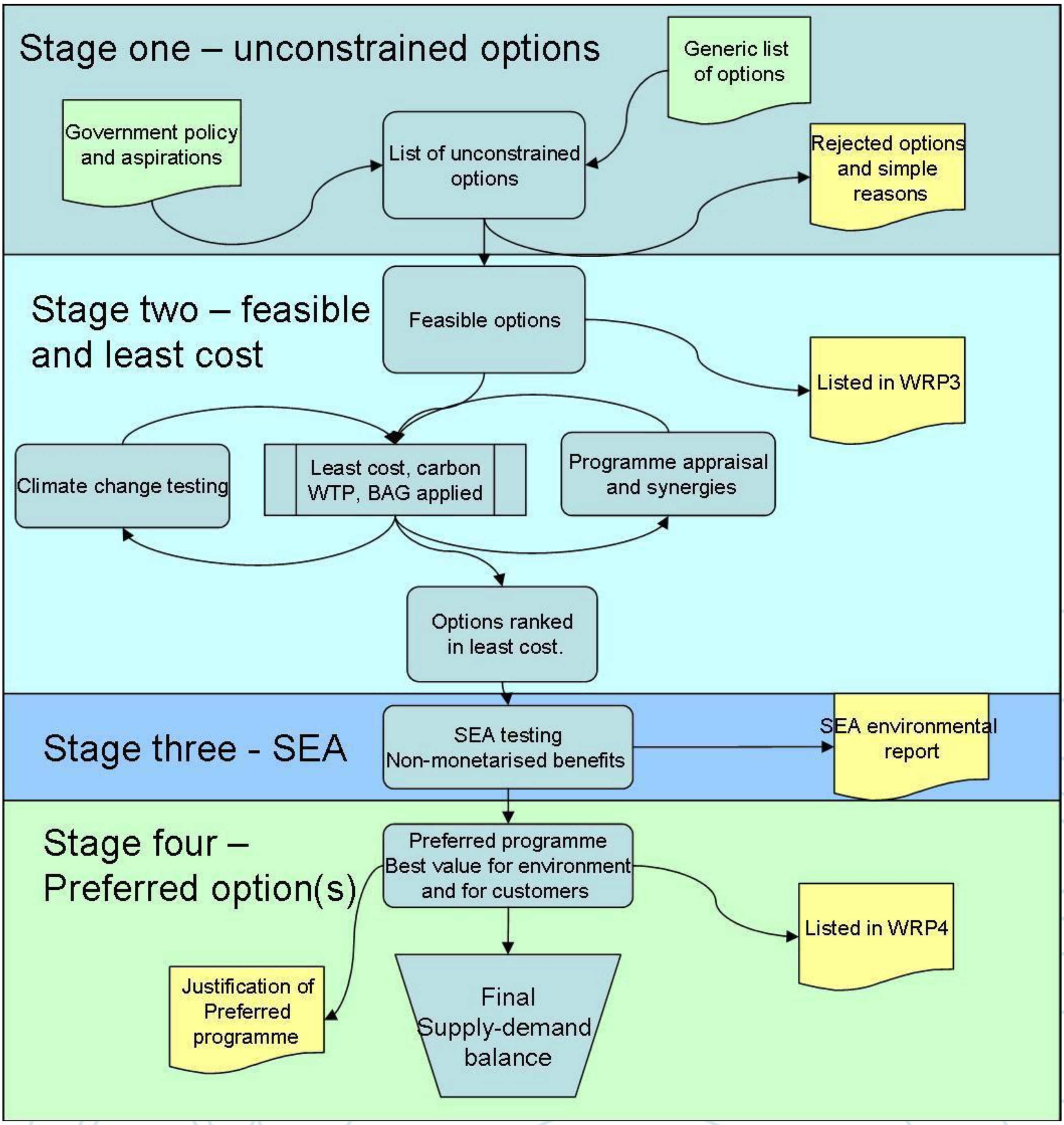
D1 Unconstrained supply / demand options

An important stage in the water resources planning process is the identification and evaluation of the range of options we have available to us for managing the supply / demand balance over time. The Environment Agency's Water Resources Planning Guideline (WRPG) includes the following summary of the recommended steps we should take in deriving the preferred investment options.

Figure D1.1: The stages of an option appraisal process



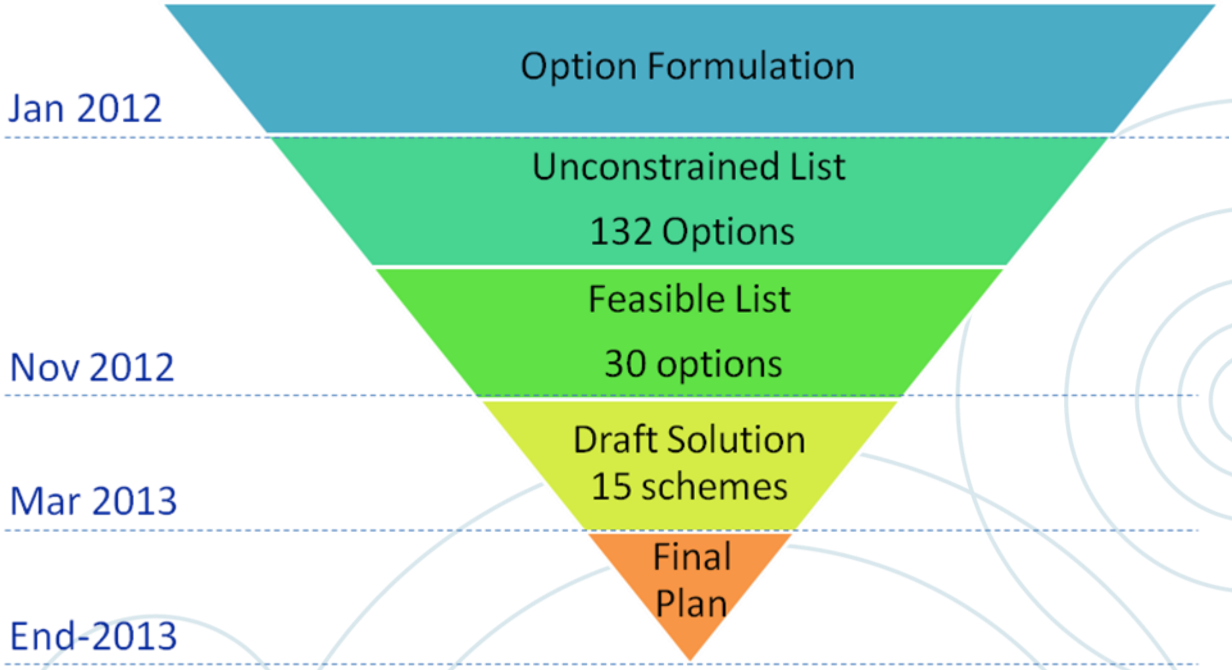
This chapter explains how we produced our unconstrained list of options and the screening process that we have followed. Chapter 4 of this WRMP summarises the preferred options that we believe will provide a sustainable and best value solution to the long term water supply / demand challenges that we face. Descriptions of the social and environmental impacts of the full range of feasible options considered in our plan are given in the accompanying Strategic Environmental Assessment report.

The first step of our options appraisal process was an initial assessment of a wide range of potential future supply and demand management options and a review of their viability. We used a screening process to exclude the least feasible options and to allow us to focus on those with the best potential for future development. The most feasible options were then taken forward for a more detailed engineering and environmental assessment.

The options appraisal process is at a strategic level and does not preclude the need for further analysis as we implement our plan. This strategic process is not a substitute for the detailed, option appraisal that would be needed to support site specific planning or abstraction consents.

The stages of this process have taken an initial list of 132 potential options to enhance water supply capability, and have reduced this to a set of 30 feasible options (plus sub-options) from which we have derived our investment plan. The stages of our screening process and how they have gradually reduced the number of options being considered in our WRMP are illustrated in figure D1.2 below.

Figure D1.2: The stages in our options appraisal process



The remainder of this chapter describes the types of options that were considered and explains the process we have followed to screen out the least feasible options.

D1.1 Developing an unconstrained list of options

For the first stage of this process, we identified a wide range of potential investment options that could be implemented to fill projected deficits in the supply demand balance over the 25 year planning period.

At the time that the initial unconstrained list was being developed, our detailed understanding of the future supply / demand needs of each of our Water Resource Zones (WRZs) had not been completed. Therefore, we developed a range of unconstrained options by considering those supply areas that we considered could be vulnerable to potential future changes in supply and demand for water. For example:

- Those WRZs fed by sources subject to AMP5 RSA low-flow investigations or sites that fall under the scope of Habitats Directive, e.g.:
    - Strategic Grid, in particular Birmingham and Bromsgrove supply zones
    - Shelton WRZ (in particular the East Shrops. area)
    - Nottinghamshire
    - North Staffordshire
- Supply areas expected to see significant population and housing growth;
- Areas fed by sources thought likely vulnerable to climate change, principally surface water sources where deployable output is linked to river flow or groundwater spring sources.

When we carried out our initial assessment we tried to identify potential opportunities to maximise the sustainable use of our existing strategic assets and abstractions. In particular, we looked for options around:

- Existing assets with underused capacity/flexibility due to constraints posed by treatment capacity, pipework constraints etc
- Existing assets where additional deployable output can be gained with relatively limited capital works
- Pipeline or river transfers from zones/assets likely to have surplus to those with deficit
- Transfer of abstraction from environmentally-unsustainable locations to locations where they would be sustainable, e.g. by moving abstraction down-catchment
- Water quality improvements that have or are likely to happen at Severn Trent's waste water treatment works river discharges that could augment river flows.
- Links from neighbouring water company assets

The range and type of supply options identified are listed in table D1.1 below.

Table D1.1 – Range of Identified supply-side unconstrained options

Type of Scheme	No. of UC Options	Comment
Direct river abstraction	21	Includes options for unsupported river abstractions
New reservoir storage	6	Includes new sites and new dams at existing sites
Reservoir raising	5	Includes a generic option for minor modifications of draw-off tower/wave-wall arrangements at several specific sites
Groundwater	27	Includes options for new/recommissioned borehole sites or springs, excluding ASR/AR and conjunctive use schemes
Infiltration galleries	0	No options identified
Aquifer Storage and Recovery (ASR)	5	1 scheme identified is the second phase of a 10-year project begun in AMP5
Artificial Recharge (AR)	3	Includes borehole recharge schemes
Desalination	0	No options identified
Reclaimed Water	8	Includes both direct waste water re-use and river augmentation options
Tankering of water	0	No options identified
Conjunctive Use	18	This includes options to improve the flexibility of existing assets.
Bulk transfers	23	Includes inter-company raw/treated transfers only
Bulk imports	14	Includes options to import from neighbouring water companies
TOTAL	**132**	

We also formulated a list of potential new water efficiency options that could be used to help customers reduce consumption, as summarised in table D1.2.

Table D1.2 – Range of identified demand-side unconstrained options

Type of scheme	Comment
New buildings Higher specification water efficient fitting as standard	Offer house builders advice on higher specification and more water efficient fittings in homes (A selection of taps, showers, WC, bath, water butts). Alternatively, we could offer a financial incentive/subsidy if there is an extra cost for installing fitting of a higher water efficiency specification.
Commercial Model	Provide up front capital to non household organisations to enable investment in retrofit water efficiency technologies. Capital used to invest in water efficiency technologies would be repaid. Following repayment, non households would benefit from lower water bills.
Distribution of free water saving products	This is a continuation of our current policy to promote and provide water saving devices to all customers. This part of our current offer to meet our statutory water efficiency duty and regulatory water efficiency targets
Product retrofit by affinity partners	Take advantage of current visits to mutual customers to install appropriate water efficient devices in customer homes.
Domestic audit and retrofit with 3rd parties	Partnership with other organisations (e.g. social housing, Green Deal providers) where partners install water efficient devices in customer homes
Education.	Offering education to children and adults about the need for and benefits of using water wisely is a continuation of our current policy to promote water efficiency information to customers. This is part of our current offer to meet our statutory water efficiency duty and regulatory water efficiency targets
Integrated meter plus water efficiency (optant/selective)	Integrating a visit to install a meter where a customer has opted to be metered or as part of a selective metering programme with water efficiency advice
Integrated meter plus water efficiency (renewals)	Integrating a visit to replace a meter with water efficiency advice
Leaking toilet valves - domestic	To promote to customers the need to check toilets for leaks, and to use existing visits (by our staff, and partnership staff e.g. Homeserve) to check for leaking WC valves. Offer a repair/replacement service. We would offer other water efficiency advice and products with this service. We envisage a partnership organisation (e.g. Homeserve carrying out repairs replacement).

Type of scheme	Comment
Rainwater harvesting - retrofit domestic	Install rainwater harvesting systems in existing domestic properties.
Rainwater harvesting – new build domestic	Install rainwater harvesting in new build domestic properties
Rainwater/grey-water new commercial/public sector Retrofit or new build	Provide funding/loan in line with commercial model to encourage installation of rainwater harvesting during major refurbishment or new build commercial or public sector (school, university etc).

In addition to these water efficiency options, we have considered options to increase the uptake of domestic water metering.

Type of scheme	Comment
Change of occupier metering	Using evidence from our AMP5 trial of selectively metering households on change of occupier
Compulsory household metering	Our supply area is not designated an area of serious water stress by the Environment Agency, and so we do not have legal powers to compulsorily meter household customers. However, we have tested whether such a policy could be cost beneficial.

