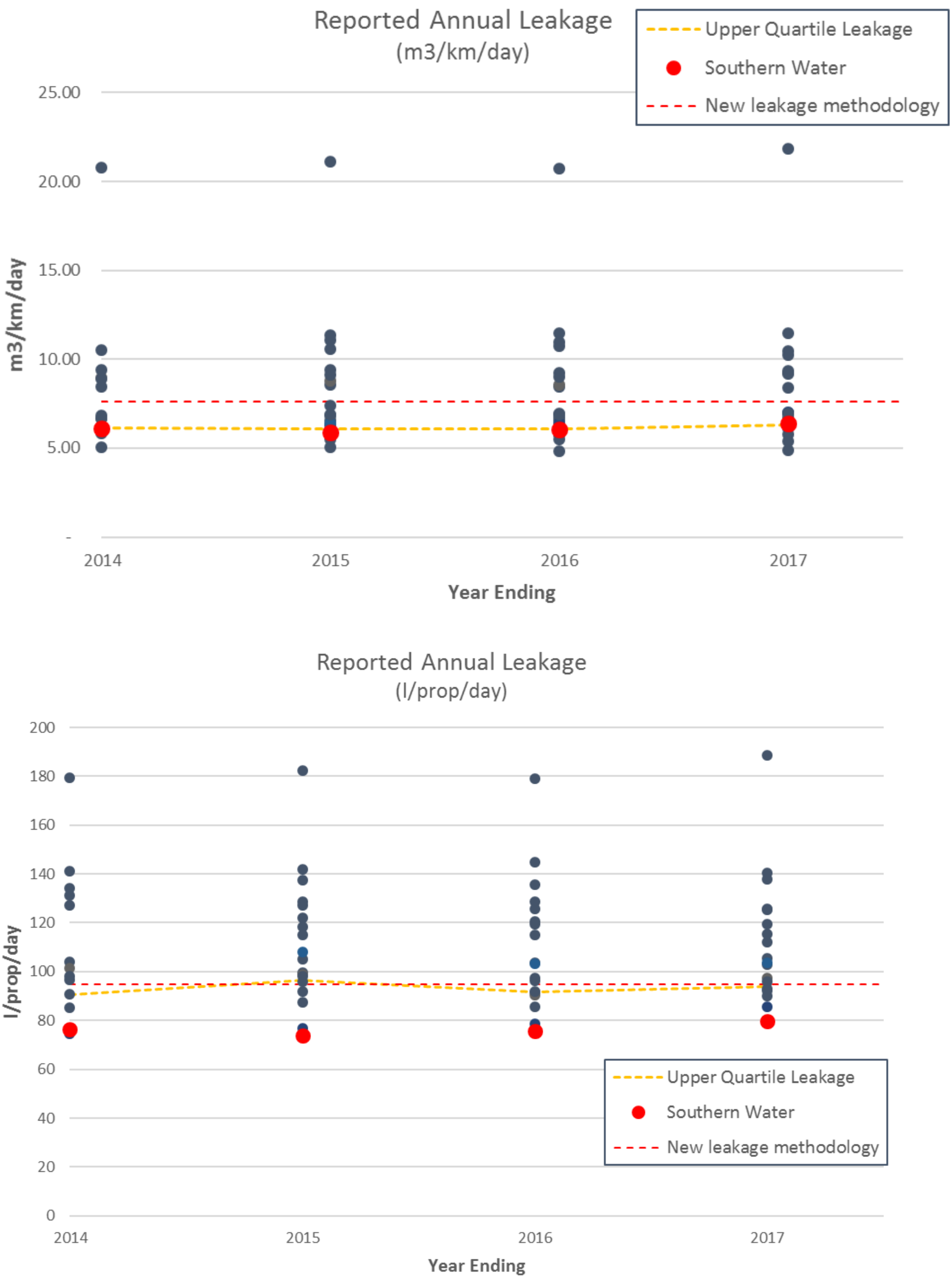
2.1 Benchmarking our leakage

Figure 3 shows our leakage performance over the past four years against the other UK water companies with the yellow dotted line identifying upper quartile performance (i.e. 25th percentile of all reported leakage values). As the figure shows, we currently have the lowest leakage levels per property across the country and are just above the upper quartile of values in terms of per km leakage. However, placing our new shadow reporting end of AMP6 leakage total on this figure (dotted red line) shows that this will place us outside upper quartile performance on a per km basis and just outside upper quartile performance on a per property basis.

We have used this data to identify the amount of leakage reduction required from our new shadow reporting leakage level to maintain our upper quartile performance on both per property and per km basis given three forecast scenarios of leakage reduction across the country. The results show that:

- If the upper quartile leakage figure remains the same, we will maintain our upper quartile performance on a per property basis and be in upper quartile performance on a per km basis by 2026;
- If the upper quartile leakage figure is lowered by 10%, we will be in upper quartile performance again on a per property basis by 2023 and on a per km basis by 2029;
- If the upper quartile leakage figure is lowered by 15%, we will regain our upper quartile performance on a per property basis by 2025 and on a per km basis by 2031.

Figure 3 Reported annual leakage values across England & Wales by km of pipe (top) and by property (bottom) (Data from water company annual reports)



2.1.1 Infrastructure Leakage Index

Work carried out by the International Water Association Water Loss Task Force (IWA WLTF) in 1999 recommended the use of an Infrastructure Leakage Index (ILI) (Lambert et al. 2000) defined in the box below. This allows a comparison of company performances and has been specifically designed to enable comparison between companies with different plumbing arrangements and connection densities, both within a country as well as in different countries. The index can compare whole systems and sub-systems down to around 2,500 service connections, although some practitioners consider that it should be applied only to larger areas, of over 10,000 connections.

Infrastructure Leakage Index (ILI)

The ILI is the ratio of the Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL). CARL are derived from the standard water balance calculation, so the ILI depends on an assessment of the unavoidable level of losses. UARL is given by:

$$UARL\ (litres\ per\ day) = \left(18 \times L_m + 0.8 \times N_c + 25 \times L_p\right) \times P_{av}$$

Where:

- L_m is the mains length (km);
- N_c is the number of service connections;
- L_p is the aggregate length of private pipe (km) between property lines and customer meters;
- P_{av} is the average operating pressure (m)

The IWA WLTF applied the index on several countries' systems and showed that generally most countries had an ILI greater than 1. ILI values have been used to categorise the condition of a system. Broadly, a system in the range of 1 to 2 can be considered 'well managed' with active leakage management while systems with no active leakage management programme and poor asset condition can have ILI's greater than 10.

Table 2 shows ILI classification ranges taken from Atkins (2006). We have simplified the ranges by grouping all ILI values above 3 into a 'Poor' category as the detail given at the higher range was not applicable in this case.

