A8: Securing cost efficiency and enhancement spend

This appendix provides a clear summary of the total expenditure (totex) in our PR19 plan, how this has been expressed in the data tables and how it can be split between price controls, outcomes and regulatory drivers. This summary also shows the link between the enhancements included in our plan, the performance commitments we're making to protect customers and how we're using real option mechanisms to protect our customers from uncertainty.

In this appendix we explain:

- How expenditure has been allocated and is reflected in the data tables (Section 8.1)
- Why our efficiency targets are stretching (Section 8.2)
- How our approach to uncertainty protects customers (Section 8.3)
- Our supporting evidence for wholesale enhancement expenditure (Section 8.4)
- Our cost adjustments on the Ofwat proforma (Section 8.5)
- Why modelling claims may be needed to ensure costs reflect our circumstances (Section 8.6) and additional cost claim cases (Section 8.7)
- How the cost benchmarking supports our plan (Section 8.8)

Section 8.1 provides a guide to the totex in the plan.

Section 8.2 summarises the efficiency targets in our plan. Our strong AMP6 track record provides the confidence we need to propose an immediate and sustained cost reduction across all price controls. We know there's no silver bullet – it's about working across many areas while appreciating the inflation cost pressures we expect to face. This section is linked to Chapter 20 and Table 24a, with supporting benchmarking studies included in Section 8.8.

Section 8.3 explains in detail how we propose to manage uncertainty. We've developed real option mechanisms which, along with a smaller committed programme where we do not have material uncertainty, protects the interests of customers and supports the use of an adaptive pathway approach being followed. It enables us to act in an efficient and timely manner if the need is confirmed while avoiding the need for AMP7 bills to increase because of a risk averse approach.

In Section 8.4 we've presented evidence for all material enhancements including summaries of the four areas where we believe cost adjustments are required (in addition to the modelling claims). The four areas – supply demand balance, water framework directive, security and supply resilience – are consistent with our 3 May 2018 submission to Ofwat. The completed proformas and full cost adjustment claims have been included in Section 8.5 and 8.7 respectively.

Our May submission also included econometric modelling claims covering four areas – treatment complexity, energy costs, economies of scale and developer services – areas where we felt there was a material risk of them not being fully accounted for in Ofwat's modelled expenditure. In Section 8.6, we've summarised our claims and the additional analysis we've undertaken to support the potential need.

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APPENDICES TO 8.8 HAVE BEEN REDACTED IN LINE WITH THE TERMS OF OUR ENGAGEMENT

In this appendix we've redacted information that relates to the location of some of our sites. We've also redacted commercially sensitive information that could prejudice current negotiations (including a current procurement process for AMP7 suppliers).

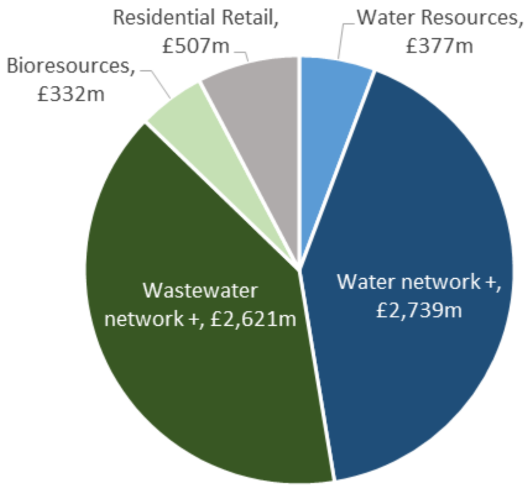
8.1 AN OVERVIEW OF THE TOTEX IN OUR PLAN

This section summaries the totex in our PR19 plan, how this has been expressed in the data tables and how it can be split between price controls, outcomes and regulatory drivers (maintenance and enhancement). This summary provides a guide to link together our plan, evidence for enhancement expenditure, cost adjustment claims and data tables.

At the highest level our plan includes £6.6bn totex, £6.1bn of which relates to Wholesale activities.

£6.1bn Wholesale totex: £3.1bn (52%) is allocated to Wholesale Water (Water Resources and Water Network Plus price controls), with the remaining £2.9bn (48%) to Wholesale Wastewater (Bioresources and Wastewater Network Plus price controls).