In addition to the above supply and demand options, we have also focussed on new opportunities to trade or share water resources with third parties. As a result, we have been exploring the potential for new water transfers to and from outside of our region, as well as new water resource development opportunities with third parties.

We have adopted a three stage approach to exploring these third party opportunities:

1 Establishing the potential need and opportunities for transfers based on the quantity of water involved, timescales when needed and water resource zones involved.

2 If Stage 1 confirms that the need and opportunities exist, then we will carry out more detailed design and costing appraisals of the potential routes and assets involved in facilitating the transfer.

3 Agree the commercial and pricing arrangements between the trading parties.

> These discussions cover both the potential for transferring water into our region as well as options to transfer water out of our region to help meet neighbouring companies' future supply / demand needs.

We completed stage 1 discussions with each of our neighbouring water companies in September 2012, and quickly moved to stage 2 discussions with:

- Thames Water
- United Utilities
- Yorkshire Water
- Anglian Water
- South Staffordshire Water
- Welsh Water

Between the draft and final WRMP, we held a number of more detailed stage 2 discussions with these companies and identified a number of potential new raw and treated water cross border supply options. These potential options are discussed in more detail in Appendix D6.

D2 The options screening process

Having identified the long, unconstrained list of potential options, we then took these through a screening process to identify those that should be excluded from the final plan. Section 6.5 of the EA's WRMP Planning Guidelines recommends a series of high level questions that can be used to screen out the least feasible options. We used these questions as the starting point for our screening process, but we also derived a more detailed sub-set of questions that would help us to understand the likely issues, risks and concerns. Where there was an overall negative response to any of the four key questions, the option was screened out, unless there was a compelling reason to take it through to the feasible list.

We shared these screening criteria with the Environment Agency at an early stage and we made some minor adjustments to the process on the basis of their feedback. The screening criteria used are set out in Table D2.1 below.

We also shared these screening questions with those bordering water companies with potential new bulk supply options in order that they could understand the screening criteria we would ultimately be applying to those options. Finally, we also published the screening criteria on our website alongside our September 2012 consultation on future water trading opportunities.

We engaged the EA during the process of screening out the options, particularly with regard to the questions on abstraction licensing risk and potential Water Framework Directive impacts. This clarification resulted in a number of unconstrained list schemes being screened out.

The screening process resulted in the majority of potential supply side and demand side scheme options being removed from the list of feasible options. The screening results for the individual options are summarised in the scheme rejection log in Appendix D3, with the key reasons for exclusion, where appropriate.

Q	Table D2.1: Unconstrained List Screening criteria	Y / N	Overall Y / N	Commentary - reasons behind decision reached
1	**Does the option address the problem?**		Y	
	Will the option have a moderate to high likelihood of providing the stated supply-demand benefit to a Water Resources Zone or area where there is a potential future shortfall?	Y		[Text]
	Will the option have a high likelihood of being able to mitigate against future D.O. loss due to climate change impacts or licence changes to existing sources?	Y		[Text]
2	**Does the option avoid breaching any unalterable constraints?**		Y	
	Is the option likely to be acceptable in terms of planning and statutory environmental constraints local to the scheme (e.g. internationally or nationally designated sites), subject to any reasonable mitigation measures?	Y		[Text]
	Does the scheme avoid causing CAMS units to become over-abstracted (and/or avoid WFD status deterioration, where known)?	Y		[Text]
3	**Is the option promotable / does it meet regulatory and stakeholder expectations?**		Y	
	Is the scheme likely to be acceptable to customers fed off this supply?	Y		[Text]
	Does the scheme avoid conflicts with other parts of STWL's business plan strategy, e.g. supply resilience, quality and capital maintenance?	Y		[Text]
	Is the scheme likely to be acceptable to local (non-statutory) stakeholder groups, subject to reasonable mitigation?	Y		[Text]
	Does the scheme avoid major carbon impacts, e.g. operational carbon effects and asset construction/replacement costs?	Y		[Text]
	Does the option avoid customer discrimination or social equity issues?	Y		[Text]
	Does the option clearly represent one of the more favourable development options for this source of water (e.g. a specific river)?	Y		[Text]
	Would the option be likely to avoid both high capex and high opex unit costs that would mean it is very unlikely to be part of the least-cost solution?	Y		[Text]
4	**Is the risk of the option failing acceptable?**		Y	
	Does the option have the potential to be scalable/adjustable to STWL demands or does it lock you into a fixed mode of operation/output?	Y		[Text]
	Is there a high level of confidence that the scheme will be technically feasible?	Y		[Text]
	Does the option have sufficient flexibility to still deliver a benefit under a range of external future scenarios? (licensing, water quality, climate change, political)	Y		[Text]
	Does the option avoid a disproportionately high level of up-front feasibility costs relative to the benefit it could deliver?	Y		[Text]
	Is there a low abstraction licensing risk?	Y		[Text]
5	**Should the option be taken through to the Constrained List?**	Y		[Summary Text]

Defining the Feasible Options

The resulting feasible list of supply-side options is shown in table D2.2. A short description of all the schemes on the feasible list is given in Appendix D7 (restricted to Ofwat and EA only due to commercial confidentiality). Each of these options has been through our Strategic Environmental Assessment and Habitats Regulations Screening Assessment to inform the environmental and delivery risks. The conclusions of these assessments have been published alongside this WRMP in the accompanying SEA and HRA reports.

Development of the Least-cost plan

Each of the feasible options was taken forward for a more detailed appraisal of capital and operating costs, likely environmental impacts, carbon impacts and indicative deployable output gain. Cost information for each of the Feasible List schemes is also included in the WRP3 tables for the relevant Water Resource Zone (access restricted to OFWAT/EA).

These feasible options were used to develop the least-cost plan, using the methodology described in Appendix D5.

Development of the preferred plan

The least-cost plan was than taken through the Strategic Environmental Assessment (SEA) process (an accompanying document to the DWRMP). This was used to identify: firstly, whether any of the schemes in the least cost plan should be removed from the preferred plan due to individual or cumulative environmental impacts; and secondly, what the scale of the alternative programme should be, noting the potential delivery risks around the preferred plan.

Table D2.2- Feasible Supply-side Options

Ref No.	Scheme Name	WRZ to benefit
3	Trimpley/Worcs. Groundwater Conjunctive use	Grid
8	River Severn Augmentation (Barnhurst)	Grid
11	Belper Meadows Borehole Recommissioning	Grid
12	Convert Central Birmingham Boreholes to Potable Supply	Grid
16	DVA to Nottingham Pipeline Enhancement	Notts.
25A	Upper Avon/Leam Resource transfer (Sub-option A)	Grid
27	Hatton (Warks.) Conjunctive Use	Grid
32	Little Eaton Conjunctive Use	Grid
35	Kenilworth Borehole Scheme	Grid
40	Monksdale Borehole Recommissioning	Grid
47	Norton Artificial Recharge (AR), Phase 1	Grid
51	Pinnock Springs Recommissioning	Grid
55	Bellington-Frankley Conjunctive Use.	Grid
61B	River Trent to Melbourne (Sub-option B)	Grid
62	Convert Short Heath Borehole to Potable Supply	Grid
64	Stanton/Milton BH to Supply at Melbourne	Grid
78	Whitacre Aquifer Storage and Recovery (ASR), Phase 2	Grid
83A	Reservoir De-siltation (Staunton Harold)	Grid
84A	Minor Reservoir Water level increase (Stanford Sub-option)	Grid
84B	Minor Reservoir Water level increase (Shustoke Sub-option)	Grid
84C	Minor Reservoir Water level increase (Whitacre Sub-option)	Grid
87	River Bourne Augmentation (Coleshill)	Grid
96	Upper Worfe Groundwater Augmentation	Grid
107B	Rutland Link (Wing Import)	Grid
120A	Middle Severn to Draycote (Sub-option A)	Grid
120B	Middle Severn to Draycote (Sub-option B	Grid
120C	Middle Severn to Draycote (Sub-option C)	Grid
120D	Middle Severn to Draycote Sub-option D)	Grid
120E	Middle Severn to Draycote (Sub-option E)	Grid
120F	Middle Severn to Draycote (Sub-option F)	Grid
121	Mythe to Mitcheldean raw main	Grid
122A	Draycote Reservoir Storage Expansion (Sub-option A)	Grid
125A/B	Lower Derwent to Melbourne (Sub-options A/B)	Grid
126	Wellesbourne Groundwater Conjunctive Use	Grid
129	Bromsgrove Groundwater Licence Transfer	Grid
130	Lower Worfe Groundwater Augmentation	Grid
131	Ogston to Mansfield Pipeline Enhancement	Notts.

Table D2.3: Feasible demand side options

Ref No.	Scheme Name	WRZ to benefit
WE002	Non-households audit and retrofit	All
WE003	General product distribution on customer request	All
WE005	Domestic customers audit and retrofit	All
WE006	Customer education	All
WE007/008	Water efficient measures alongside Fropt activity	All
WE009	Repair / replace leaking toilet valves	All

D3 Scheme rejection log

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
1	Acton Trussell Borehole	N	N	N	Y	**N**	Low confidence in Deployable Output gain Potential environmental impacts on protected sites
2	Aquifer Storage and Recovery (Warks.)	Y	Y	Y	N	**N**	Technical delivery risk Disproportionate feasibility costs
3	Trimpley/Worcs. GW Conj. Use	Y	Y	Y	Y	**Y**	n/a
4	Bamford Conjunctive Use	Y	N	Y	Y	**N**	Potential Water Framework Directive impact
5	Derwent Valley Transfer Main	Y	Y	N	N	**N**	Technical Delivery Risk Better alternatives for using resource
6	Derwent Valley Storage increase	Y	N	Y	N	**N**	Potential environmental impacts on protected sites Delivery risk
7	Barnhurst to Trent	Y	Y	N	Y	**N**	Better alternative for developing resource
8	Barnhurst to Severn	Y	Y	Y	Y	**Y**	n/a
9	Barston Aquifer Storage and Recovery	Y	Y	N	N	**N**	Better alternative site for developing the aquifer High proportion of feasibility costs High technical delivery risk
10	Beckbury Peak Increase	N	Y	N	Y	**N**	Low confidence in Deployable Output benefit Better alternative use of resource
11	Belper Meadows	Y	Y	Y	Y	**Y**	n/a
12	Central Birmingham Groundwater to Potable supply	Y	Y	Y	Y	**Y**	n/a

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
13	Buckshaft Borehole Conjunctive Use	N	N	Y	Y	**N**	Potential impact on local Water Framework Directive status Low confidence in Deployable Output benefit
14	Church Wilne Expansion	Y	Y	N	Y	**N**	Better alternatives to use resource Technical delivery risk
15	Cotswold Springs Recommissioning	N	N	Y	N	**N**	Low confidence in Deployable Output benefit Uncertainty around the scheme's resilience to climate change High technical delivery risk
16	Derwent Valley Aqueduct (DVA) to Nottingham Pipeline Enhancement	Y	Y	Y	Y	**Y**	n/a
17	Melbourne (Dove) Conjunctive Use	Y	Y	N	Y	**N**	Better alternative for developing resource
18*	CONFIDENTIAL 3rd PARTY OPTION						
19*	CONFIDENTIAL 3rd PARTY OPTION						
20*	CONFIDENTIAL 3rd PARTY OPTION						
21*	CONFIDENTIAL 3rd PARTY OPTION						
22	Elmhurst Borehole to Potable Supply	N	Y	Y	N	**N**	Low confidence in Deployable Output benefit
23	Elan Valley Aqueduct capacity increase	N	Y	N	N	**N**	Low confidence in Deployable Output benefit Low confidence in technical deliverability Highly unlikely to be part of the least-cost plan

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
24	Elan to Frankley Pipeline enhancement	N	Y	N	N	**N**	Low confidence in Deployable Output benefit Highly unlikely to be part of the least-cost plan
25	Upper Avon/Leam Resource	Y	Y	Y	Y	**Y**	n/a
26*	CONFIDENTIAL 3rd PARTY OPTION						
27	Hatton Conjunctive Use	Y	Y	Y	Y	**Y**	n/a
28	Hencott Borehole	N	N	Y	N	**N**	Low confidence in Deployable Output gain Licensing Risk
29	Homesford Conjunctive Use	N	Y	Y	N	**N**	Low confidence in Deployable Output gain Not resilient to climate change
30	New Borehole in Hopton Groundwater Unit	N	Y	Y	N	**N**	Low confidence in Deployable Output Gain High technical delivery risk
31*	CONFIDENTIAL 3rd PARTY OPTION						
32	Little Eaton Conjunctive Use	Y	Y	Y	Y	**Y**	n/a
33	Shelton Treatment Works expansion	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Conflict with Severn Trent's resilience strategy
34	Longdon Marsh to Frankley	Y	N	N	N	**N**	Major planning constraints Better alternatives for developing resource Highly unlikely to be part of least-cost plan Lack of scalability
35	Kenilworth Borehole	Y	Y	Y	Y	**Y**	n/a

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
	scheme						
36*	CONFIDENTIAL 3rd PARTY OPTION						
37*	CONFIDENTIAL 3rd PARTY OPTION						
38	Minworth Direct Re-use (large scheme)	N	N	N	N	**N**	Environmental impact Uncertainty around Deployable Output gain Customer acceptability Technical delivery risk
39	Minworth Direct Re-use (medium scheme)	Y	Y	N	N	**N**	Customer acceptability Technical delivery risk
40	Monksdale Borehole	Y	Y	Y	Y	**Y**	n/a
41	Re-commission Nanpantan Treatment Works	N	Y	N	N	**N**	Uncertainty around Deployable Output gain Better alternatives for developing resource Uncertainty around climate change resilience
42	New Treatment Works at Carsington	Y	Y	N	Y	**N**	Better alternatives for developing resource Highly unlikely to be part of least cost plan
43	New Treatment Works at Hayden	N	Y	N	N	**N**	Uncertainty around Deployable Output gain Highly unlikely to be part of the least cost plan
44	New Treatment Works at Stafford	N	Y	N	N	**N**	Low confidence in Deployable Output gain Better alternative for developing resource Highly unlikely to be part of least-cost plan High technical delivery Risks