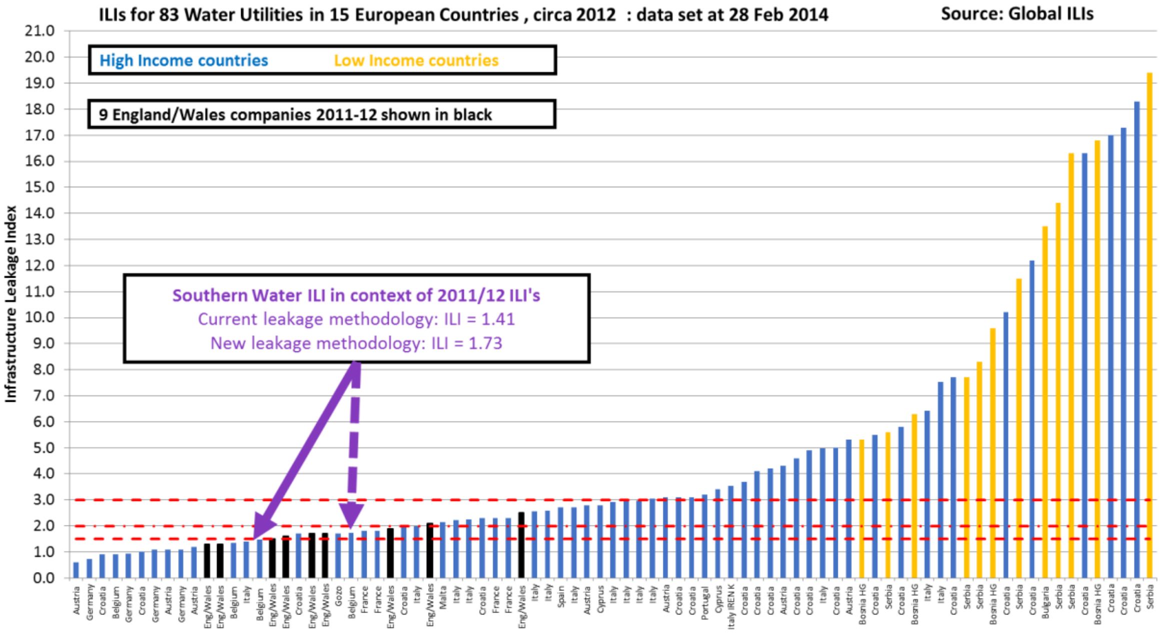
Table 2 ILI value classification

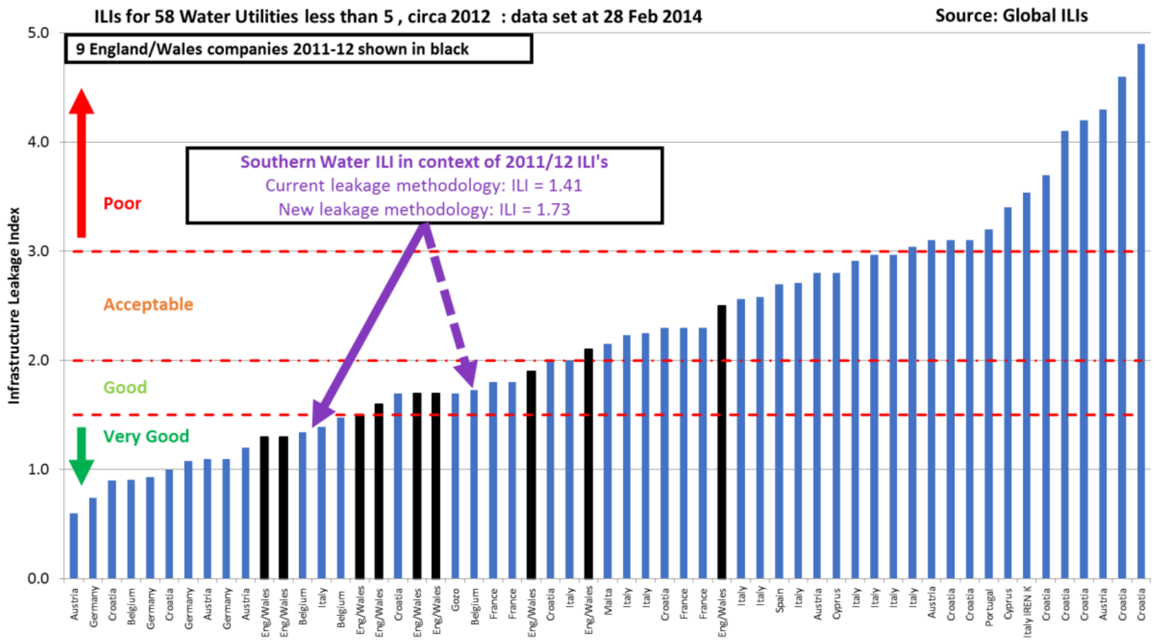
ILI Category	ILI Value
Very good	1–1.5
Good	1.5–2
Acceptable	2–3
Poor	>3

Between 2002 and 2004 a review of ILI values among UK water companies placed us in the top three in the country with ILI values of 1.29 and 1.38 for the years 2002–03 and 2003–04 respectively (Atkins, 2006). We have updated this ILI calculation to reflect our end of AMP6 leakage target and achieved a value of 1.41 suggesting we have maintained the 'very good' status of our network for over 10 years.

In Figure 4 our end of AMP6 ILI value is placed in the context of over 80 water utilities across Europe taken from Lambert et al. (2014). While the sample may not be fully representative of water utilities across Europe, this shows that under the new leakage methodology we fall just outside the upper quartile of the sample.

Figure 4 ILI's for sample of 83 water utilities across Europe (from Lambert et al. 2014).





3. Leakage reduction profile

To maintain our industry-leading position, we have set ambitious leakage reduction commitments:

- 15% reduction from end of AMP6 level by 2025
- 40% reduction from end of AMP6 level by 2040
- 50% reduction from end of AMP6 level by 2050

While the changes in the leakage calculation have not yet been embedded into the supply demand calculations, to ensure we commit to the highest possible savings our leakage reductions have been based on the new leakage total at the end of AMP6 of approximately 105Ml/d. This equates to a profile of greater percentage reductions when compared against our current leakage levels.

Figure 5 shows our proposed leakage reduction profile with the initial 15% leakage reduction target identified and Figure 6 presents the breakdown of reduction by leakage activity which are outlined in Section 3.