£0.5bn (8% of all totex) is allocated to residential retail.



[REDACTED]

[REDACTED]

We've used driver trees to link outcomes with activities and resources, recognising an element of shared costs:

Outcome £m	Wholesale Water	Wholesale Wastewater	Wholesale totex
Good to Drink (Chapter 11)	866	-	866
Water always there (Chapter 12)	1,721	-	1,721
Wastewater safely taken away (Chapter 13)	-	767	767
A thriving environment (Chapter 16)	102	1,599	1,701
Shared costs	427	587	1,013
Total	**3,116**	**2,953**	**6,069**

The enhancement values align to Tables WS2 (Water Service) and WWS2 (Wastewater service).

Ensuring costs are efficient

In Chapter 20 securing cost efficiency, we've explained how we're planning to build on our strong AMP6 efficiency performance to deliver 13% efficiency on wholesale costs and over 10% efficiency on our retail average cost to serve. We conducted a number of external benchmarking studies to build and test the efficiency of our costs including construction contract costs, construction on-costs and support costs. The range of studies helped to ensure we avoided potential bias from not comparing costs on a like-for-like basis and, as we also repeated some PR14 benchmarking, provided a consistent analysis. The analysis proved to be an eye opener, helping us to find and prioritise specific areas of opportunity to build into our PR19 efficiency plans. The results of our benchmarking analysis are summarised in Chapter 20, with the studies in this Appendix.

We also tested our plan against updated econometric benchmarks including a challenging set of catch-up (UQ) and frontier shift (1% per annum) assumptions. Where we found our costs to be consistently and materially greater than top down econometric benchmarks, we applied further top down efficiency challenges. This approach provided a holistic view of efficiency which recognised there may be further scope for efficiency beyond that captured by a bottom up cost assessment.

This evidence demonstrating efficient costs applies across all our activities as we operate our business holistically as a system, with many of the cross-cutting efficiency initiatives flowing through the price controls. As such, to avoid repetition, the enhancement cases only include specific additional evidence to support efficient costs described in Chapter 20.

Interaction between enhancement expenditure and cost adjustment claims

In section 8.4, and in line with Information Notice 18/11, we've identified all material programme items of our enhancement expenditure and have:

- explained why the expenditure is classified as enhancement and not as base, including identifying the drivers of the expenditure and the benefits; and
- provided evidence to support the need for the expenditure, how customers are protected. As explained above, evidence to support cost efficiency is in Chapter 20, supported by the benchmarking studies in Section 8.8.

To reduce the risk of confusion between enhancement expenditure and cost adjustment claims, and to ensure all material enhancement have been evidenced, we've mapped the evidence cases to enhancement purposes used in the data tables and our performance commitments, clearly identifying where the cost adjustment claims fit in.

Wholesale Water enhancement expenditure overview

£m	Enhancement	Cost Adjustment**	Totex	Table WS2 lines covered	Performance commitment coverage	Wider customer protection mechanism
Supply demand balance: driven by future supply and demand	138.2 (133.6 capex, 4.6 opex)	80.0 (80.0 capex, Nil opex)	218.2	Capex: 7, 8, 9, 10, 21, 22, 23 Opex: 46, 47, 48, 49, 60, 61, 62	• Inspiring our customers to use water wisely • Leakage • Per capita consumption (PCC) • Abstraction Incentive Mechanism (AIM) • Increasing water supply capacity • Risk of severe restrictions in a drought • Number of water meters installed	WRMP process Real options mechanism*
Supply demand balance: driven by environmental legislation	23.9 (23.9 capex, Nil opex)	60.3 (45.0 capex, 15.3 opex)	84.2	Capex: 18, 19, 20 Opex: 57, 58, 59	• Abstraction Incentive Mechanism (AIM) • Improvements in WFD criteria	EA prosecutions
[REDACTED]						
Resilience	73.4 (61.4 capex, 12.0 opex)	74.0 (74.0 capex, Nil opex)	147.4	Capex: 14 Opex: 53	• Resilient supplies • Water supply interruptions • Water quality complaints	
Drinking Water Quality	60.8 (34.0 capex, 26.8 opex)	Nil	60.8	Capex: 13 Opex: 52	• Water quality compliance (CRI) • Water quality complaints • Farming4Water	DWI undertakings or prosecutions
Lead	16.8 (16.4 capex, 0.4 opex)	Nil	16.8	Capex: 6 Opex: 45	• Water quality compliance (CRI) • Protecting our schools from lead	DWI undertakings or prosecutions
Drinking water aesthetic	22.4 (Nil capex, 22.4 opex)	Nil	22.4	Capex:5 Opex: 44	• Water quality complaints	
Environmental performance	18.4 (10.9 capex, 7.5 opex)	Nil	18.4	Capex:1, 2, 3 Opex: 40, 41, 42		EA prosecutions
Low pressure	10.1 (10.1 capex, nil opex)	Nil	10.1	Capex:4 Opex: 43	• Persistent low pressure • Resolution of low pressure complaints	Regulatory enforcement
Developer Services	258.2 (258.2 capex, Nil opex)	Nil	258.2	Capex:11, 12 Opex: 50, 51	• D-mex	Regulatory enforcement
[REDACTED]						