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
45	New Treatment Works on Lower Trent	Y	Y	N	N	**N**	Better alternatives for developing resource Highly unlikely to be part of least-cost plan High technical delivery Risks
46	New Treatment Works on River Idle	N	N	N	N	**N**	Uncertainty around Deployable Output gain Major planning risk Lack of resilience to climate change Highly unlikely to be part of the least cost plan
47	Norton Artificial Recharge Phase I	Y	Y	Y	Y	**Y**	n/a
48	Norton Artificial Recharge Phase II	Y	Y	Y	N	**N**	High technical delivery Risks
49	Nottingham GW scheme	Y	N	Y	N	**N**	High abstraction licensing risk
50	Ombersley River Treatment Works	Y	N	N	N	**N**	Planning Risk Abstraction Licensing Risk
51	Pinnock Springs Recommissioning	Y	Y	Y	Y	**Y**	n/a
52	Worcester Treatment Works (Severn)	N	Y	N	N	**N**	Low confidence in Deployable Output gain Better alternative for developing resource Highly unlikely to be part of least-cost plan Abstraction Licensing Risk
53	Buildwas Treatment Works (Severn)	N	Y	N	N	**N**	Low confidence in Deployable Output gain Better alternative for developing resource Highly unlikely to be part of least-cost plan Abstraction Licensing Risk
54	River Soar to Cropston	Y	Y	Y	N	**N**	Lack of resilience to climate change Technical delivery risk

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
55	Bellington-Frankley Conjunctive Use	Y	Y	Y	Y	**Y**	n/a
56	River Tame Resource	Y	Y	N	N	**N**	Better alternative for developing resource Highly unlikely to be part of least-cost plan Technical delivery risk
57*	CONFIDENTIAL 3rd PARTY OPTION						
58	River Weaver to Stoke	N	Y	N	N	**N**	Low confidence in Deployable Output gain Highly unlikely to be part of least-cost plan Abstraction Licensing Risk
59	Lower Severn to Draycote	Y	Y	N	Y	**N**	Better alternative for developing resource Highly unlikely to be part of least-cost plan
60	New Birmingham Trent Support Borehole	Y	Y	N	N	**N**	Better alternative for developing resource Abstraction Licensing Risk
61	R.Trent to Melbourne	Y	Y	Y	Y	**Y**	n/a
62	Short Heath Borehole to Potable Supply	Y	Y	Y	Y	**Y**	n/a
63	Stableford Borehole to Potable Supply	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
64	Stanton and Milton Borehole to supply	Y	Y	Y	Y	**Y**	n/a
65	Stanton and Milton Borehole to River Trent	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Better alternative for developing resource

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
66	Strensham Treatment Works expansion	Y	Y	N	Y	**N**	Better alternative for developing resource Highly unlikely to be part of least-cost plan
67*	CONFIDENTIAL 3rd PARTY OPTION						
68	Stourbridge Borehole conjunctive use	Y	N	Y	Y	**N**	Potential environmental impact
69	River Dane to Tittesworth	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
70	Abbey Green Artificial Recharge	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
71	Elmhurst Borehole to Tittesworth	N	Y	N	N	**N**	Low confidence in Deployable Output gain Better alternative for developing resource Abstraction Licensing Risk
72*	CONFIDENTIAL 3rd PARTY OPTION						
73	Change Tittesworth Compensation Release	N	Y	N	N	**N**	Low confidence in Deployable Output gain Lack of resilience to future licensing/climate change risks Abstraction Licensing Risk
74	Trimpley Winter Peak	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
75*	CONFIDENTIAL 3rd PARTY OPTION						
76	Expand Uckington Borehole	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
77	Wash Green Springs Recommissioning	N	Y	Y	N	**N**	Low confidence in Deployable Output gain Lack of resilience to future climate change risks Technical delivery risk

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
78	Whitacre Aquifer Storage and Recovery Phase 2	Y	Y	Y	Y	**Y**	n/a
79	Wolverhampton-Birmingham Main	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Potential environmental impact Better alternatives for deploying resource
80	Worcester Basin Aquifer Storage and Recovery	Y	Y	Y	N	**N**	Technical delivery risk Disproportionate feasibility costs
81*	CONFIDENTIAL 3rd PARTY OPTION						
82	Cross-Wolverhampton Link Main	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
83	Reservoir de-siltation	Y	Y	Y	Y	**Y**	n/a
84	Minor Reservoir Expansions	Y	Y	Y	Y	**Y**	n/a
85*	CONFIDENTIAL 3rd PARTY OPTION						
86	Elan Valley Aqueduct to Trimpley Link	N	Y	Y	N	**N**	Low confidence in Deployable Output gain
87	River Bourne Augmentation (Coleshill)	Y	Y	Y	Y	**Y**	n/a
88	River Weaver to Tittesworth	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Highly unlikely to be part of least-cost plan Lack of resilience to future climate change risks

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
89	Melbourne to Staffs & Telford Link Main	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Highly unlikely to be part of least-cost plan
90	Leek to Stafford Trunk Main	N	N	Y	Y	**N**	Low confidence in Deployable Output gain Potential environmental impact
91*	CONFIDENTIAL 3rd PARTY OPTION						
92	Whitacre to Birmingham Trunk Main	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
93	Whitacre to Leicester main	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
94	Wildmoor Borehole conjunctive use	Y	N	Y	Y	**N**	Potential environmental impact
95	Ogston Output increase	Y	Y	N	Y	**N**	Better alternatives for deploying resource
96	Upper Worfe Borehole Augmentation	Y	Y	Y	Y	**Y**	n/a
97	Blackbrook Reservoir Transfer	N	Y	N	N	**N**	Low confidence in Deployable Output gain Lack of resilience to climate change Unlikely to be part of least-cost plan
98	D.O. Recovery at Groundwater sites	Y	N	Y	N	**N**	Potential Environmental Impact Low confidence in technical feasibility
99	D.O. Recovery at Surface Water sites	Y	N	Y	N	**N**	Potential Environmental Impact Low confidence in technical feasibility
100	Clungunford Resource	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
101	Kinsall Resource	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
102	Llandinam Expansion	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
103	Mardy Resource	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
104	Newark Link Main	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
105	Ruyton Link Main	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
106*	CONFIDENTIAL 3rd PARTY OPTION						
107	Rutland Link	Y	Y	Y	Y	**Y**	n/a
108	Stoke to Stafford Link	N	N	Y	N	**N**	Low confidence in Deployable Output gain Potential environmental impacts Lack of resilience against future licence scenarios
109	Highters Heath Aquifer Storage and Recovery	Y	Y	N	N	**N**	Better alternative way of using resource High delivery risk High feasibility costs
110	Wolverhampton to Stafford Link	N	Y	N	N	**N**	Low confidence in Deployable Output gain Not resilient to future scenarios Highly unlikely to be part of least cost plan
111	Melbourne to Staffs Link	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Highly unlikely to be part of least cost plan
112	Croxton Output increase	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
113	New Borehole at Chalford	N	Y	Y	N	**N**	Low confidence in Deployable Output gain High delivery risk High licensing risk
114	Ombersley Borehole conjunctive use	Y	N	Y	N	**N**	Environmental impact Technical delivery risk
115*	CONFIDENTIAL 3rd PARTY OPTION						

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
116*	CONFIDENTIAL 3rd PARTY OPTION						
117*	CONFIDENTIAL 3rd PARTY OPTION						
118*	CONFIDENTIAL 3rd PARTY OPTION						
119	Process water recovery	N	Y	Y	N	**N**	Low confidence in Deployable Output gain High Technical risk
120	Middle Severn to Draycote	Y	Y	Y	Y	**Y**	n/a
121	Mythe to Mitcheldean main	Y	Y	Y	Y	**Y**	n/a
122	Raise Dam at Draycote	Y	Y	Y	Y	**Y**	n/a
123	Raise Dam at Tittesworth	N	Y	Y	Y	**N**	Low confidence in Deployable Output gain
124	River Dove Augmentation (Clay Mills)	Y	Y	Y	N	**N**	Technical delivery risk
125	Lower Derwent to Melbourne	Y	Y	Y	Y	**Y**	n/a
126	Wellesbourne Conjunctive Use	Y	Y	Y	Y	**Y**	n/a
127	Ombersley to Frankley main	N	Y	N	N	**N**	Low confidence in Deployable Output gain Better alternative way of using resource Highly unlikely to be part of least cost plan
128	Carsington to Tittesworth Transfer	N	Y	N	Y	**N**	Low confidence in Deployable Output gain Better alternative way of using resource

Appendix D: Deriving our investment plan

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
129	Bromsgrove Licence Transfer	Y	Y	Y	Y	**N**	n/a
130	Lower Worfe Augmentation	Y	Y	Y	Y	**Y**	n/a
131	Ogston to Mansfield Pipeline Enhancement	Y	Y	Y	Y	**Y**	n/a
132	Whaddon to Forest transfer	N	Y	Y	N	**N**	Low confidence in Deployable Output gain
WE001	Water efficient fittings in new builds	N	Y	Y	N	N	High unit costs. V uncertain long term benefits and there are better water efficiency options available.
WE002	Non-households audit and retrofit	Y	Y	Y	Y	Y	n/a
WE003	General product distribution on customer request	N	Y	Y	Y	Y	n/a
WE004/005	Product exchanges	N	Y	N	N	N	High cost and likely low uptake mean savings likely to be low in comparison with what will result from natural churn.
WE005	Domestic customers audit and retrofit	Y	Y	Y	Y	Y	n/a
WE006	Customer education	N	Y	Y	Y	Y	n/a
WE007/008	Water efficient measures alongside Fropt activity	Y	Y	Y	Y	Y	n/a
WE009	Repair / replace leaking toilet valves	Y	Y	Y	Y	Y	n/a
WE010	Rainwater harvesting	N	Y	N	N	N	High up front installation costs and very uncertain

Scheme Ref:	Scheme Name	Q1 (Solves the Problem?)	Q2 (Avoids breaching unalterable environ. constraints?)	Q3 (Promotable?)	Q4 (Is the risk of failure acceptable?)	Overall	Key Reasons, if Overall N
	- domestic retrofit						customer demand mean there are other cheaper and simpler options to be explored first.
WE12	Greywater in new buildings	Y	Y	N	N	N	Current low uptake in UK likely to continue, therefore high risk option.
ME01	Change of occupier metering	Y	Y	N	Y	N	Company specific evidence from AMP5 trials demonstrates that this policy is very unpopular with customers and is not the most cost effective way of increasing household meter uptake.
ME02	Compulsory household metering	Y	N	N	N	N	Our region is not a designated area of significant water stress, therefore we do not have legal powers to compulsorily meter household customers

**This schemes involve the use of third party assets or abstraction licences.*

**These schemes involve the use of third party assets or abstraction licences. Our discussions with third parties around these options are still at an early stage and we do not yet have sufficient cost / benefit data to include them in the full appraisal of feasible options. In Chapter D4 we summarise the discussions we have had so far with neighbouring water companies to explore the potential for future water trading and cross border supplies. We will continue to develop these options as part of the ongoing WRMP review process.*

D4 Water trading options

For the WRMP, we have investigated new opportunities to trade or share water resources with third parties. As a result, we have been exploring the potential for new water transfers to and from our region, as well as new water resource development opportunities with third parties. Since the draft WRMP was published, we continued to explore these options with neighbouring water companies. We have agreed which of the options should be developed further, and we have agreed to work these up to sufficient detail that they can be considered as feasible options with outline costs and benefits.

We have adopted a three stage approach to exploring these third party opportunities:

Stage 1. Establishing the potential need and opportunities for new third party supplies based on the quantity of water involved, timescales when needed and water resource zones involved.

Stage 2. If Stage 1 confirms that the need and opportunities exist, then we will work with those third parties to carry out more detailed design and costing appraisals of the potential routes and assets involved in facilitating the transfer.

Stage 3. Agree the commercial and pricing arrangements between the trading parties.

These discussions cover both the potential for supplying water into our region as well as options to transfer water out of our region to help meet neighbouring companies' future supply / demand needs.

We had completed stage 1 discussions with each of our neighbouring water companies by September 2012, and quickly moved to early stage 2 discussions with:

- Thames Water
- United Utilities
- Yorkshire Water
- Anglian Water
- South Staffordshire Water
- Welsh Water
- Bristol Water

At the time of writing the consultation version of the draft WRMP, we had held a number of more detailed stage 2 discussions with all of these companies with the exception of Bristol Water, and had identified a number of feasible new raw and treated water cross border supply options. Since then, we held stage 2 discussions with Bristol Water to understand potential new water transfer opportunities, and these are identified in the following tables..

The new options first identified through stage 2 discussions are summarised in the tables below, followed by an update on progress with developing these options. Our discussions with each of the companies named below have confirmed that there is no supply / demand need for these new trading options until AMP7.

Thames Water.