Figure 5 Leakage reduction profile

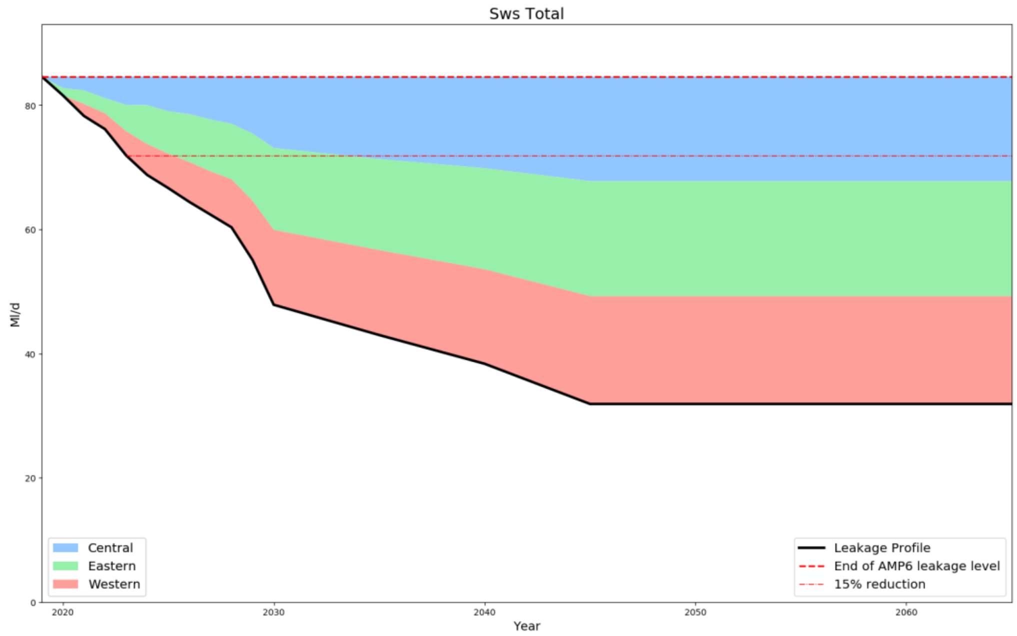
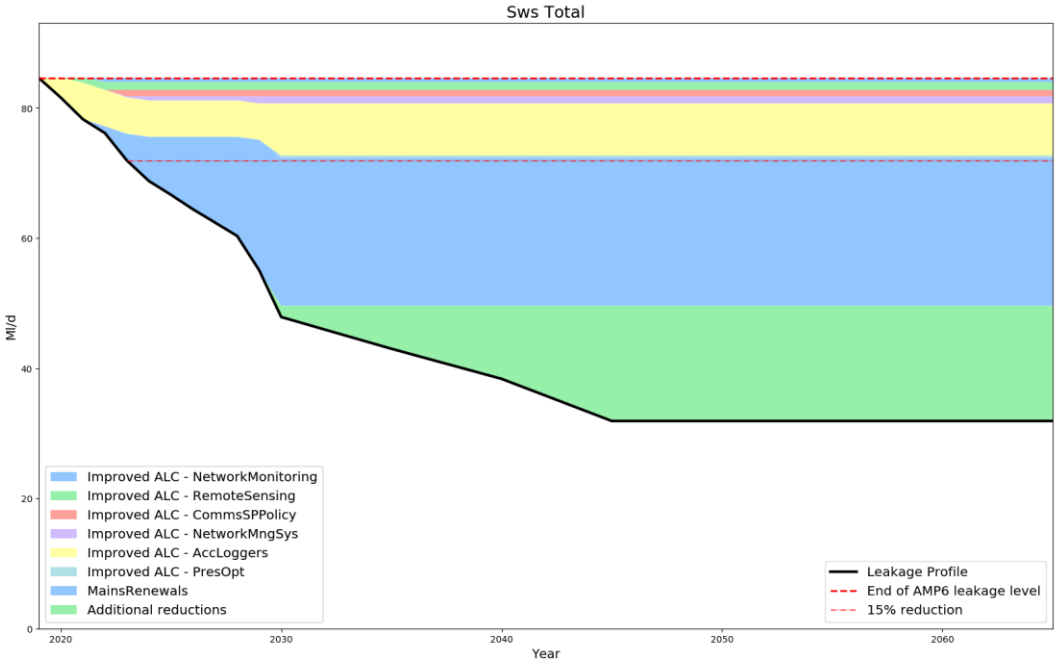


Figure 6 Breakdown of leakage reduction activities



3.1 Minimum Achievable Leakage Level

As noted in the introduction, Ofwat has challenged companies to justify their leakage reduction commitments relative to their Minimum Achievable Leakage (MAbL). The box below provides a summary of MAbL and its calculation methods.

There is no accepted method for calculating MAbL and so we have employed several approaches, including the two UKWIR methods as well as a direct calculation approach broadly based on the approach adopted to develop the UKWIR equations. We have critically compared the results of these methods and estimate our MAbL value to be 37.6Ml/d which is consistent with the minimum leakage value we calculated in WRMP14.

Our commitment to reduce leakage by 50% by 2050 is equivalent to a reduction of over 52Ml/d which will reduce the gap between our shadow reporting leakage level and MAbL to approximately 15Ml/d.

Minimum Achievable Leakage (MAbL)

MAbL is the theoretical minimum leakage level given limitless ALC effort (UKWIR, 2013). Historically, the minimum achieved levels of leakage in each area have been used to calculate a company's minimum leakage levels, referred to as the Minimum Achieved Leakage (MAL) or the Policy Minimum Leakage. However, MAbL is an attempt to go beyond this by estimating a theoretical minimum potentially lower than can be seen in the historic record.

UKWIR (2013) first identified the concept of MAbL as distinct from the Policy Minimum and proposed the following equation as a means of estimating it in a District Metered Area (DMA):

$$MAbL\ (l\ per\ hour) = \ a \times \left(\frac{L}{N}\right)^{\alpha} \times kJ^{\gamma} \times AZNP^{\delta}$$

Where:

- $L = length\ of\ mains\ (m)$
- $N = number\ of\ properties$
- $kJ = (7.N + L/3)/1000,\ a\ measure\ of\ network\ size$
- $AZNP = average\ zonal\ night\ pressure\ (m)$

Further work by UKWIR (UKWIR, 2016) aimed to consolidate the understanding of the variations in minimum leakage between DMAs by proposing a formula for examining percentiles of MAL, termed MAL 'frontiers', and given by:

$$MAL_{50} = \left(\frac{L}{N}\right)^{\alpha} \times AZNP^{b} \times R_1^{c} \times D_1^{d} \times R_2^{e} \times D_2^{f} \times kJ^{g} \times Age^{h}$$

Where:

- $R1 = reported\ customer\text{-}side\ repairs\ per\ year\ per\ 100\ properties$
- $R2 = report\ company\text{-}side\ repairs\ (mains, communication\ pipe\ and\ ancillary\ leaks)\ per\ year\ per\ kJ$
- $D1 = detected\ customers\text{-}side\ repairs\ per\ year\ per\ 100\ properties$
- $D2 = detection\ company\text{-}side\ repairs\ per\ year\ per\ kJ$
- $Age = average\ age\ based\ on\ mains\ pipe\ age\ weighted\ by\ length\ (years)$

4. Leakage reduction activities

To achieve our ambitious leakage reduction targets a range of leakage reduction options have been considered. This represents a diversified strategy to deliver leakage reduction in the most efficient way to best guarantee the delivery of our leakage targets.