*The real options mechanism is part of our approach to manage uncertainty and is explained in section 8.3

** Modelling claims are not shown in this table

Wholesale Wastewater enhancement expenditure overview

£m	Enhancement	Cost Adjustment**	Totex	Table WS2 lines covered	Performance commitment coverage	Wider customer protection mechanism
Wastewater environmental programme (WINEP)	151.2 (108.8 capex, 42.4 opex)	275.0 (275.0 capex, Nil opex)	426.2	Capex: 4 to 23 Opex: 51 to 70, 80	• Improvements in WFD criteria	EA prosecutions Real options mechanism*
Sewer flooding	140.8 (139.4 capex, 1.3 opex)	Nil	140.8	Capex: 30, 34 Opex: 77	• Internal sewer flooding • Risk of sewer flooding in a storm • External sewer flooding • Collaborative flood resilience • Sewer blockages	
Sewage treatment growth	80.6 (80.3 capex, 0.3 opex)	Nil	80.6	Capex: 26 Opex: 73		Regulatory enforcement
Wastewater Network+ new legislative requirements	47.7 (47.7 capex, Nil opex)	Nil	47.7	Capex: 32 Opex: 79		Statutory enforcement
Bioresources	29.3 (23.9 capex, 5.4 opex)	Nil	29.3	Capex: 2, 3 Opex: 49, 50	• Satisfactory sludge use and disposal	EA prosecutions
First time sewerage (S101a)	17.4 (16.9 capex, 0.5 opex)	Nil	17.4	Capex: 1 Opex: 48		Water Industry Act 1991 enforcement
Developer services	70.6 (70.4 capex, 0.1 opex)	Nil	70.6	Capex: 25 Opex: 72	• D-Mex	Regulatory intervention
Other	14.4 (10.0 capex, 4.4 opex)	Nil	14.4	Capex:33 Opex 71, 75, 81	• Sewer blockages	
[REDACTED]						

*The real options mechanism is part of our approach to manage uncertainty and is explained in section 8.3

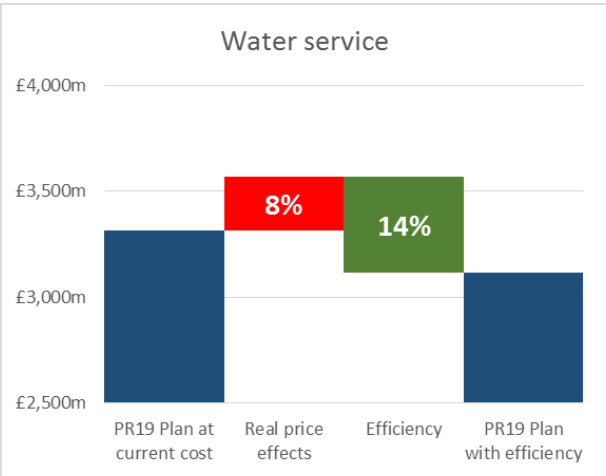
** Modelling claims are not shown in this table