Option description	Flow	Earliest date available
Raw water export to Thames Water via canal network.	Approx 50Ml/d but more could be available.	2025
Raw water support to future Thames Water lower Severn abstraction point at Deerhurst.	Additional 128 Ml/d support in summer months, in addition to normal river flows	From 2020 onwards for first 15Ml/d, 2025 for remaining 113 Ml/d
Treated water supply to Thames Water at Banbury.	Up to 15 Ml/d but more could be possible	From 2020 onwards
Raw water transfer to Thames Water via River Cherwell or River Thames,	Up to approx 200Ml/d, but more could be possible	Part of flow from 2025 onwards, full flow from 2030

Discussions with Thames Water following the draft WRMP confirmed that the most feasible of these options would be to provide untreated water to either support a future Thames Water lower Severn abstraction at Deerhurst or to transfer into the Thames region. We continued to develop the potential engineering solutions that could facilitate these transfers. In August 2013 we gave an indicative price to Thames Water for these two options in order that Thames can include them in their cost / benefit appraisal of new supply options.

United Utilities

Option description	Flow	Earliest date available
Treated water supply from UU's WTW in Stockport to Severn Trent Water customers in NW.Derbyshire	30Ml/d	To be confirmed
Raw water transfer to Seven Trent Water via the River Severn.	30 to 180Ml/d	2020 for lower rates, later for higher volumes

Discussions with United Utilities following the draft WRMP confirmed that the option of providing up to around 30Ml/d of raw water using releases from Vyrnwy Reservoir into the River Severn would be the most feasible. We agreed to provide United Utilities with confirmation of the frequency, duration and volume of raw water support needed once we completed our baseline deployable output modelling incorporating the abstraction licence changes required by the latest version of the EA's National Environment Programme. We have now completed our baseline deployable output modelling and will be sharing with United Utilities our estimate of likely river abstraction support needed.

Yorkshire Water

Option description	Flow	Earliest date available
Treated water transfer from Sheffield to Severn Trent Water near Chesterfield	Up to 25Ml/d	To be confirmed

Anglian Water

Option description	Flow	Earliest date available
Treated water transfer to Anglian Water near Rutland	18Ml/d or more	2020
Raw water transfer to Anglian Water via canal network.	Approx 50Ml/d but more could be available.	2025

We have held further discussions with Anglian since the draft WRMP, and they have confirmed they do not require a new source of supply until AMP7. We have agreed that the option to provide a treated water transfer into the Rutland area is the most feasible option, and we have continued to work up the engineering feasibility assessment for providing this supply. We have provided Anglian with an indicative price for this option in order that it can be included in their cost / benefit appraisal of new options.

South Staffordshire Water

Option description	Flow	Earliest date available
Raw water transfer from SSW borehole site to Elan Valley Aqueduct near Kinver, Worcs.	Up to 10Ml/d (more could be available in early part of planning period)	2020
Treated water transfers to Severn Trent Water network in north Birmingham.	Up to 10Ml/d	2020

Discussions with South Staffordshire Water since the draft WRMP have confirmed that they have a supply / demand surplus that could be used to supply into our Strategic Grid zone. We have confirmed that the most feasible option is to use existing assets to link into our Elan Valley Aqueduct to provide 10-20Ml/d of treated water supply. South Staffs have given us an indicative price for providing this supply.

Welsh Water

Option description	Flow	Earliest date available
Treated water transfer to Welsh Water near Caersws	Up to 0.5Ml/d	2015
Raw or treated transfer to Severn Trent Water at Mitcheldean	Up to 30Ml/d	To be confirmed

Bristol Water

Option description	Flow	Earliest date available
Raw water support to additional Lower Severn abstraction into Gloucester / Sharpness Canal.	10-15Ml/d	2020

At the time of writing the draft WRMP, we had insufficient details of the engineering costs and commercial terms of these potential new supplies to include them with any confidence in the preferred set of supply measures in the draft WRMP. Since the draft WRMP was published, we continued to work on the engineering feasibility assessments for these options to determine the associated capital and operating costs. We now have sufficient confidence around costs, benefits and impacts of these options that they can be considered as feasible options.

None of the options to import water into our supply area are likely to be available within AMP6, and so do not impact on our proposed plan for the short term. Furthermore, none of the potential receiving companies face supply / demand deficits in AMP6 and so do not need new transfer schemes in place in the short term. However, there are feasible import and export options that could be deployed within AMP7 if required. Our intention is to continue to develop with the neighbouring companies the engineering costs and benefits of these named, feasible options, as well as the environmental and delivery risks so that they can be fully considered within the next round of WRMPs. We will also consider the potential synergies with other needs identified in PR14 (e.g. resilience) and continue to work with the third parties to confirm the commercial terms, conditions and pricing principles that would apply for these new trading options.

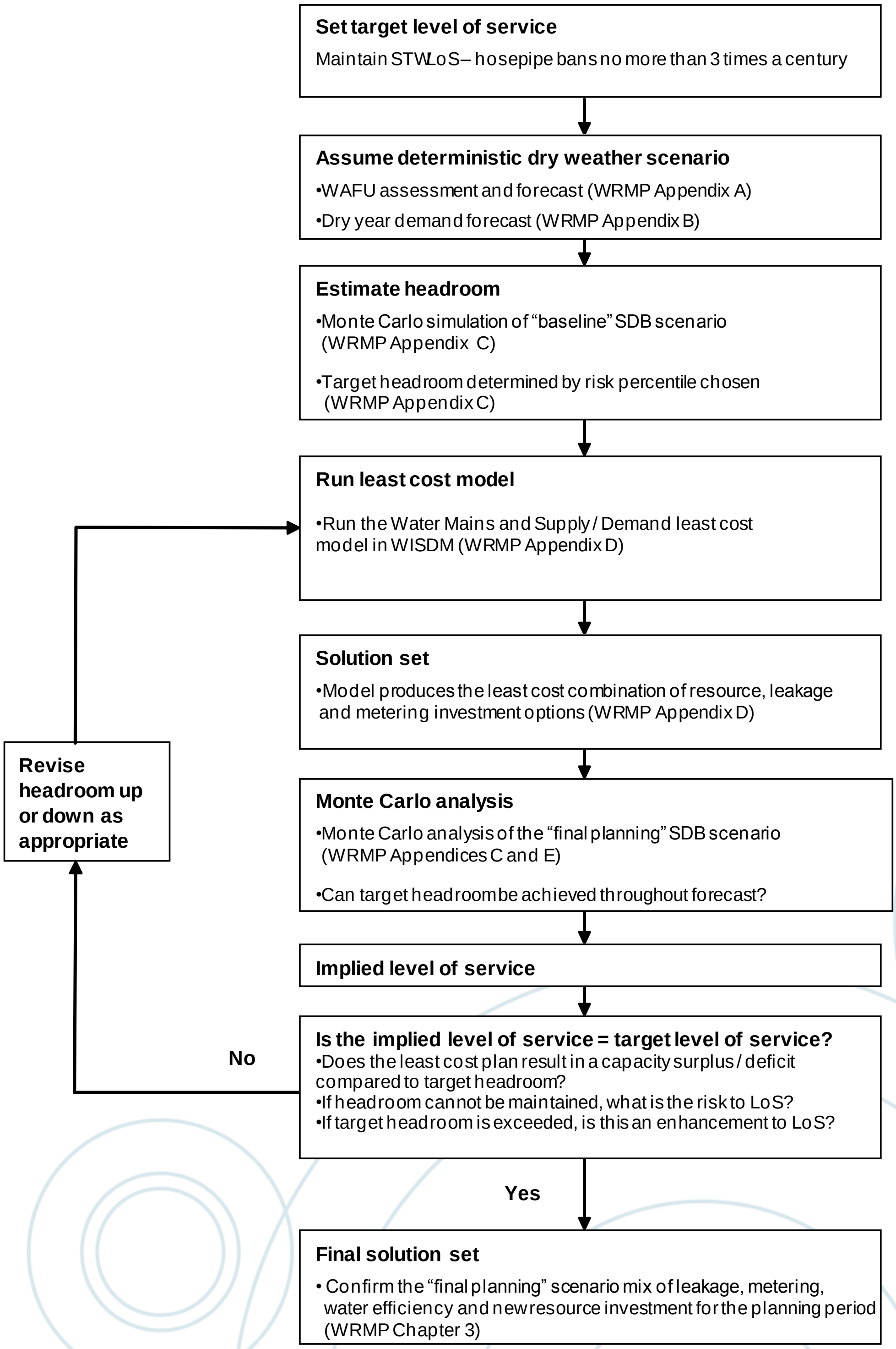
We will use the WRMP process to review how the costs and benefits of these feasible options compare with our preferred new supply options. We will use this cost / benefit assessment to indicate which of the options we are proposing to deliver in AMP7 and beyond could be substituted by the new feasible import options.

In addition to the discussions around water trading opportunities, we are also in early discussions with a number of other third parties in our region who hold assets that could be used as part of our long term water resources strategy. These discussions are commercially confidential and we have not included further details here. We will update our scheme rejection log as and when these third party discussions conclude.

D5 The least cost modelling approach

The schemes that make up our strategy for water resources, leakage (SELL) and water efficiency, investment for ensuring security of supply, have been derived by applying the principles of the UKWIR/EA report Economics of Balancing Supply and Demand (EBSD). Our approach follows elements of the “intermediate” and “advanced” application of the EBSD methodology. The stages in the EBSD approach and how they relate to our WRMP are set out in Figure D5.1 below,

Figure D5.1: The stages in the “intermediate” EBSD approach



As explained in Appendix D1, we have considered a wide range of potential options for balancing future supply and demand for water. We have considered the delivery risks and impacts of those options and have derived a final list of feasible options. Each of these feasible options has been taken forward for a more detailed assessment of long run financial, social and environmental costs and benefits. The costs and benefits associated with each of these schemes has then been used to determine the overall net least whole-life cost package of schemes able to deliver the required security of supply over the long run to 2040 and beyond.

Our least cost investment plan has been derived using our Water Infrastructure Supply / Demand Model (WISDM). The model assesses the combined capital, maintenance and operating investment requirements associated with our infrastructure and non-infrastructure assets over the next 25 years. The model allows us to derive a truly holistic, least whole-life cost investment plan that meets our infrastructure maintenance and future supply / demand needs. As a result, the strategy set out in this WRMP is fully integrated with our wider capital maintenance and serviceability investment plans for AMP6 and longer term.

The WISDM model was originally built to inform the PR09 business plan and WRMP, and has been used as part of our business-as-usual investment planning activities throughout AMP5. For PR14 we have been through a significant program of enhancement and strengthening of the model to improve the underlying data relationships and results.

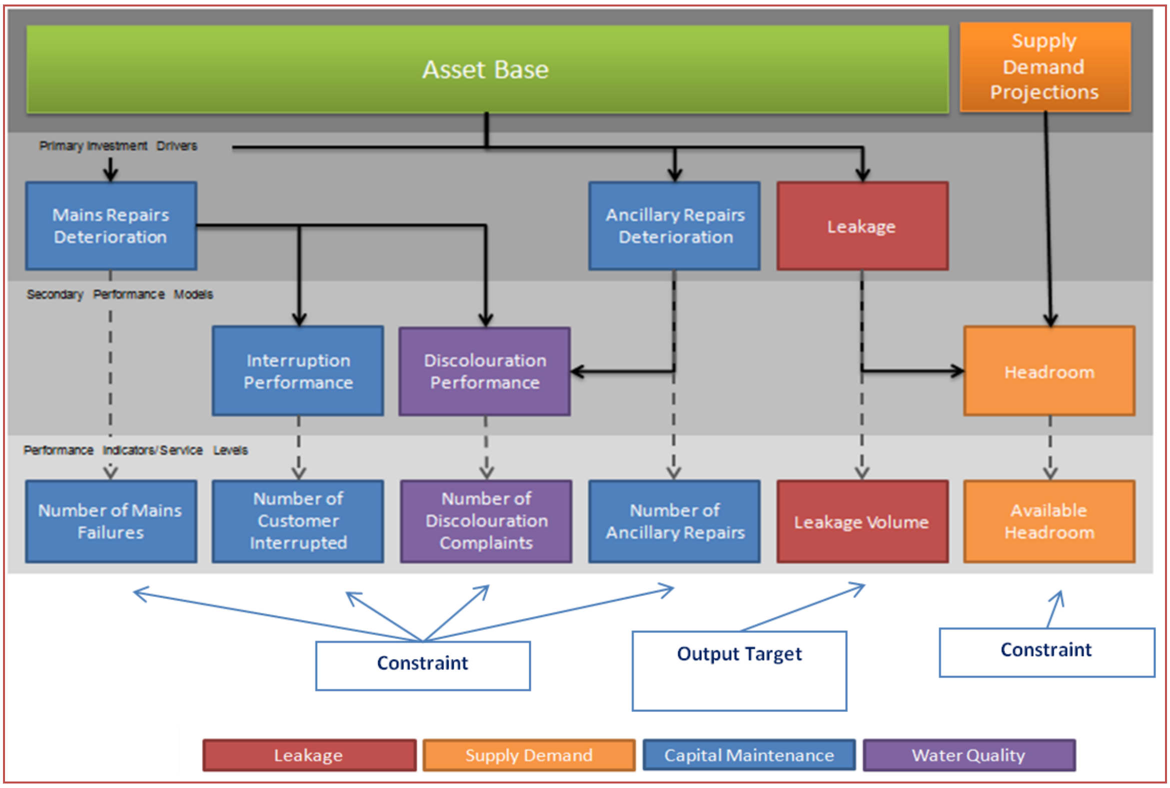
D5.1 Overview of the Water Infrastructure and Demand Model

The WISDM model is made up of six linked sub-models:

- Headroom
- Leakage
- Mains repair
- Interruptions
- Discolouration
- Ancillaries

The inter-relationships between these sub-models are illustrated in figure D5.2.