The development of the leakage options and associated costs have been taken directly from the work conducted for the recent Business Plan submitted for PR19. Our overall cost assessment approach for this work has been reviewed and indicated to be appropriate and effectively managed.

To take a conservative approach and recognise the uncertainty in leakage reduction benefits a judgement of 'certainty', given as a percentage, has been used to scale the maximum leakage savings from each option to a 'most likely' savings value.

4.1 Smart network technologies and improved active leakage control

Our AMP6 leakage performance has been strong and will see Southern Water end AMP6 as a frontier company for leakage. To achieve this baseline level of leakage our team of 'leakbusters' work around the clock to find and repair leaks with over 20,000 leaks having been repaired during each of the last six years. We plan to maintain this robust performance on background leakage levels through continuing these 'find and fix' activities.

To meet our leakage reduction targets, options to improve efficiency in 'find and fix' activities are included and summarised in Table 3. The suite of options includes adopting an innovative range of emerging smart network technologies complemented by enhanced 'Big Data' analytics capability. Many of these options have high setup costs but deliver cost-efficient leakage reductions thereafter.

As some of the technologies are relatively immature and have not been implemented on this scale before, there are limited to the amount of benefits they can deliver over the immediate term. As part of our long-term strategy, we will invest in emerging technology in AMP7 to enable successful implementation during AMP8 – particularly Artificial Intelligence to support smart networks.

Options to increase 'find and fix' effort were also considered but have been excluded as this is considered practicably limited due to a shortage of sufficient numbers of suitably qualified leakage personnel in south east England. We anticipate this will be further exacerbated by other water companies also attempting to increase ALC resources to achieve leakage reductions of above 10%. In the long run increases in resourcing levels may become viable and we will aim take advantage of all reduction opportunities.

Table 3 Smart networks and improved ALC to meet leakage reduction targets

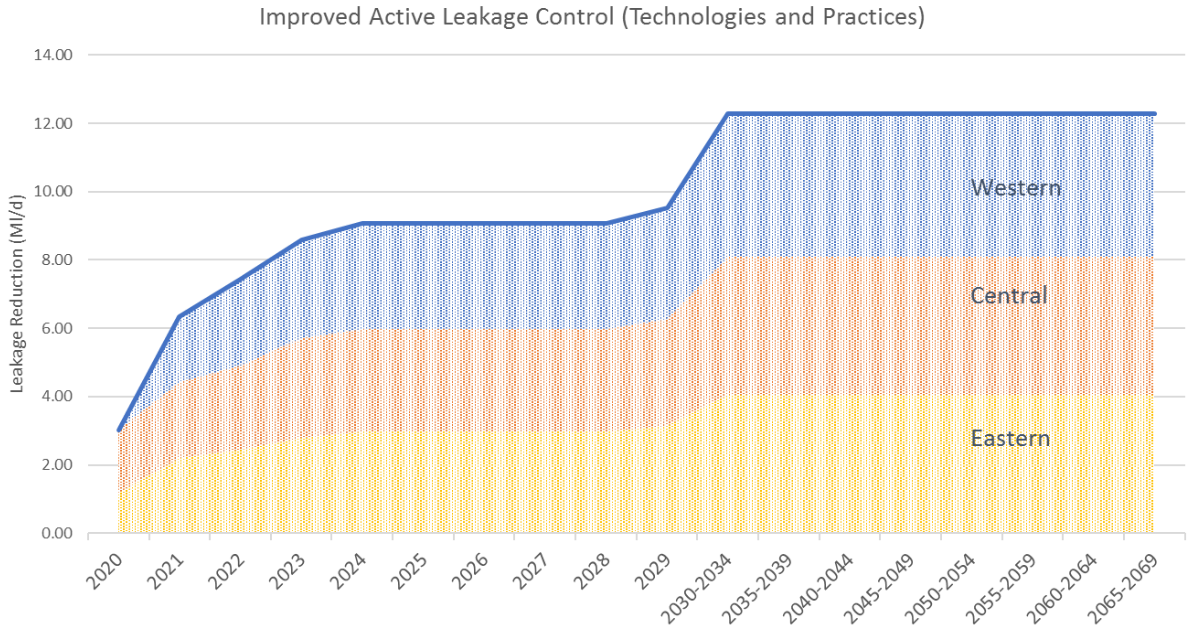
Option	Area	Certainty	Max savings (Ml/d)	Most likely savings (Ml/d)	CAPEX (£k)	OPEX (£k/a)	AMP
Semi-permanent acoustic logging	Central	80%	2.30	1.84	1,133	141.6	AMP7
	Eastern		2.31	1.85	1,136	142.0	AMP7
	Western		2.39	1.91	1,177	147.2	AMP7
Remote Sensing (Satellite Imaging and Drones)	Central	80%	0.49	0.39	435.0	11.6	AMP7
	Eastern		0.49	0.40	436.4	11.6	AMP7
	Western		0.51	0.41	452.2	12.1	AMP7

Option	Area	Certainty	Max savings (Ml/d)	Most likely savings (Ml/d)	CAPEX (£k)	OPEX (£k/a)	AMP
Additional Network Monitoring (Flow/Pressure and Transient Sensors)	Central	80%	0.26	0.21	390.5	53.4	AMP7
	Eastern		0.26	0.21	391.7	53.5	AMP7
	Western		0.27	0.22	405.9	55.5	AMP7
Change in Comms and Supply Pipe Policy	Central	99%	0.33	0.33	0.0	302.3	AMP7
	Eastern		0.33	0.33	0.0	303.3	AMP7
	Western		0.34	0.34	0.0	314.3	AMP7
Network Management System - Phase 1 (Data Collection / Visualisation and Reporting)	Central	80%	0.26	0.21	1114.8	53.1	AMP7
	Eastern		0.26	0.21	1118.5	53.3	AMP7
	Western		0.27	0.22	1159.0	55.2	AMP7
Network Management System - Phase 2 - Automated Optimisation and Control	Central	30%	0.49	0.15	985.1	32.9	AMP8
	Eastern		0.49	0.15	989.1	33.0	AMP8
	Western		0.51	0.15	1,025.0	34.2	AMP8
Real-Time pump and pressure optimisation	Central	30%	0.39	0.12	821.6	32.9	AMP9
	Eastern		0.40	0.12	824.3	33.0	AMP9
	Western		0.41	0.12	854.2	34.2	AMP9
Permanent acoustic logging	Central	30%	2.63	0.79	6,573	164.3	AMP9
	Eastern		2.64	0.79	6,594	164.9	AMP9
	Western		2.73	0.82	6,833	170.8	AMP9

4.1.1 Leakage reduction profile

Our leakage reduction profile comprises 9.1Ml/d of leakage reduction through improved ALC technologies and practices by the end of AMP7. Figure 7 shows that the AMP7 reductions are roughly equal across our three areas (approx. 3Ml/d reduction in each area).