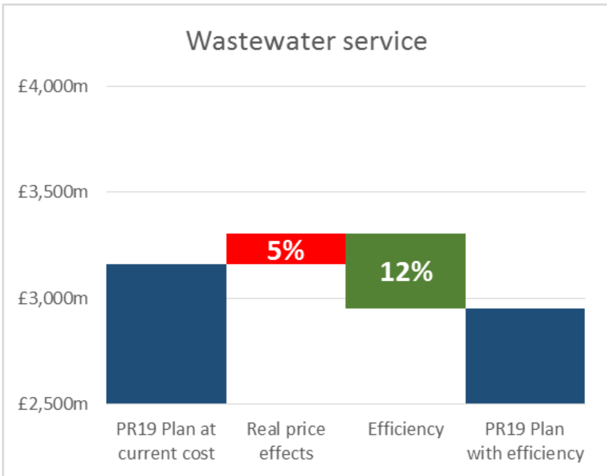
8.2 OUR EFFICIENCY TARGETS ARE STRETCHING

Appointee Table 24a provides a breakdown of the expected cost increases above inflation – known as real price effects - and the impact of our efficiency plans. The table commentary in Appendix 13 provides more detail on the real price effects, and our efficiency initiatives are described in Chapter 20. Our Wholesale plan builds in 13% efficiency, which we've weighted towards our water service partly in response to the expected above inflationary impacts. Our retail plan builds in an 11% efficiency on an already efficient cost base (over 10% average cost to serve on a like-for-like basis).

Efficiency in the Wholesale plan

Our overall efficiency of 13% is weighted slightly towards our water service activities. It will be more challenging to deliver efficiency in wastewater given our PR14 frontier position. Wastewater also benefits from a lower impact of energy price effects because of the investment we've made to generate a large portion of our own power needs.





Our efficiency plans are based on achieving an immediate and sustained cost reduction. An essential element of this will be our revised approach to capital delivery, coupled with a strong emphasis on productivity management and control enabled through the additional £100m investment being made in the latter part of AMP6.

Real price effects

There are four areas where we believe we will face above inflation cost increases in AMP7:

- **Labour:** We have included a 3% per annum increase in labour costs, based on our company view of average wage inflation over the period for our geographical area.
- **Electricity:** Prices are broadly made up of three categories;

- Wholesale price – this is based on the Department for Business, Energy and Industrial Strategy (BEIS) reference rate forecast in nominal prices.
- Variable pass-through costs – these are based on the Severn Trent specific Cornwall price forecast.
- Fixed pass-through costs - increased in line with RPI which historically has been a good indicator.

- **Rates:** Business rates revaluations will take effect in 2021/22 and 2024/25. In addition, the tax rate is inflated by CPI (using the previous September's annual increase) between the revaluation dates.
- **Traffic Management Act (TMA):** A significant rise in Traffic Management costs based on discussions with the relevant authorities in our area have been forecast up to 2025 driven by two factors;
    - Permitting schemes; and
    - Lane Rental charges.

[REDACTED -under the terms of our engagement]

Our efficiency plans in retail follow a similar pattern, with an efficiency of 11% and real price effects of 10%. In terms of average cost to serve (ACTS), we've calculated an improvement of over 10% between the 2019/20 and 2024/25 ACTS (on a like-for-like basis).

8.3 REAL OPTIONS (UNCERTAINTY MECHANISM)

We've developed a new approach to managing uncertainty - referred to as a real option mechanism - which deliver better outcomes for customers by providing a targeted tool to manage uncertainty.

We are proposing to use the real option mechanism in the following areas:

Enhancement case	Enhancement (£m included in the plan)	Total value of claim for AMP7 (Section 8.7)	PCs used to reflect uncertainty	£m (excluded from the plan)
Supply demand balance: driven by future supply and demand	218.2	218.2	Climate change Metering	651.7 supply schemes (to 2040) 35.0 metering
Wastewater environmental programme (WINEP)	426.2	398.6	WFD	120.9
Water trading - interconnector	Nil	Nil	Interconnector	40.0
Total	**644.4**			

In the interests of simplicity we've not created new metrics which would require additional data tables, but instead used the ODI framework. We have:

- Introduced four performance commitments;
- modified the ODIs to include outperformance payments (rewards); and
- defined trigger to initiate delivery above the committed performance commitment level.

In this section we explain why real option mechanisms deliver the best result for our customers and set out the key design features. This should be read in conjunction with Appendix A3 designing PCs - Part 2 (definitions); and Appendix A4 designing ODIs.