Figure D5.2: The components of the WISDM model



These linked sub-models assess how the performance of our service measures; headroom, leakage, supply interruptions and discolouration will change over time if we do not maintain our asset base.

The supply / demand balance is modelled using the output from the demand and deployable output models and the leakage model (as this is a key component of demand).

Asset deterioration is modelled through predictive asset performance models. These models forecast the expected levels of mains bursts and leakage as the asset base ages. Consequence models calculate the impact of a burst in terms of supply interruptions and discolouration.

The following investment options are available within the WISDM model; active leakage control, metering, water efficiency measures, new sources of supply and mains renewal.

The model uses these interventions, running all sub-models concurrently, in order to provide an integrated, least cost plan to meet our service targets.

The predicted service and serviceability measures that the model targets are:

- Available headroom
- Levels of leakage (output, not input)
- Number of mains repairs
- Numbers of unplanned interruptions as a result of mains repairs
- Numbers of discolouration complaints
- Numbers of repairs on ancillary assets

The integrated model calculates, for each water resource zone, the least cost mix of capital and operational interventions needed to achieve the desired service targets. Social and environmental costs of the chosen interventions are included in the least cost calculation resulting in a plan that is holistically least cost.

To reduce the computational complexity, the model is run in two stages, each covering the same 25 year period of AMP6 through AMP10. First the model is run with five time-steps of five years each (5x5) to set our mains renewal programme on an AMP by AMP basis, resulting in five, five year blocks of investment. For the next stage, the levels of mains renewal are taken forward from the 5x5 model to a model run that looks at the 25 year problem on an annual time step basis (25x1). The 25x1 model is then used to adjust the levels of the remaining interventions (mains cleaning, pressure management, active leakage control, water efficiency and resource options) to ensure the serviceability and supply demand targets are met on an annual basis within each AMP.

The sections below provide a summary of the methodologies used in these sub-models. They define the assumptions made, the data used in the models, the inputs that have been taken from other studies and modelling, and the outputs that are available.

D5.2 The Headroom and Demand sub-model

The Headroom / Demand Sub-model calculates the available headroom for each water resource zone based on water available for use, demand and leakage projections. The model's objective is to achieve and maintain target headroom by increasing available headroom, using demand management, reducing leakage or selecting new resource options available to it. Figure D5.3 below depicts the location of the sub model in the overall WiSDM hierarchy.

Figure D5.3 Headroom sub model

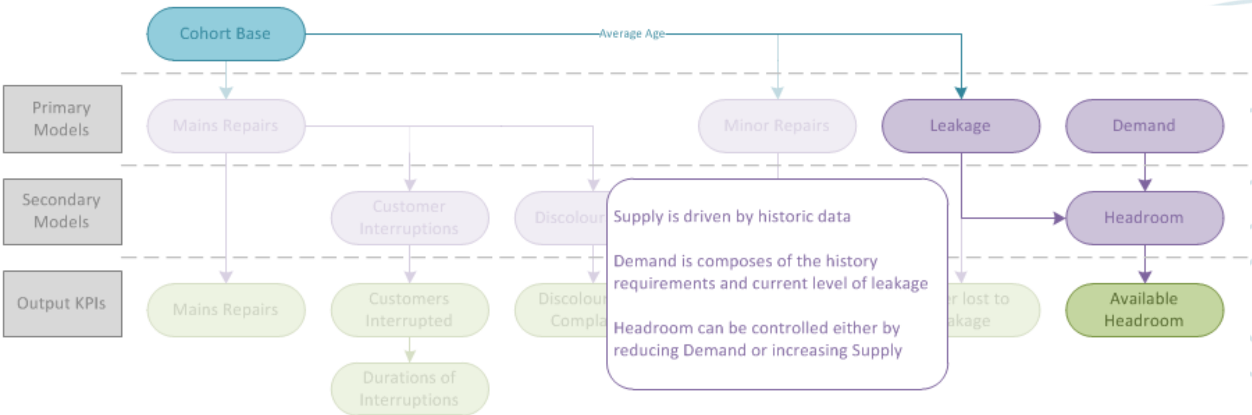
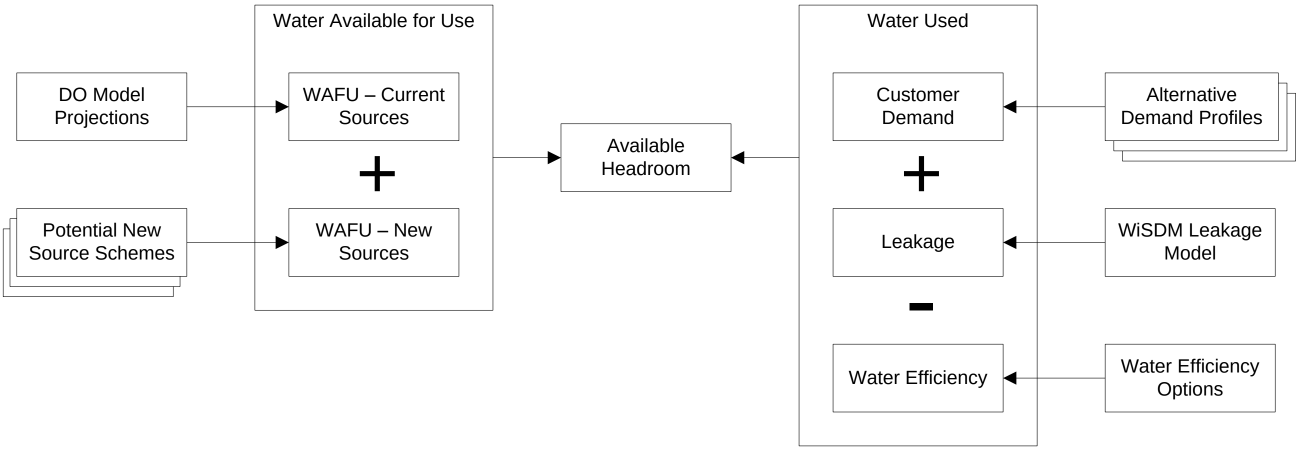


Figure D5.4 portrays the calculations within the model. Water available for use (WAFU) is made up of the predicted output from existing sources and the contribution from any new resource schemes that the model has chosen.

The default baseline demand projection includes the benefits of our ongoing free meter policy and a continuation of our AMP5 water efficiency activities. The model then has options available to reduce demand further using compulsory metering, additional water efficiency measures or reducing leakage.

Leakage levels are calculated dynamically by the leakage sub-model and are a function of the underlying network deterioration and the chosen mains renewal and active leakage control interventions.

Figure D5.4 Calculation of available headroom in the WiSDM model



The WAFU benefits of new sources/demand options are all input to the model at the water resource zone level. Each option has associated with it the following data:

- Available daily output/benefit
- Construction costs
- Operation costs
- External costs (carbon and amenity / social)
- Dependencies with other options
- Inter-zonal effects if a scheme involves transferring water between zones

When optimising using the 5x5 model, the model initially calculates available headroom in five year time steps over the projected 25 year period. Where there is a headroom shortfall in any timestep, the model will seek to close that shortfall using the options available to it in that timestep; this includes reducing leakage to lower levels. The model works through an iterative process to calculate the least cost set of options that will ensure that there is no headroom shortfall in any time step over the full 25 year period. For the second stage optimisation using the 25x1 model, the mains renewal programme is fixed from the 5x5 and the inter-AMP sequence and timing of the remaining interventions is refined using annual headroom targets.

The key outputs from the Headroom and Demand sub-model are:

- Total water available for use
- Resource options chosen
- Available headroom

- Distribution Input
- Household water delivered
- Numbers of meters installed
- Level of enhanced water efficiency activity
- Supply demand balance

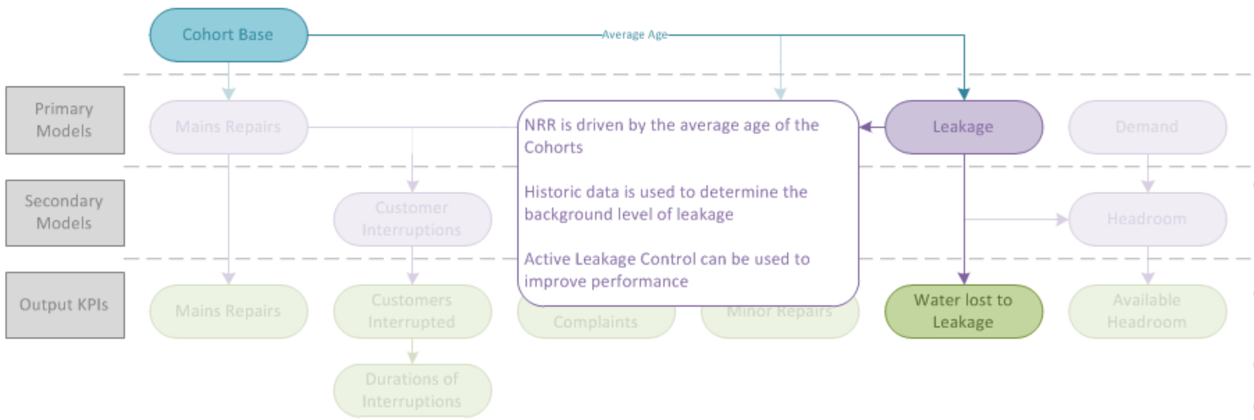
D5.3 The Leakage sub-model

The purpose of the Leakage Sub-model is to calculate the quantities of water lost through leakage based on the relationship between the age and makeup of the network for each WRZ. The model's objective is to calculate the level of leakage reduction required to achieve a least cost solution taking into account supply demand challenges and practical constraints.

We use the model to calculate the Sustainable Economic Level of Leakage (SELL). The SELL is calculated in the optimisation by balancing the relative costs and benefits of combining different supply and demand-side interventions, alongside achievement of serviceability measures. The leakage target is an output not an input of the overall WiSDM model.

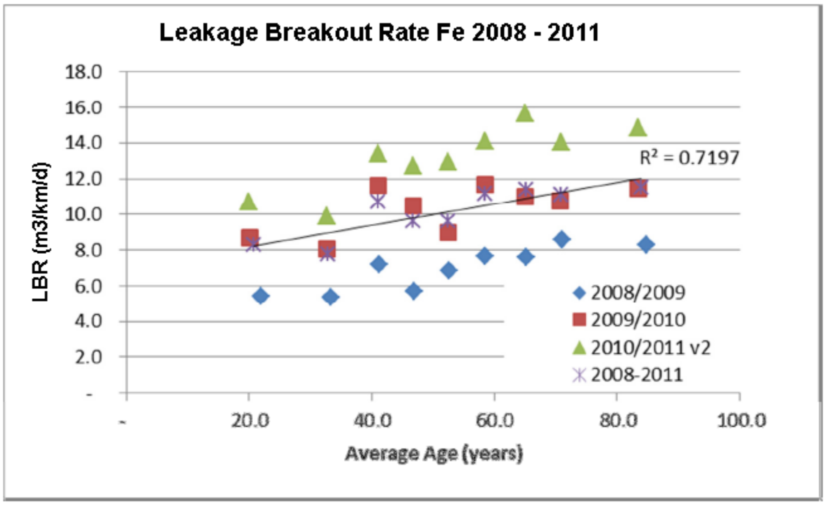
Figure D5.5 below depicts the location of the sub model in the overall WiSDM hierarchy.

Figure D5.5 Leakage sub model



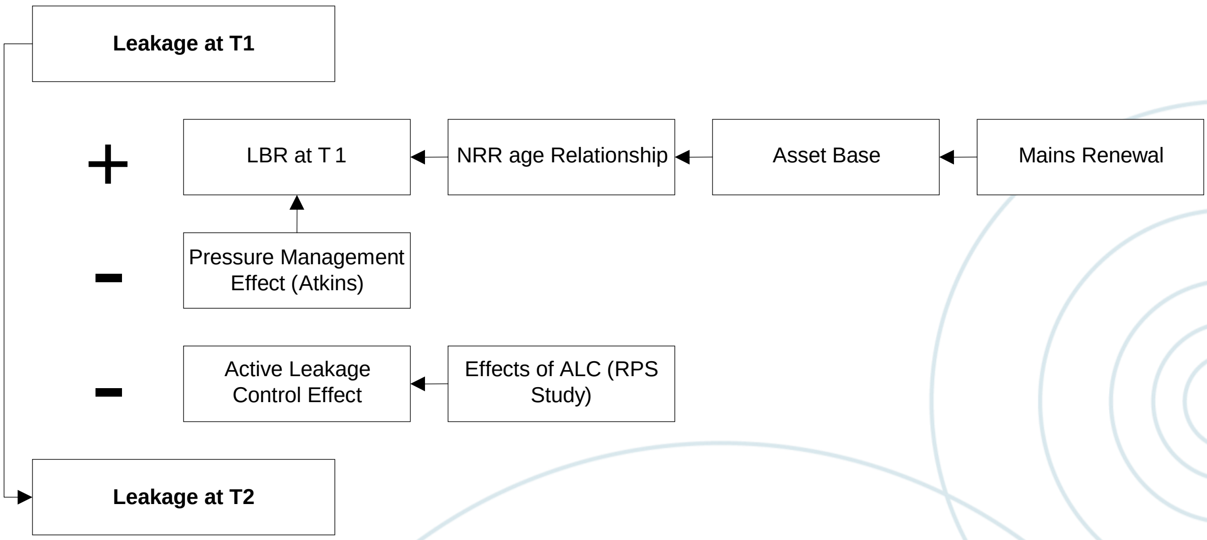
The predicted increases in distribution mains leakage resulting from network deterioration are calculated in the model through the Leakage Breakout Rate (LBR) for the mixture of assets within the water resource zone. LBR for each cohort of material is calculated using historic data, Figure D5.6 below shows an example of the analysis. All LBR deterioration profiles used in the model are linear with age.