Figure 7 Leakage reduction through improved ALC technologies



4.2 Mains renewals

While mains renewals for leakage reduction are significantly less efficient than ALC or smart technologies, due to the limits on these options, renewals still have a key role to play in our diversified leakage strategy.

To maximise leakage benefit, and building on lessons learned from other water companies, we have adopted a complete District Metered Area (DMA) replacement policy which will see the replacement of all water mains, communication pipes and customer supply pipes in each DMA. This will lead to the creation of 45 'No Leak Zones' and ensure that future maintenance needs in these areas are negligible providing customers with an improved level of service.

Table 4 shows the mains renewals options included in the investment model alongside the AMP period they are planned to be implemented in. Two of the mains renewals 'blocks' in AMP7 are selected due to other non-leakage drivers but they also provide a small leakage benefit.

Table 4 Mains renewal leakage reduction options

Option	Area	Certainty	Max savings (Ml/d)	Most likely savings (Ml/d)	CAPEX (£k)	OPEX (£k/a)	AMP
Regional mains renewal Block 1	Central	60%	1.73	1.04	4,809.1	0	AMP7
	Eastern		2.44	1.46	4,690.9	0	AMP7
	Western		0	0	0	0	AMP7
Regional mains renewal Block 2	Central	60%	0.99	0.59	2,284.8	0	AMP7
	Eastern		0	0	0	0	AMP7
	Western		1.67	1.0	4,522.6	0	AMP7

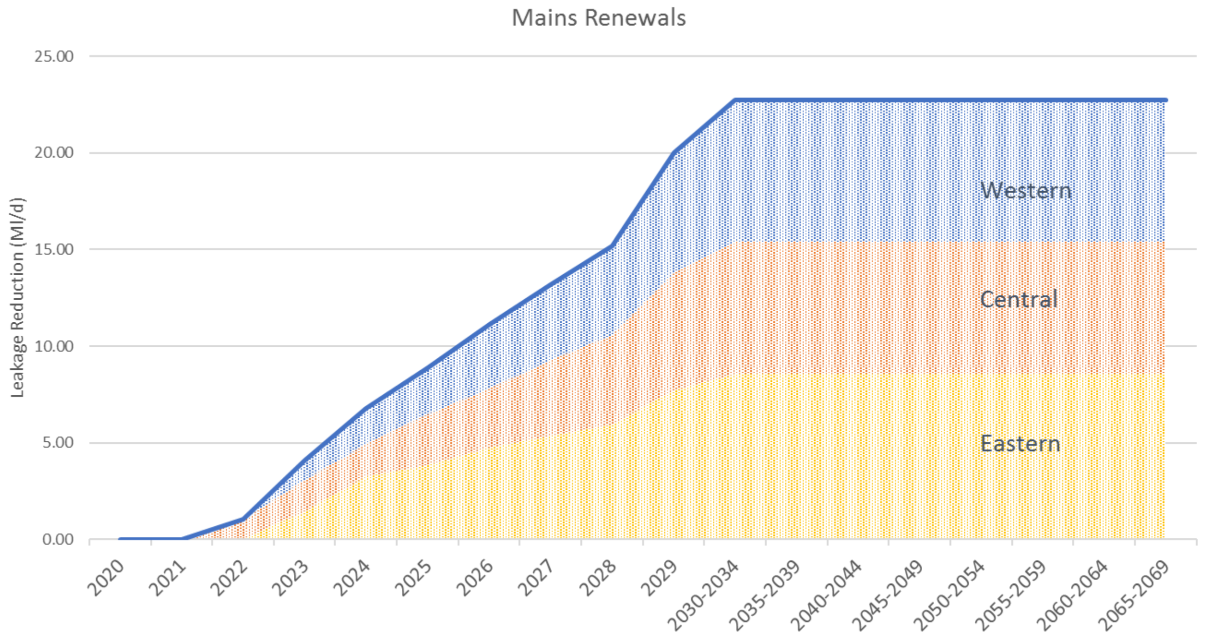
Option	Area	Certainty	Max savings (Ml/d)	Most likely savings (Ml/d)	CAPEX (£k)	OPEX (£k/a)	AMP
Regional mains renewal Block 3 (Deal Lead Reduction Scheme)	Central	60%	0	0	0	0	AMP7
Regional mains renewal Block 3 (Deal Lead Reduction Scheme)	Eastern	60%	3.04	1.82	21,115.8	0	AMP7
Regional mains renewal Block 3 (Deal Lead Reduction Scheme)	Western	60%	0	0	0	0	AMP7
Regional mains renewal Block 4 (Rownhams and IoW North DWI discolouration)	Central	60%	0	0	0	0	AMP7
Regional mains renewal Block 4 (Rownhams and IoW North DWI discolouration)	Eastern	60%	0	0	0	0	AMP7
Regional mains renewal Block 4 (Rownhams and IoW North DWI discolouration)	Western	60%	1.44	0.86	29,990.3	0	AMP7
Regional mains renewal Block 5	Central	60%	0.92	0.55	3,647.8	0	AMP8
Regional mains renewal Block 5	Eastern	60%	0.92	0.55	3,659.8	0	AMP8
Regional mains renewal Block 5	Western	60%	0.96	0.57	3,792.4	0	AMP8
Regional mains renewal Block 8	Central	60%	0.72	0.43	3,253.5	0	AMP8
Regional mains renewal Block 8	Eastern	60%	0.73	0.44	3,264.1	0	AMP8
Regional mains renewal Block 8	Western	60%	0.75	0.45	3,382.4	0	AMP8
Regional mains renewal Block 7	Central	60%	0.76	0.45	3,417.8	0	AMP8
Regional mains renewal Block 7	Eastern	60%	0.76	0.45	3,429.0	0	AMP8
Regional mains renewal Block 7	Western	60%	0.79	0.47	3,553.3	0	AMP8
Regional mains renewal Block 6	Central	60%	0.79	0.47	3,582.1	0	AMP8
Regional mains renewal Block 6	Eastern	60%	0.79	0.47	3,593.8	0	AMP8
Regional mains renewal Block 6	Western	60%	0.82	0.49	3,724.1	0	AMP8
Regional mains renewal Block 9	Central	60%	0.66	0.39	3,023.4	0	AMP8
Regional mains renewal Block 9	Eastern	60%	0.66	0.40	3,033.3	0	AMP8
Regional mains renewal Block 9	Western	60%	0.68	0.41	3,143.3	0	AMP8
Regional mains renewal Block 10	Central	60%	0.59	0.35	3,187.7	0	AMP8
Regional mains renewal Block 10	Eastern	60%	0.59	0.36	3,198.2	0	AMP8
Regional mains renewal Block 10	Western	60%	0.61	0.37	3,314.1	0	AMP8
Regional mains renewal Block 11	Central	60%	0.69	0.41	3,976.4	0	AMP8
Regional mains renewal Block 11	Eastern	60%	0.69	0.42	3,989.5	0	AMP8
Regional mains renewal Block 11	Western	60%	0.72	0.43	4,134.1	0	AMP8
Regional mains renewal Block 12	Central	60%	0.69	0.41	4,206.5	0	AMP8
Regional mains renewal Block 12	Eastern	60%	0.69	0.42	4,220.3	0	AMP8
Regional mains renewal Block 12	Western	60%	0.72	0.43	4,373.3	0	AMP8
Regional mains renewal Block 13	Central	60%	0.56	0.34	3,516.4	0	AMP8
Regional mains renewal Block 13	Eastern	60%	0.56	0.34	3,527.9	0	AMP8
Regional mains renewal Block 13	Western	60%	0.58	0.35	3,655.8	0	AMP8
Regional mains renewal Block 14	Central	60%	0.56	0.34	3,713.5	0	AMP8
Regional mains renewal Block 14	Eastern	60%	0.56	0.34	3,725.7	0	AMP8
Regional mains renewal Block 14	Western	60%	0.58	0.35	3,860.8	0	AMP8