We've carefully considered the decision to use real options, balancing the need to include totex in our base plan against customers' bearing the risk of stranded investment should the need does not materialise or having to wait until PR24 for redress. We've challenged ourselves to look for ways of using the real options approach to provide additional benefits for customers.

- On addressing supply demand challenges, we've been able to include additional totex in our plan to fully deliver the three certain schemes that would otherwise have been delivered over ten years, and by doing so, provide earlier benefits for customers and the environment. We've also been able to include totex in our plan to meaningfully progress feasibility and design on the less certain schemes – this will provide much more certainty on the optimal solution and efficiency in the future without having to make an early – and relatively uniformed - call on the timing/scale of climate change. Our commitment to using the Annual Performance Report as a vehicle to inform customers on climate change decisions is also a positive step – we recognise the need to do this even though, as once with asset health, we may initially have felt climate change was too complex for discussion;
- Supply demand also includes metering, where the real options approach responds to stakeholder feedback on our draft WRMP which highlighted the experience of other companies who'd been

unable to fully deliver the significant step up in metering proposed. Using real options protects our customers from this risk, with the alternative being to fully fund the programme upfront;

- On the wastewater environment programme, we're confident that the real options approach follows guidance in the PR19 methodology on managing uncertainty and helps bring regulatory timelines together without delaying improvement or risking stranded assets;
- On the interconnector, the real options mechanism enables us all – companies, regulators, other stakeholders – to make meaningful progress on making large scale water trading a practical reality, with more confidence that service levels for all customers will improve and without adverse environmental impacts.

This section is structured as follows:

- Section 8.3.1 sets out the importance of managing uncertainty from our customers' perspective;
- Section 8.3.2 highlights the key outcome uncertainties associated with our investment programme;
- Section 8.3.3 sets out our proposed solution - using real option mechanisms;
- Section 8.3.4 presents the results from our customer engagement on uncertainty, including customer views on our use of real option mechanisms;
- Section 8.3.5 sets out our four real option mechanisms; and
- Section 8.3.6 explains the governance process for applying these real option mechanisms.

8.3.1 Principle for using real option mechanisms

An important feature of our PR19 business plan is our approach to managing uncertainty. In infrastructure industries managing uncertainty appropriately is critical to delivering the best outcome for customers. Because investment lead-times can be quite long, investment decisions will often be based on forecasts, which inevitably carry an inherent degree of risk. If the future might be materially different to the forecast, there is a risk that solutions are sized and/or specified in ways that end up not being well-aligned with customer needs.

The significance of this can be compounded by the long life of the assets that may be put in place. From a customer perspective this could mean:

- There is a risk that investment is undertaken when it is not needed and bills are too high as a result – for example, Kielder dam was built based on assumptions about future industrial growth in the North East which did not eventuate; or
- Companies do not invest sufficiently for the future and as a result are unable to continue to deliver service levels customers expect – for example, in Victoria, Australia, the water companies and Government did not address the risks associated with El Nino sufficiently (and then hurriedly built a very large desalinisation plant which is rarely used).

In the water sector we face another complexity in the form of the price review occurring every five years. This means that for some items in our plan, there will be a degree of uncertainty about whether the solution is appropriate. The transition to an outcomes and totex approach helps to lessen the likelihood of problems arising, as companies have more flexibility to adapt to changing circumstances within an AMP. However, material problems can still arise because of uncertainty over the outcomes that it is considered desirable and/or feasible to deliver when plans are being developed.

We recognise that there are mechanisms in place to manage uncertainty, notably interim determinations. However these are quite cumbersome tools, which involve significant cost and resource from all parties.

We have developed a more targeted and proportionate tool to manage 'outcome uncertainty' through the use of 'real option mechanisms'. These protect the interests of customers by not exposing them to the risk of unnecessary upward pressure on bills; and support effective response to new information that reduces uncertainty.

We refer to them as real option mechanisms as they support an approach that recognises the real option value that can be associated with waiting before committing to a particular investment (and considering actions that may increase flexibility) when uncertainty is expected to lessen to material degree during AMP7.

8.3.2 What is uncertain?

There are two enhancement cases in our PR19 Plan – supply demand balance and the wastewater environmental programme – where we face material outcome uncertainty because the driver for some of the investment is uncertain and/or the full deliverability of the investment is uncertain due to factors outside our control. We also recognise that there is a degree of uncertainty about the timing of the need for an interconnector between the Severn and Thames to support water trading from the North West to the South East of England.