Figure D5.6 Leakage Breakout Rate derivation



In the baseline forecast, predicted leakage for each year is calculated by adding the LBR of leakage to the leakage level from the previous year. For the final, sustainable economic level of leakage forecast, leakage is derived by subtracting the effects of the available leakage reduction interventions, namely: pressure management and active leakage control. This sustainable economic level of leakage calculation is carried out for each water resource zone. Figure D1 details the calculations within the leakage sub model.

Figure D1.7 Leakage calculation



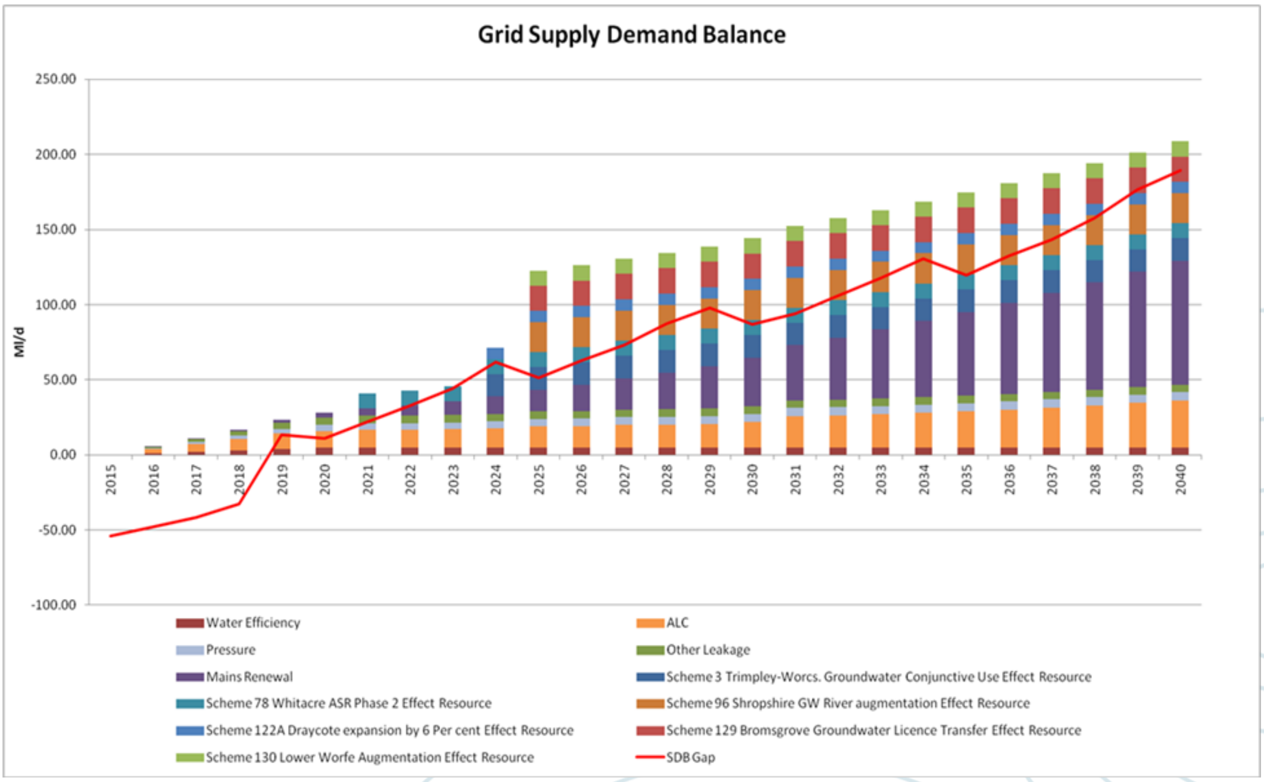
For each water resource zone, a series of leakage reduction options are considered in the model, each with costs and benefits.

The LBR of leakage resulting from network deterioration can be controlled through mains renewal and pressure management. The calculation of LBR by material enables mains renewal to be focused on the materials contributing most to LBR. The rate of rise of leakage is also controlled through pressure management, the benefits calculated in studies outside of the model and represented in the model as a number of levels to allow refinement in the optimisation. In addition to the effect on LBR pressure management has a direct effect on the level of leakage.

The Active Leakage Control (ALC) intervention represents the effort and cost involved in finding and fixing leaks. It is configured in the model as a series of levels of reduction from current leakage to background levels (the minimum possible). The model can choose to do any number of leakage reduction levels in any one time step as long as the over all reduction in AMP6 is not greater than 10% in any WRZ, this constraint has been configured to take account of the practicality of delivery. The costs incurred for ALC include the cost of the effort to reduce leakage from one level to another and the cost of the additional effort needed to maintain leakage at the new lower level. The additional number of repairs, equipment needed, carbon and amenity costs associated with ALC are also calculated in the model and included in the calculation of the least cost solution.

An example of how leakage reduction, both ALC and pressure management, contribute to the overall optimal solution can be seen in Figure D5.8 below. It can be seen that leakage is used along side new sources of supply and further water efficiency to find the overall least cost solution.

Figure D5.8 Strategic Grid Supply Demand Solution

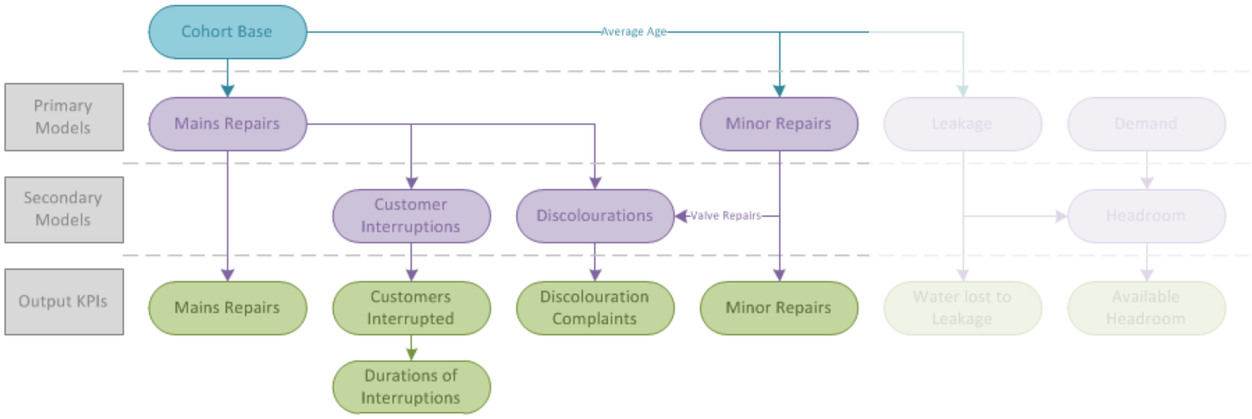


D5.4 The Mains repair sub-model

The purpose of the Mains Repair Sub-model is to predict the number of mains bursts based on relationships with the age and makeup of the network for each WRZ. The number of bursts and the materials bursting has a direct effect on the number of unplanned customer supply interruptions. There is also a secondary effect on the number of discolouration complaints as mains bursts are a trigger of a discolouration events. The model's objective is to calculate the length of mains renewal required to maintain a stable number of mains bursts and prevent an increase in the number of unplanned customer interruptions of greater than 12 hours and to maintain the number of unplanned customer interruption minutes greater than three hours.

Mains renewal, as well as acting on LBR as described in the leakage sub-model section, is also used in the model to control the number of mains bursts and resulting unplanned interruptions through the moderation of the average age and material profile of the asset base. By holistically considering the benefit of mains renewal to leakage, mains bursts, unplanned interruptions, ancillary repairs and discolouration, we have ensured that the mains renewal investment profile is optimal. Figure D5.5 below depicts the location of the sub model in the overall WiSDM hierarchy.

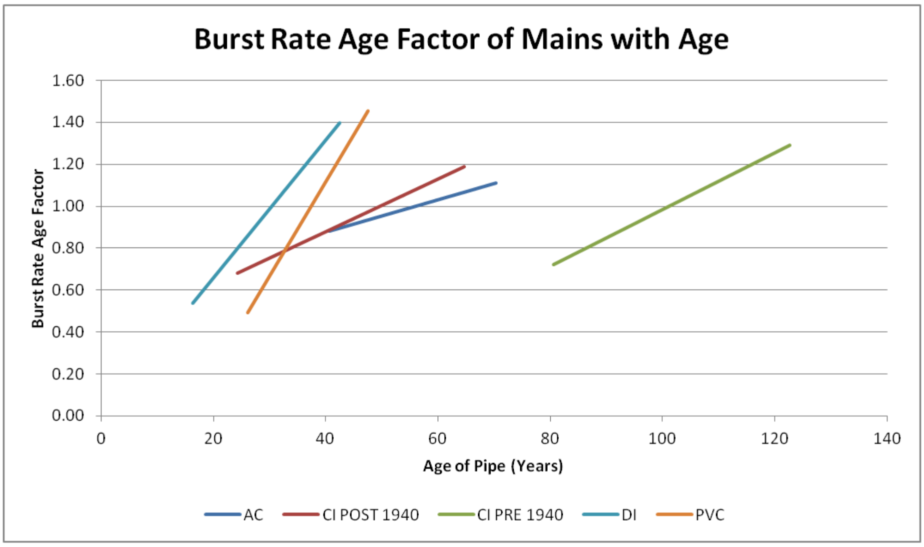
Figure D5.9 Mains Repairs Sub Model



Company specific burst data is used to derive the deterioration relationships for each material, age, diameter and soil type. The two key relationships derived are detailed below with an example in Figure D5.10D5.10:

- A linear burst factor relationship for each material type by age. This is used to calculate the change in the number of bursts as the average age of the cohorts change.
- A multiplier relationship for each soil/diameter combination by material. This is used to modify the number of expected bursts taking into account ground conditions.

Figure D5.10 Deterioration by Material and Soil

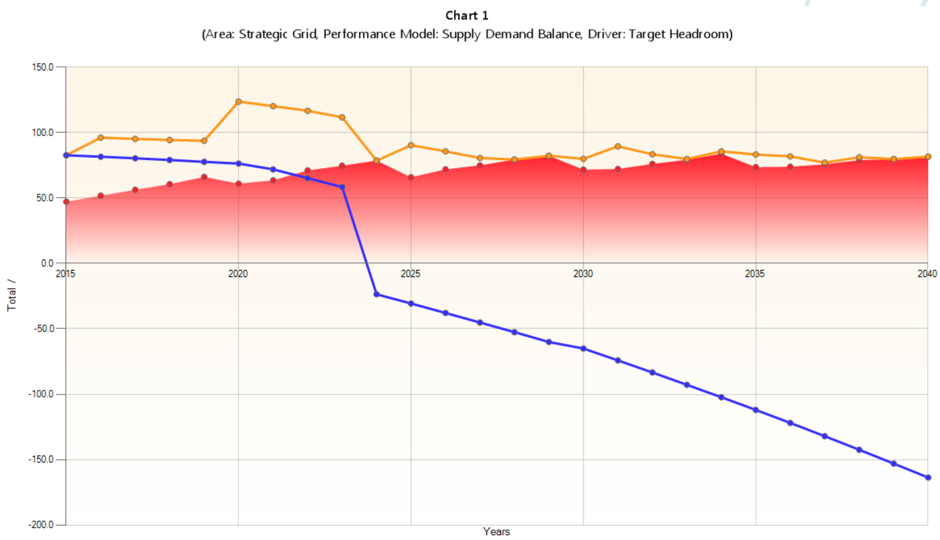


The number of unplanned customer interruptions resulting from mains burst is calculated in the Customer Interruptions Sub-Model. We have derived relationships between pipe diameter, material and location (urban or rural) and the number of customers interrupted and the duration of those interruptions. We constrain the model the keep the number of interruptions greater than 12 hours stable, this focuses mains renewal on larger diameter pipe in materials which tend to cause longer duration interruption events (asbestos cement and PVC). The benefit to discolouration complaints is a secondary effect as the number of complaints isn't constrained or targeted in the model.

D5.5 Model outputs

The WiSDM model produces output files by water resource zone for each simulation/optimisation run as well as a series of graphical and tabular summaries. Figure D5.11 below illustrates the type of graphical output produced.

Figure D5.11 Illustrative graphical output from the WiLCO supply-demand balance modelling system



Careful analysis and interpretation of the output from individual model runs has enabled us to understand the outcomes from different possible investment strategies, and to develop confidence in the operation of the modelling system. We have spent considerable time tuning the modelling system to meet our needs following PR09 and have undertaken an extensive model strengthening exercise for PR14.