Option	Area	Certainty	Max savings (Ml/d)	Most likely savings (Ml/d)	CAPEX (£k)	OPEX (£k/a)	AMP
Regional mains renewal Block 14_2	Central	60%	0.43	0.26	3,483.5	0	AMP9
	Eastern		0.43	0.26	3,494.9	0	AMP9
	Western		0.44	0.27	3,621.6	0	AMP9
Regional mains renewal Block 16	Central	60%	0.43	0.26	3,516.4	0	AMP9
	Eastern		0.43	0.26	3,527.9	0	AMP9
	Western		0.44	0.27	3,655.8	0	AMP9
Regional mains renewal Block 15	Central	60%	0.95	0.57	8,051.5	0	AMP9
	Eastern		0.96	0.57	8,077.8	0	AMP9
	Western		0.99	0.59	8,370.7	0	AMP9

4.2.1 Leakage reduction profile

Our leakage reduction profile comprises 6.8Ml/d leakage reduction through mains renewals by the end of AMP7. Figure 8 shows that the AMP7 reductions are larger in the Eastern area (approx. 3.3Ml/d) compared to 1.6Ml/d and 1.9Ml/d in the Central and Western areas respectively.

Figure 8 Leakage reduction through mains renewals



4.3 Additional leakage reduction activities

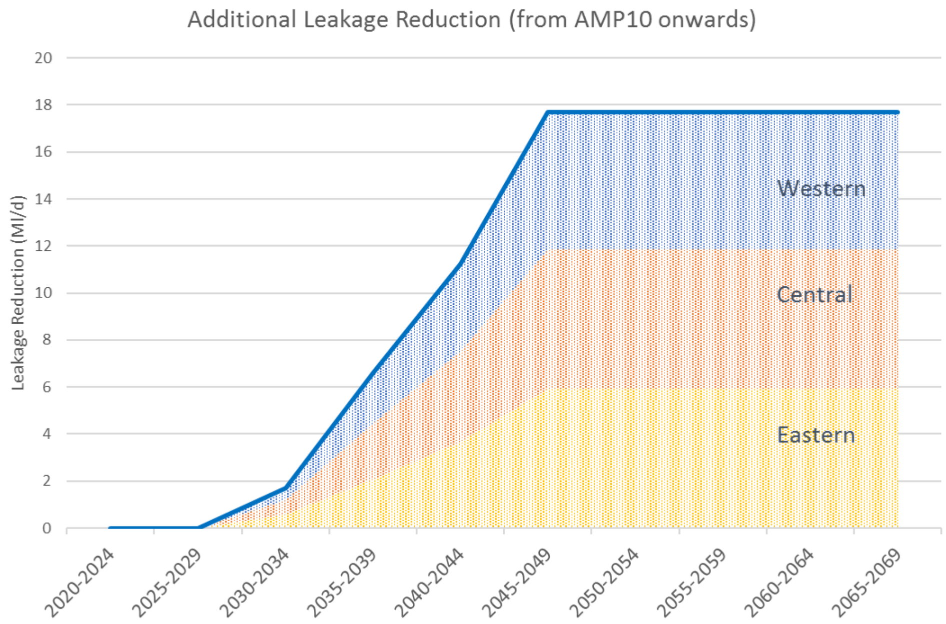
Advancements in leakage reduction capabilities are being made all the time and to ensure that we are building in new and innovative methods to our leakage reduction strategy a series of 'additional' leakage reduction options are included to represent future reduction potential. These may be made up of improvements in ALC, smart networks or mains renewals and represents our commitment to continue to investigate and take advantage of opportunities as they arise.

These options are implemented from AMP10 onwards (i.e. 2035 onwards) to achieve 50% leakage reduction by 2050. As these options are inherently uncertain a conservative cost estimate has been taken to match the whole life average incremental cost (£/Ml) of the most expensive mains renewal programme (Block 15).

4.3.1 Leakage reduction profile

Figure 9 shows the leakage reduction profile from additional future activities totalling approximately 17.5Ml/d by the end of AMP12 (2049-50) to meet our 50% leakage reduction commitment.

Figure 9 Additional long-term leakage reduction



5. Comparison to SELL

By committing to our leakage reduction targets, we are moving away from SELL calculation. However, to show to what extent our commitments exceed the SELL we have run a sensitivity of the Investment Model where the leakage reduction profile is not forced in. Leakage options selected under this sensitivity run equate to our SELL.

The results of this analysis are shown below against our forced in leakage profile. It should be noted this has been used as an indicative comparison only as the only constraints placed on the leakage options in these runs were to restrict the 'Additional leakage reduction' options to 2030 or later. As can be seen from the figures this has resulted in a large amount of leakage reduction being selected in individual years. In reality, to meet the required reduction by this year a steadier profile of increasing leakage reduction up to the year in question would be needed.