Below we describe these uncertainties before setting out how we are managing them in our plan to deliver the best outcome for customers.

Supply demand balance

Section 8.4 contains the cost adjustment claim relating to supply demand balance. In summary, our water resource management planning modelling has enabled us to identify three water resources zones where pressures are expected to cause a supply demand deficit. This shortfall reflects two key drivers:

- reductions in our abstraction licences relating to WINEP3, a legal requirement; and
- uncertainty associated with the impact of climate change.

For each of the three zones, the reduction on our supply capacity (to the nearest Ml/d) for each of the contributory factors is shown below. Note under the WRMP guidelines we are required to include a direct reduction in deployable output (DO) due to climate change as part of the baseline water available for use calculations and also to include uncertainty around climate change in target headroom. We currently are not seeing any impacts of climate change on our flows, so for our modelling we opted to include a smaller direct reduction in DO and allow for more uncertainty in target headroom.

Cumulative reductions (Ml/d) from base year 2016/17 by water resource zone

Ml/d Impact in the Strategic Grid zone	2020	2025	2030
Environmental (WINEP3)	0	5	90
Climate change	8	18	28
Climate change uncertainty	53	125	169

Ml/d Impact in the Nottinghamshire zone	2020	2025	2030

Environmental (WINEP3)	0	0	38
Climate change	13	28	43
Climate change uncertainty	1	1	2

Ml/d Impact in the North Staffordshire zone	2020	2025	2030
Environmental (WINEP3)	0	36	36
Climate change	2	4	6
Climate change uncertainty	1	2	3

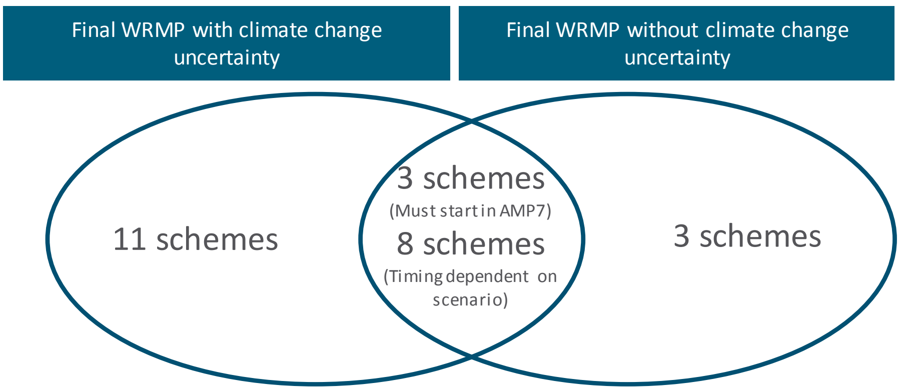
To meet these challenges, we have followed a twin-track approach that considers demand and supply interventions and also considers the implications of managing uncertainty using adaptive pathways. Our demand management solutions are significantly more ambitious than ever before and we've included progressive implementation of supply schemes where our analysis shows that there is an unequivocal need to act. We are confident that this approach aligns with our wider statutory, regulatory and customer driven expectations.

Alongside our demand side solutions, we have identified the need for 22 supply schemes in our final WRMP over the 25 year planning period (the same as our dWRMP, which included a similar programme of demand-side interventions).

We have tested the sensitivity of these identified schemes to major uncertainties, including:
- Climate change uncertainty (variance around the central view of climate change impact) and
- Scheme uncertainty (the Ml/d that the schemes will deliver, the cost of the schemes and the construction time required).

Our analysis shows that there is a high level of certainty that three supply schemes will need to start in AMP7 in order to solve spatially distinct deficits driven by WINEP3 abstraction reductions which cannot be solved by company-wide demand side solutions.

Sensitivities show when supply schemes are selected



The three schemes are required in AMP7 irrespective of any assumption made on climate change uncertainty. These schemes are included in our PR19 plan (see our supply-demand enhancement business case) and described in the table below.