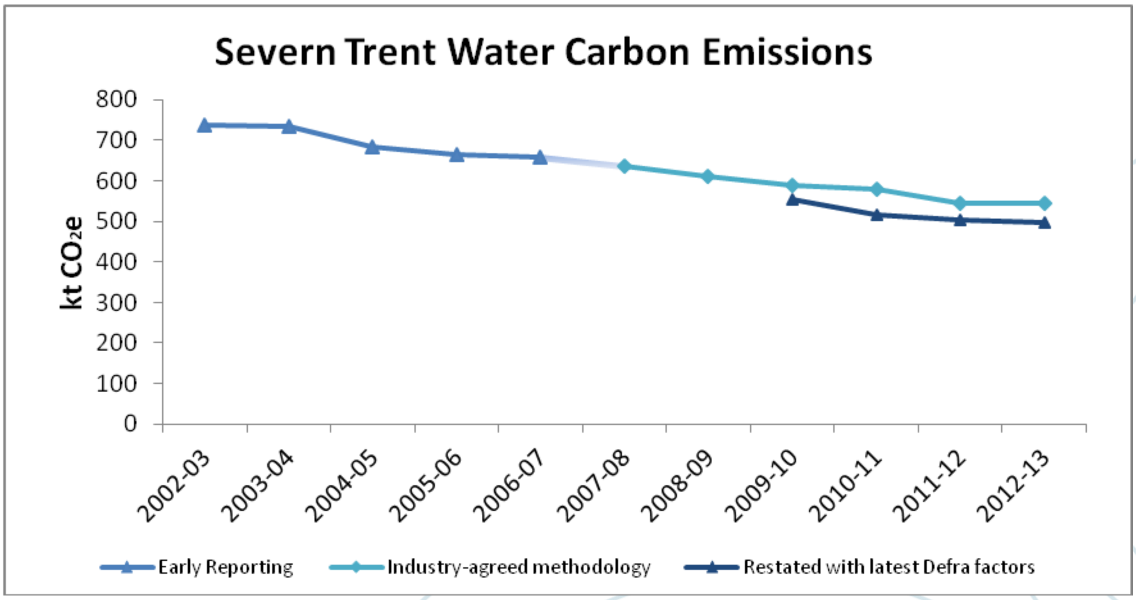
D6 Greenhouse gas emissions

Greenhouse Gas (or 'carbon') emissions contribute to climate change and need to be reduced. Severn Trent Water's operational emissions were 520 ktCO2e in 2012/13 which is about 0.1% of the UK's total emissions. On top of this, there are significant emissions in our supply chain resulting from outsourced maintenance and construction activity.

We recognise that we need to reduce our direct carbon emissions and help reduce our indirect emissions. In our 2020 business plan we have set out our long term aim to be carbon neutral and energy self sufficient, provided this is the best value option for our customers. This represents an evolution of the key strategic intention to minimise our carbon footprint, set in our last strategic direction statement. In AMP6 we plan to continue to improve our performance towards this aim.

We consistently track and project our operational emissions in line with Defra guidance[1]. Since 2008 we have been using the UKWIR Carbon Accounting Workbook for calculating operational greenhouse gas emissions[2]. We publish this information annually on our website and report our performance to Ofwat and to the Carbon Disclosure Project. We also set ourselves internal and external carbon targets and incorporate these into our business plans. In our 2020 business plan we have set out an ambition to reduce our operational greenhouse gas emissions in the appointed business by 6% from current levels by 2020, despite the upward drivers we face and excluding the impact of external changes such as the national grid decarbonising. We are beating our target for 2015 and we have reduced operational emissions year on year since 2002, as shown in figure D6.1.

Figure D6.1: Severn Trent Water Operational Carbon Emissions 2002 – 2013



Since 2009 we have held the Carbon Trust Standard in recognition of our consistent carbon reduction and our carbon management programme.

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[1] Defra, *'Guidance on how to measure and report your greenhouse gas emissions'*, available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/206392/pb13944-env-reporting-guidance.pdf

[2] *Carbon accounting in the UK Water Industry: methodology for estimating operational emissions, report no 08/CL/01/5*

The price of energy and environmental taxes mean that there is an increasingly close link between our operating costs and our carbon impact. These costs are likely to increase as the UK moves to a low-carbon economy. So aside from our commitment to play our part in reducing emissions, cost and the impact this has on our customers' bills is a key reason to focus on carbon emissions.

As part of our business planning process for 2015 and beyond, we have been consulting with our customers and our stakeholders on whether our existing approach to reducing carbon is correct and what we should do in the future. The feedback we have received, and the research we have conducted, confirms that stakeholders agree with our overall strategy. Our engagement also shows that stakeholders want us to prioritise action where there is a long-term financial benefit to customers.

We want to maintain the improvements we have made, and find ways to reduce carbon emissions further whilst still improving service. We know that this should be done only at a cost our customers are willing to pay, so we will continue to prioritise actions which allow us to keep customer bills down. There are many challenges for us in reducing emissions, not least of which are the challenges addressed by our water resource management plan i.e. the need to ensure adequate supplies of water for our customers and the environment. Meeting these objectives can require carbon-intensive solutions.

D6.1 Measures to reduce our carbon impact

The schemes set out in the water resources management plan to ensure we can meet the future demand for water form part of our overall investment plans. Our investment plans for the period 2015-2020, and the estimated carbon impacts of these schemes, are set out in more detail in our business plan for 2020.

As part of our business plan we will be continuing measures to reduce our overall carbon emissions. The beneficial effects of these schemes have not been included in the carbon projections shown below but the main actions are summarised below. Other measures include improving our transport efficiency and research into better ways to manage our process emissions.

Energy Efficiency

70% of our company emissions come from grid electricity consumption. Over AMP5 we have reduced our energy consumption through a dedicated programme of energy efficiency schemes. These projects include pump replacement and refurbishment, pump optimisation and site heating and lighting improvements. Over the past three years this has reduced consumption by approximately 5GWh per year in water services, resulting in a combined carbon saving of approximately 15,000t CO2e. We plan to continue a programme of efficiency measures to continue to reduce emissions. Our strategy also includes an ongoing focus on asset optimisation and process improvement, for example through improving our telemetry systems and optimising the way we control our network. This will further reduce our energy consumption and hence carbon impact across the company.

Renewable Energy

We are leaders in the UK Water sector for renewable energy generation. The more renewable energy we generate, the lower our carbon footprint. Currently, the equivalent of 24% of the energy we use in Severn Trent Water is generated from Severn Trent plc renewable energy sources. In the regulated business, the majority of this energy generation comes from sewage sludge but we also generate energy from hydropower in the clean water side of the business. We will look at remaining renewable opportunities in the regulated business and pursue those where it is economic to do so. We also generate energy in the non-regulated business from wind power and crop digestion. We will continue to explore the significant renewable opportunities in the non-regulated business, which reduce UK carbon emissions.

Optimisation in delivery and innovation

There are a number of ways by which we can reduce carbon impacts as we deliver our plan. These include innovating in design, consistently challenging our supply chain to come up with low-carbon solutions and selecting newer, more efficient technologies. For example, we would expect to take advantage of improved technology available on the market as we come to deliver the capital schemes described in the water resources management plan over the next 25 years.

We are also adopting more innovative ways of working, including partnerships, sustainable urban drainage solutions, catchment management and customer education to deliver our plans, all of which can allow us to reduce environmental impacts.

Our research and development programme will continue to seek lower-carbon ways of delivering our services and we plan to focus on waste product recovery and low-energy technologies. This includes investing in new technologies which enable us to remove valuable products from waste, a good example being phosphate, which is the least abundant of the major plant nutrients and is thus a very valuable resource.

D6.2 Our approach to carbon emissions in the water resource management plan

Our approach to considering carbon emissions in the water resource management plan has been to assess the carbon impacts of different activities and include them in the selection of options. To do this we estimated the carbon impacts of the individual capital scheme options and combined these with a price for carbon in our option cost benefit assessment in the options modelling. Our approach is similar to the approach we used for our last water resource management planning process, but it has been updated to take account of more recent guidance and information particularly on the assumed costs of carbon emissions.

The benefits of this approach are:

- We are able to quantify the most significant direct and indirect carbon impacts of our water resource management plan over the 25 year period.

- Carbon cost is considered as a part of our decision making and will influence the cost benefit ratio of different schemes. This helps us to identify the lower-carbon solutions which meet our requirements.

Since our last WRMP, DECC have released new guidance on using the traded and non-traded price of carbon in policy appraisal[3]. This superseded previous guidance on the shadow price of carbon. In May 2012 an UKWIR project[4] to develop a standard set of carbon accounting guidelines for water companies was completed. The UKWIR project took into account DECC's changes and included:

- Guidelines on estimating embodied and operational carbon associated with water company projects.
- Guidelines for carrying out whole-life costing including carbon values.
- Guidelines for what carbon prices and emissions factors to apply in whole life costing.

Our approach is based on these latest UKWIR guidelines and on Defra accounting guidelines on emissions boundaries. Defra Carbon Accounting Guidelines describe three scopes of emissions. These are:

- Scope 1 – Emissions for which we are directly responsible.
- Scope 2 – Emissions associated with our consumption of energy.
- Scope 3 – Emissions resulting from our actions which occur at sources we do not own or control but are not related to our energy consumption.

For each individual capital scheme, changes to scope 1 and 2 emissions were estimated and used to calculate the annual operational carbon impacts of our work. The predominant driver of operational carbon emissions in all water supply schemes is electricity consumption. For cost benefit assessment, we applied the electricity grid emissions conversion factor projections up to 2040 provided by DECC in 2012[5], converted to CO2 equivalent as recommended by the UKWIR guidelines. For our carbon calculations we used the grid factors from 2020 onwards.

The largest scope 3 carbon impact of individual capital schemes is embodied carbon, i.e. the carbon associated with the construction of assets. Embodied carbon for each scheme in the plan was estimated using a bespoke carbon calculator for embodied emissions associated with water asset construction schemes. This tool has been used for all schemes in the final WRMP because of its simplicity and the consistency of calculation this approach offers. We have found a consistent approach has more value than bespoke analysis for individual schemes because it is more efficient and it helps to mitigate the high level of uncertainty which remains in estimating embodied carbon. Embodied emissions were profiled in line with the capital expenditure profile.

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[3] Department of Energy and Climate Change (DECC) (2009) *Carbon Valuation in UK Policy Appraisal: A Revised Approach'*
[4] UKWIR (2012) *'A framework for accounting for embodied carbon in water industry assets' (*CL01/B207)
[5] These forecast factors are frequently revised by DECC. The projection values used in our modelling were those available prior to the December 2012 update.
DECC, *'GHG emissions and energy appraisal Toolkit – Supporting Tables 1-20'*, latest version available from: https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal

Valuing Carbon in the options modelling

As set out in the latest DECC guidance for valuing carbon in policy appraisal, there are two potential prices to use in cost benefit assessment; the traded and non-traded price of carbon.

The traded price of carbon is a theoretical price used in government policy making based on mitigation costs in sectors covered by the EU emissions trading scheme (EUETS). It is meant to represent the financial savings to the UK from having to purchase less allowances through the EUETS. Annual prices are given to 2100 and are periodically updated by DECC. The Non-Traded price of carbon represents the costs of meeting emissions targets in sectors not covered by the EUETS. The non-traded price is assumed to align with the traded price of carbon from 2030. UKWIR suggest that the non-traded price of carbon should be applied in areas where carbon is not represented in the price of good or services, for example in regions where the Climate Change Levy and the EU Emissions Trading Scheme does not apply. Broadly, this only applies to products from outside the EU. Applying this value requires a complicated separation of emissions projections between traded and non-traded sectors.

We elected to apply the Government's "central" traded price of carbon in our cost benefit analysis[6]. This approach has the merits of being simple and transparent. This is because, under this approach, there is no need to distinguish between traded and non-traded emissions sources, which at this stage of planning is technically impossible to do with any degree of accuracy. UKWIR guidelines suggest that because carbon values will be passed through in the future costs of most goods and services (such as electricity), financial or non-financial evaluations may need to be reduced to avoid the risk of double-counting. We have chosen not to adjust the carbon value in the non-financial evaluation because we deem this risk to be very low. The key reasons for this are:

- Financial cost benefit analysis for the WRMP does not include any specific uplifts to account for rising emissions allowance prices. This reduces the likelihood of double counting.
- Applying the traded price in all cases (instead of the non-traded price), which is the lower of the two values reduces the impact of any double counting.
- The values of carbon in each project compared to the capital and operating costs and the other environmental and social costs, was found to be very low. This means the impact of any double counting is also very low.

We did include a projection of the additional costs under the Carbon Reduction Commitment which we would expect to incur as a result of the additional carbon emissions. These represent real, direct financial costs for the company. Our total CRC allowance cost in 2011-12, which was the first year we were obliged to purchase allowances, was £5.85m. For the modelling, the projection was based on the most up to date information available at the time about the future allowance price, which was drawn from 2010 Treasury Spending review information[7]. In December 2012 updated information was released about the scheme simplification and allowance prices in the future, which has enabled us to improve our assessment of the total CRC cost impact of the water resource management plan. The Government have announced that the allowance unit price will increase in line with inflation after 2014-15.

[6] This value is periodically updated by the Government. The value used for our WRMP was based on the value available prior to the December 2012 update. The value stated by government has reduced since this version but sensitivity analysis indicates that this change is not material to our cost benefit analysis.
[7] HM Treasury, Spending Review 2010, available from: http://cdn.hm-treasury.gov.uk/sr2010_completereport.pdf

D6.3 The carbon impacts of our WRMP

Using the approach outlined above, we have estimated both the embodied and operational carbon emissions impact of the investment strategy set out in our water resources management plan.