Figure 10 shows that in both the Central and Eastern areas our leakage reduction profile exceeds the SELL by approximately 3.6Ml/d and 5.8Ml/d respectively by the end of AMP7. In the Western area a greater amount of leakage reduction is implemented towards the start of the planning period but by the end of AMP8 our leakage reduction profile reaches the SELL range before exceeding it.

We have committed to reduce leakage by 50% by 2050. As can be seen from Figure 10 this value will exceed the SELL range by as much as 40.7Ml/d depending on the supply-demand balance 'future'. The figure shows that even in the most extreme future our leakage profile will exceed the SELL by approximately 13.5Ml/d. This emphasises the ambitious targets we have set.

Table 5 compares the cost of carrying out our Preferred Plan, including our leakage reduction commitments, against the SELL run. This shows that the total expected NPV (net present value) of our Preferred Plan exceeds the SELL cost by approximately £347.1m across all our areas. While there is strong customer support for leakage reduction (see following Section) the size of this difference in part represents our policy decision to align with government guidance over customer preferences where conflicts arise.

Figure 10 Comparison of leakage profile against range of SELL reductions for each area

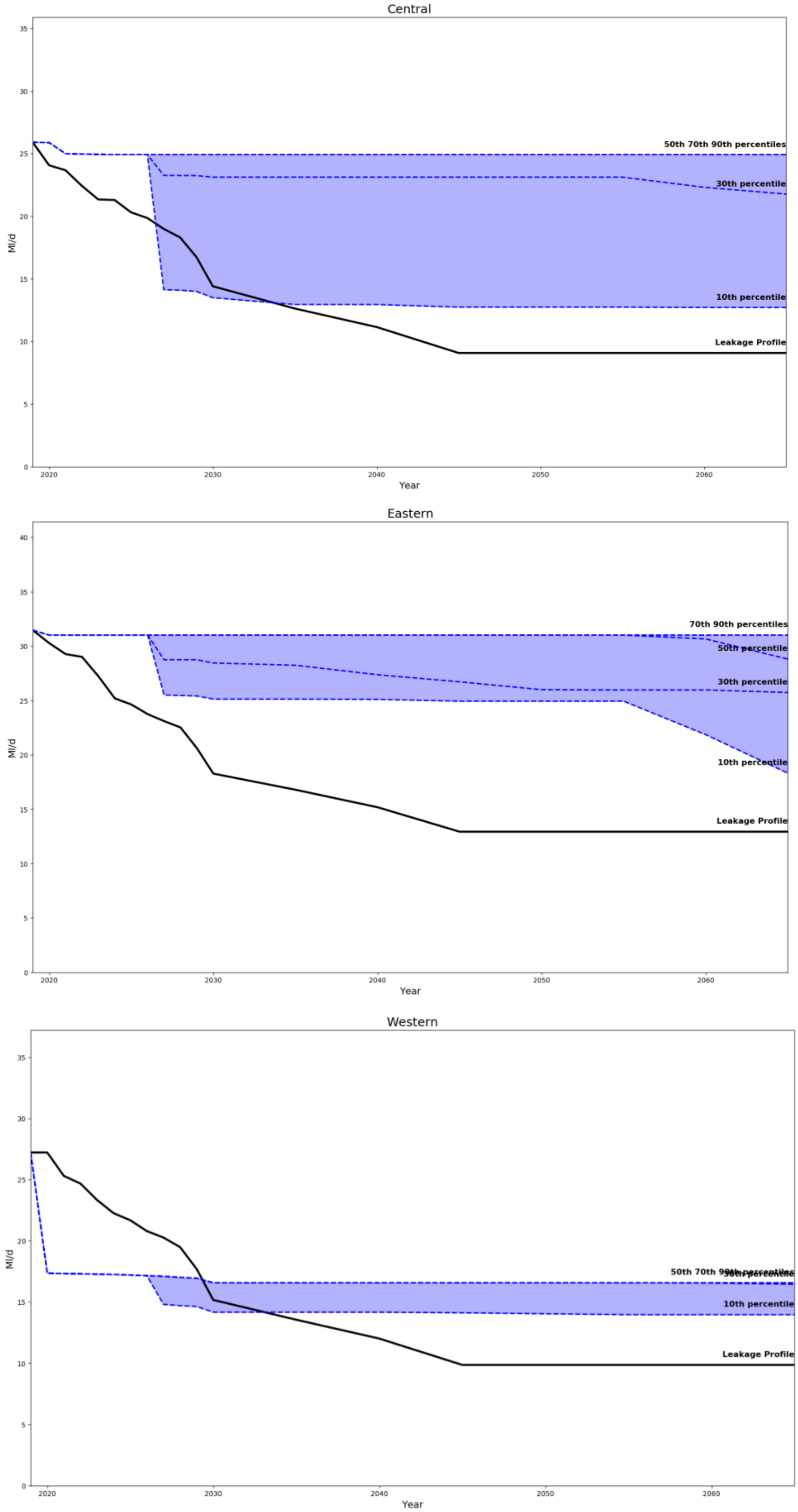


Table 5 Comparison of costs (total NPV) between the Preferred Plan and SELL run

Option	Preferred Plan		SELL run	
	Total plan NPV (£m)	Total AMP7 cost (£m)	Total plan NPV (£m)	Total AMP7 cost (£m)
Central	501.0	96.50	357.8	86.24
Eastern	283.3	52.56	151.4	50.14
Western	1,036.5	108.58	964.5	159.24
Total	**1,820.80**	**257.64**	**1,473.70**	**295.62**

6. Customer views

Customer engagement has been undertaken during the development of both this WRMP and the PR19 business plan to determine customers' priorities across all areas of our business:

- In August 2016 - An 'app', 1:1 interviews and focus groups were used to capture customers' long term priorities; 1:1 interviews were also held to capture businesses' long-term priorities.
- In February 2017 - An 'app' and focus groups were used to capture the long-term priorities of customers of the future (ages 11-18).

Specifically, for this plan, we also carried out an online scheme preference survey, undertook willingness-to-pay research and held scheme preference workshops.

In the online scheme preference survey reducing leakage was ranked fourth out of ten supply and demand management options for maintaining future supplies. Leakage improvements were found to be of the highest priority to customers amongst the water service measures in the willingness-to-pay survey. However, in the scheme preference workshops it was recognised that the economics of reducing leakage to lower levels was a potential constraint.

Further details of the customer engagement undertaken to inform the development of the WRMP and the results can be found in the pre-consultation section of Annex 1 (Pre-consultation and problem characterisation) of the WRMP.