Investment to deliver three schemes in AMP7 will be included in our PR19 Plan

Scheme	Benefit (Ml/d)	Time to deliver benefits (years)
[Location REDACTED] pipeline capacity increase	7.5	2
[Location REDACTED] transfer solution	25	4
[Location REDACTED] asset and water treatment enhancements	36	5

There are also eight supply side interventions selected in both scenarios but these have a choice on start time depending on whether climate change uncertainty is included or not.

The selection of the remaining schemes is dependent on core climate change uncertainty and scheme specific assumptions. This means that there is an elevated risk that the delivery of these schemes may not lead to the most economic or efficient solution to customers.

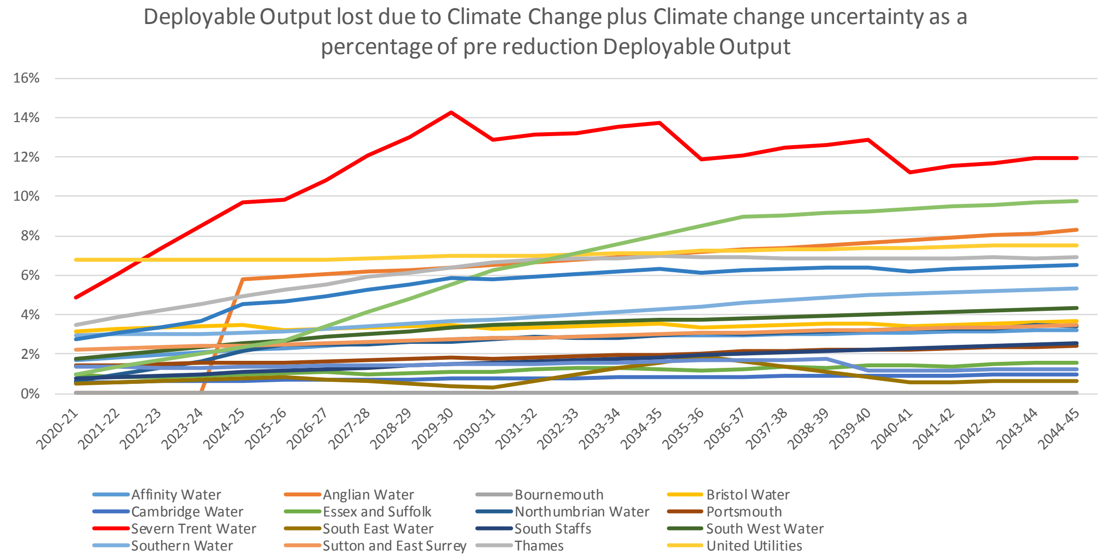
If climate change does not lead to a reduction in deployable output at the pace and scale predicted then customers would face higher bills. This is because the supply schemes have a degree of irreversibility. Furthermore if we can identify cheaper solutions to reducing leakage it would change the balance of solutions, potentially leading to more demand side measures at PR24 and beyond.
However we recognise that there are uncertainties associated with both the speed and magnitude of the impact of climate change and also the willingness of customers to voluntarily adopt metering in such a large step-up.

Climate change uncertainty

The impact of climate change is uncertain. The consensus is that there will be less water available (and so less deployable output) in the future. To inform our future investment needs we have modelled a range of scenarios to estimate the change in deployable output, drawing on:

- the UK Climate Change Projections 2009 data set, issued by the MET Office and supported by BEIS and Defra; and
- a range of scenarios that depict different potential climate outcomes.

We have analysed the draft WRMP of different companies and it is apparent that different assumptions about climate change uncertainty have been adopted. There is a significant variance in the impact of climate change and climate change uncertainty, both in terms of scale and timing as illustrate in the figure below.



The differences are partly attributable to the underlying assumptions used by companies as the WRMP guidance allowed companies freedom in terms of selecting which methodology to use to model climate change impacts. Companies were able to devise their own approach or use one of three suggested best practice approaches:

- Approach 1: Using the previous assessment of climate change;
- Approach 2: Using 1 of 8 methods described in their 2013 technical guidance (which uses 2030s projections from UKCP09 or the Future Flows assessment (Future Flows was an EA project that used 11 regional climate models); or
- Approach 3: Using the 2017 technical guidance, which suggests using 2080s UKCP09 projections, future flows hydrology monthly change factors, 11 climate data scenarios from the UKCP09 Spatially Coherent Projections.