Operational Emissions

We have used our operational GHG emissions model to generate a projection of the likely carbon impacts that result from our 25 year WRMP strategy. We have shown the impacts under two scenarios. Neither of these scenarios includes the effects of our carbon reduction measures such as improving energy efficiency or expanding renewable energy generation

The first scenario assumes the grid electricity conversion factor changes in line with the latest DECC projections for grid electricity consumption by industry[8]. This is the approach recommended by UKWIR in their report 'A framework for accounting for embodied carbon in water industry assets'. We would note that the estimates of the future grid emissions factor trajectory available from DECC are based on a more rapid decrease in the carbon intensity of grid electricity than has been observed in recent years. As the electricity grid decarbonises this will have a significant impact on our emissions as 99% of our carbon emissions in water services are caused by grid electricity consumption.

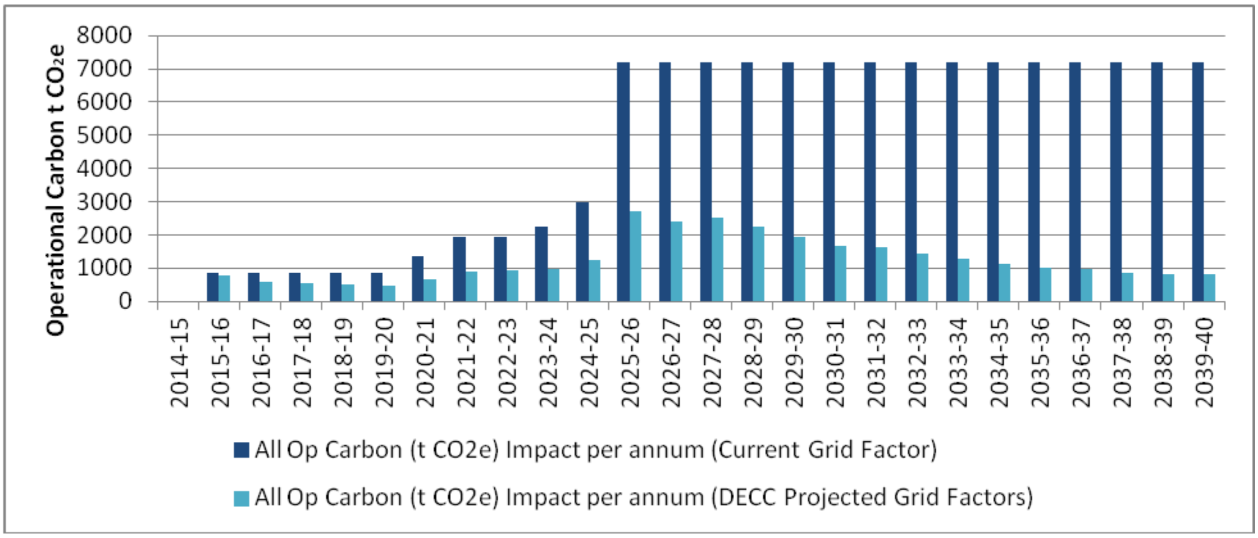
The second scenario assumes the emissions conversion factor for national grid electricity remains the same throughout the period (for the purposes of this scenario we used Defra's latest grid emissions factor of 0.483 kg CO2e/kWh, including both scope 2 and scope 3 emissions[9]). This removes the influence of the national electricity grid changes over the period. We have shown this scenario to demonstrate the contribution made by our activities in the water resource management plan in the absence of external changes. This projection is likely to present a worst case scenario because realistically we expect the carbon-intensity of energy generation to decrease.

The operational carbon impact of the individual capital schemes in the plan under these two scenarios is shown in figure D6.2 below.

[8] DECC, *'GHG emissions and energy appraisal Toolkit – Supporting Tables 1-20'*, latest version available from: https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal

[9] Government conversion factors for company reporting:, available from: http://www.ukconversionfactorscarbonsmart.co.uk/

Figure D6.2: Operational carbon impact of capital schemes in the WRMP to 2040



The cumulative operational emissions impact over the 25 year period of the individual capital schemes under the second scenario (i.e. assuming the grid factor does not change) is 123kt CO2e. The projected additional energy consumption per year as a result of the capital schemes is 14.8 GWh by 2039-40.

We have also calculated the impact of demand growth, leakage reduction and demand management measures included in the plan to estimate our total emissions profile for water services.

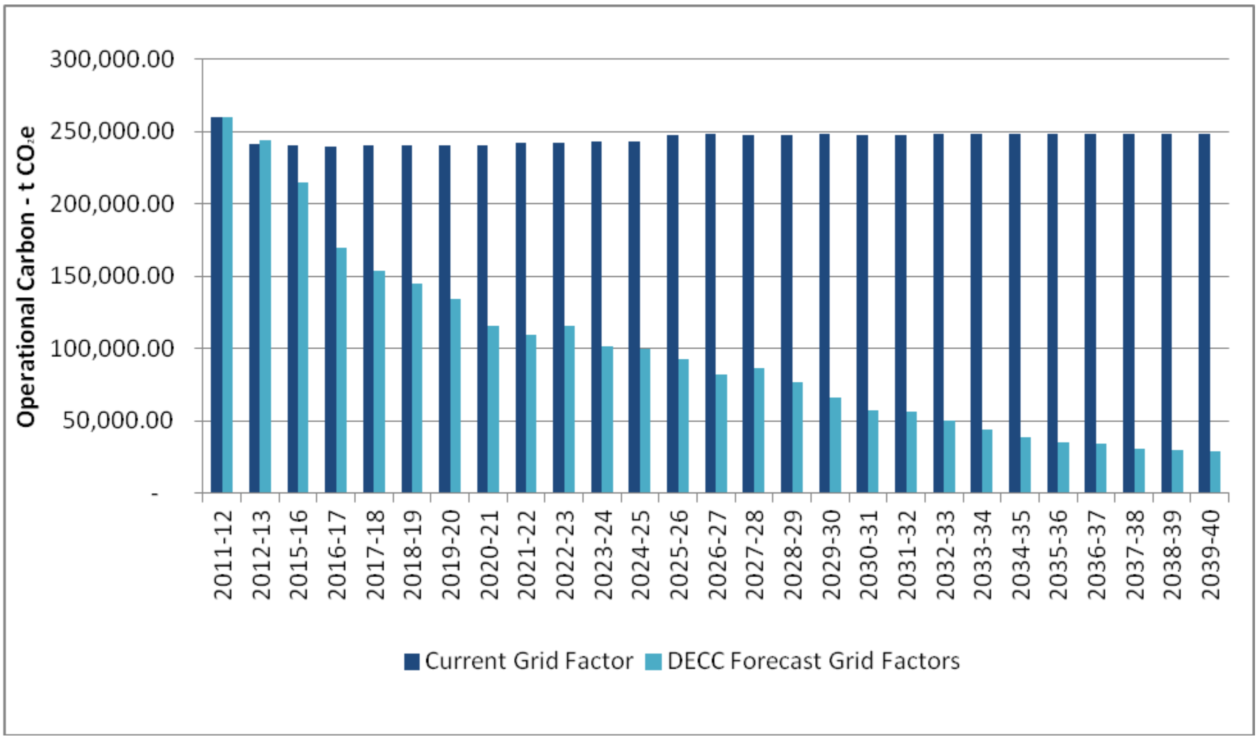
The baseline for operational emissions from water supply activities was calculated using version 7 of the UKWIR Carbon Accounting Workbook (April 2013). We considered the emissions associated with water supply activities only (i.e. those sources included on the ‘Drinking’ section of the Carbon Accounting Workbook). The 2015 baseline is based on our actual performance in 2012-13.

- Increases to the baseline have been calculated where new capital schemes in the water resource plan require additional electricity after commissioning as described above.

- Changes to the baseline emissions have been estimated based on the projected changes to the overall level of leakage and demand (for example due to growth or water efficiency measures). These factors influence the energy requirement to pump and treat water and hence affect carbon emissions. Leakage control activity also involves some operational emissions, primarily for transport.
- Future improvements to the energy efficiency of our operations and our renewable energy generation from water services assets have **not** been included.

The resulting 25 year net operational carbon projection for water services is shown in figure D6.3 under the two grid emissions factor scenarios.

Figure D6.3: Impact of the WRMP schemes on operational emissions in the water service excluding the effect of carbon reduction schemes

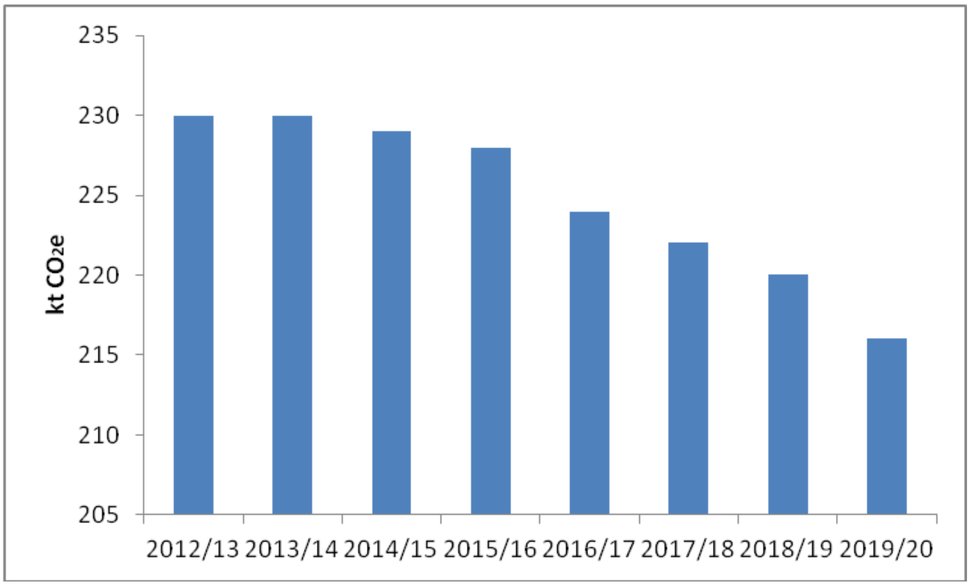


The net result of the long term strategy set out in the WRMP, excluding the impact of our efficiency schemes, renewable energy generation and the effect of changes to the emissions intensity of the national electricity grid, is an increase of 3% in carbon emissions. This represents a 'worst case' scenario as the net effect of:

- An increase in energy consumption due to new water supply capital schemes;
- an overall marginal increase in the demand for water across our region over the period; and
- a reduction in leakage over the period.

Including the impact of carbon emissions reduction schemes and renewable energy expansion, but still excluding the effect of changes to the emissions intensity of the national electricity grid, our carbon emissions target for the water service is a reduction of 6% by 2020 compared to current levels. It has not been possible to estimate the reductions beyond 2020 because there is very high uncertainty about the scope and benefits of efficiency. The forecast for water services including these factors is shown in figure D6.4.

Figure D6.4: Carbon emissions forecast for water services up to 2020 including the effect of carbon reduction schemes.



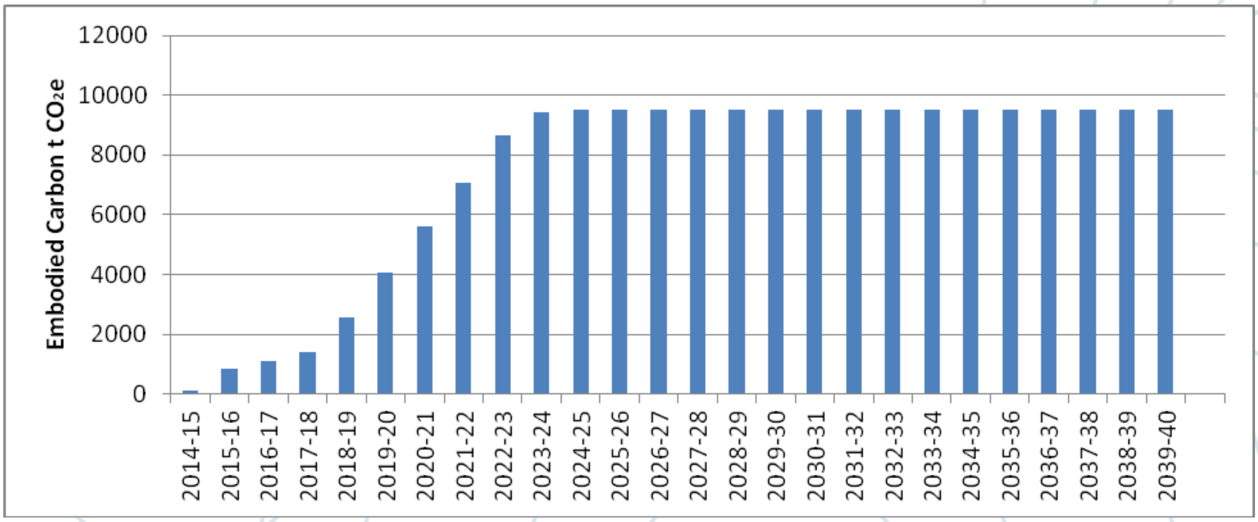
Emissions intensity in the water service, measured as kWh/Ml, will decrease marginally over the period as overall distribution input is expected to increase proportionally more than carbon emissions.

Taking into account the effect of a national move to low-carbon generation as projected by DECC, our total emissions and emissions intensity would decrease significantly over time, as the majority of our emissions result from our consumption of grid electricity.

Embodied Emissions

We have summed the embodied emissions projections from the capital schemes included in the plan to understand the total embodied carbon impact. Note that no consideration of future changes to emissions intensity of different products and activities is considered in these numbers. The cumulative embodied emissions projections are shown in figure D6.5.

Figure D6.5: Cumulative embodied carbon impact of capital schemes in the WRMP to 2040.



The total embodied emissions impact of the schemes in the plan is estimated to be 9.5 ktCO2e. This is a relatively low impact, equal to approximately 1.8% of our current company annual operational emissions.