7. Conclusions

Historically our leakage performance has been among the best in the UK. We have the lowest leakage per property across the country, a position that we have maintained for a number of years. On a per km basis we were above the upper quartile in 2016-17 and were at or just below the upper quartile in the previous 3 years.

However, changes in the leakage reporting methodology are resulting to an increase in our reported leakage with our end of AMP6 target expected to increase from approximately 86Ml/d up to 105Ml/d. Whilst the changes have not yet been embedded into the supply demand calculations to maintain our industry leading position, we have set ambitious leakage reduction commitments against our new methodology leakage value of 105Ml/d. These commitments are to achieve:

- 15% reduction from end of AMP6 level by 2025
- 40% reduction from end of AMP6 level by 2040
- 50% reduction from end of AMP6 level by 2050

We have calculated our SELL and compared this to our leakage reduction commitments to show that we have set ourselves ambitious targets that significantly outperform the SELL. Additionally, we have used benchmarking against reported leakage totals across England and Wales to show that our leakage reduction profile will see us maintain or regain upper quartile performance against the new methodology leakage value on both a per property and per km basis.

8. References

- Atkins, 2006, ‘Economic Level of Leakage Review: Stage 2 report Performance indicators based on system characteristics’, Environment Agency
- Environment Agency, 2017, “Leakage in WRMPs”
- Lambert et al., 2000, ‘A review of performance indicators for real losses from water supply systems’, IWA/AQUA
- Lambert et al., 2014, ‘14 years’ experience of using IWA Best Practice water balance and water loss performance indicators in Europe’
- Ofwat, 2017, ‘Delivering Water 2020: Our final methodology for the 2019 price review’
- UKWIR, 2013, ‘Factors affecting background leakage’, UKWIR Report Ref 13/WM/08/49
- UKWIR, 2016, ‘Factors affecting minimum achieved levels of leakage’, UKWIR Report Ref 16/WM/08/58

A1. Shadow reporting – background

Leakage is an important and critical estimate for the water industry. Since the mid-1990s we have undertaken a lot of work to reduce the levels of leakage across our water supply areas. The cornerstone of this work was the establishment of over 900 District Metered Areas (DMAs) or cul-de-sacs type networks which allow measurement the water flowing into them. Each DMA serves, on average, just over 1,000 properties.

Flows into a DMA are recorded at 15-minute intervals and it is the flow recorded at night (midnight to 3 am) which is reviewed and used to establish if leakage in that particular DMA is increasing (rising trend).

During the night, not all of the water flowing into the DMA is being lost through leakage and therefore it is important to establish a night-use consumption figure. This estimate of night-use allowance is undertaken by sampling a number of properties and then using these to estimate the night-use allowance across the network.

The subtraction of the night-use allowance figure from the flow provides an estimate of the operational or bottom-up leakage for the month. As these estimates vary from day to day, a percentile figure of all of the leakage estimates is used to calculate the operational leakage for the month. This method has been audited and reported to Ofwat several times in the past.

In April 2015 Water UK board meeting, members decided that the industry could benefit from cross-industry alignment on four key performance measures. The four measures were:

i) Leakage
ii) Sewer flooding in domestic properties,
iii) Interruptions to supply and
iv) Pollution incidents.

A series of working groups, using existing network groups, were used to bring together the pieces of work.

In January 2016 an updated paper was brought back to the board on progress that had been made and to consider the next steps. A further meeting between the CEOs later agreed to a consistent method of reporting for leakage and work on the final methodology concluded at the end of March 2017 (UKWIR, 2017).

The final methodology identified thirteen areas for discussion, debate and agreement of what Best Practice for the industry would look like. These topics for discussion ranged from the overall approach to the final calculation of leakage to specific percentiles to use for the derivation of the minimum night flow value.

The full range of measures that were considered by the working group are listed in Table 1. The table also summarises whether we currently comply with the suggested best practice approach and any relevant comments regarding the measure.

Table 1 Measures covered in the new leakage methodology

Measure	Current position of Southern Water	Additional comments
Overall leakage calculation	Already comply with the proposed best practice	This approach recommends the use of a bottom up, pre Maximum Likelihood Estimate (MLE), and top down (post MLE) approach to the derivation of the annual leakage figure
Leakage reporting level	Already comply with the proposed best practice	We currently use DMAs to collect 15-minute flow data which is then aggregated up into a zonal area. This level of aggregation is recommended in the report
Daily minimum night flow	We will have to alter our current practice to align with the proposals.	We currently use a 90th percentile value when calculating leakage for the minimum night flow. The recommendation is that we move to an average value during a fixed hour. This change could increase the leakage at the WRZ and company level.
Night use allowances for households (HH)	Already comply with the proposed best practice	Our historic approach complies with the proposed best practice. However, we are trialling an improved method utilising a fast logging approach which would provide an improved data set which could also help us comply with the proposed summer leakage methodology.
Non HH night use	Already comply with the proposed best practice	We currently comply with the proposed best practice approach.
DMA area, size and operability	Already comply with the proposed best practice	Our network has already been divided into DMAs and these are aggregated into at a zonal level.
Hour to Day factor	Already comply with the proposed best practice	Hour to day factors are calculated for each zone.
Summer leakage	We will have to alter our current practice to align with the proposals.	We are aligning our current method to comply with the proposed shadow reporting approach. This will require new systems to be put in place to change our processes to record monthly values of night use potentially using a fast logging approach.
Negative leakage values	Already comply with the proposed best practice	We do not encounter this problem as we aggregate DMAs together and undertake the review at a zonal level.
Trunk mains	Already comply with the proposed best practice	
Service reservoirs	Already comply with the proposed best practice	
Water delivered measured	Already comply with the proposed best practice	We periodically update the meter under registration analysis for our domestic meters.

In order to fully comply with the new reporting methodology a new software reporting system has been installed and is being uploaded with historic leakage data.

As described in **Error! Reference source not found.** above it is likely that the following two measures will have the greatest impact on our calculation of leakage:

- Moving to a 50th percentile value for the daily minimum night flow, and

- The inclusion of the actual summer months in the annual assessments of leak instead of the interpreted summer night use.

These two modifications are anticipated to have the greatest impact in increasing the bottom-up estimation of leakage. This potential increase will change the estimate of distribution losses and consequently it will also change the bottom up leakage estimate (the pre MLE estimate).

The bottom-up (pre-MLE) estimate of leakage is used in the water balance calculation to derive the final top down leakage estimate through the MLE process. The MLE procedure distributes the error term, which is the difference between the sum of the individual bottom up estimates and DI.

Typically, the error term has always been within 5% (the acceptable limit) and therefore we have always been able to use the MLE approach to calculate the final leakage value, which has been reported to the regulators.

References

- UKWIR, 2017, 'Consistency of reporting performance measures', UKWIR Report Ref 17/RG/04/5