Companies also had a choice of scaling methods (using the current guidance, previous guidance or their own method).

We used a combination of two approaches from the 2013 technical guidance. We carried out a vulnerability assessment which flagged high vulnerability in the Strategic Grid and Nottinghamshire zones which required us to follow one of the more rigorous methods. 10,000 projections were sampled down to 100 using Latin Hypercube Sampling. These were then sub-sampled down to 20 using a drought indicator. For consistency we applied this approach to all zones, even groundwater only zones that had a low vulnerability.

Previous engagement with the EA and Natural England indicated they were supportive of the approach we used. However, despite our approach being in-line with the best practice guidance, our approach shows that we would be an outlier in responding to climate change uncertainty, as noted by several stakeholders in their responses to our draft WRMP.

Looking across the sector, the variety of approaches used and feedback from stakeholders shows that there is no one right approach to use. The need to protect customers from the risk of drought while ensuring that they do not bear the costs of investment unnecessarily has been a catalyst in addressing this risk through the use of real options.

Although the impact of climate change will inevitably be uncertain we note that there are two relevant factors that may reduce the uncertainty. The first is the updated data UK Climate Change Projections which will be issued in late 2018. This data set is being updated and improved through the publication of UKCP18. This includes both (i) refreshed data; and (ii) more granular data, so will support more accurate modelling.

The second element that reduces uncertainty is time, which allows for more empirical testing to understand the impact and speed of change. This point was underscored in CMA in the Bristol decision which noted that "as time progresses, *the uncertainty relating to a future point in time will necessarily decrease, (all things remaining equal).*[1]]

The conclusions we can draw from the above information are that:

- we need to reduce demand and/or increase supply in response to climate change (based on the best available modelling); and
- our response will be more effective if we can effectively defer so that we can reduce uncertainty.

Metering uncertainty

Our supply demand balance cost adjustment claim also contains a degree of uncertainty on the metering take-up rates. We've proposed a significant increase in metering to support both a reduction in leakage and provide greater focus on water efficiency. We've assumed that our metering programme will deliver 10.2 Ml/d reduction in demand by the end of AMP7.

The table below compares the metering programme under our PR14 metering policy with the programme in our PR19 plan. This highlights the scale of ambition of our PR19 programme, which involves meter installations that for AMP7 are more than 300% of the level under our PR14 policy.

		AMP7	AMP8	AMP9	AMP10
PR14 metering policy	Number of meter installations	147,878	134,619	122,549	111,560
	% households metered by end of AMP	55%	60%	65%	69%
PR19 metering policy	Number of meter installations	493,765	771,313	428,030	0
	% households metered by end of AMP	65%	88%	100%	100%

There are two key uncertainties associated with metering:

- Whether it is possible to increase metering installations rates as quickly as planned
- Whether the increase would deliver the forecast 10.2 Ml/d reduction in demand.

In response to our draft WRMP both Ofwat and the EA supported our ambitious programme but expressed concerns about the deliverability and the subsequent impact on meeting the supply demand deficit if the target is not achieved. In particular they noted that "given the uncertainties in delivery, the consequences of not meeting the ambitious metering target on the supply-demand balance should be tested and the impacts on other options presented."

[1] CMA page 214, https://assets.publishing.service.gov.uk/media/56279924ed915d194b000001/Bristol_Water_plc_final_determination.pdf

Our view is that we should manage the uncertainty associated with the scale of the demand reduction that can be achieved through delivering our metering programme. However we do think there is material uncertainty over whether the metering programme can be delivered in full due to the level of ambition. We consider in section three how that uncertainty could be best managed to protect the interests of customers.

Waste environmental uncertainties

Our wastewater environmental programme is driven primarily the Water Framework Directive (WFD). This directive requires us to:

- ensure 'no deterioration' to waterbodies as a consequence of our activities;
- deliver improvements to achieve 'good ecological status' where these improvements are cost beneficial (subject to meeting technical feasibility disproportionate cost criteria).

The large majority of our WFD improvement programme is set at amber status in WINEP3, which means there is a degree of uncertainty about whether the investment should proceed. The overall scale of the WFD improvement programme will be confirmed through ministerial decisions on affordability and can only occur following completion of the statutory River Basin Management Plan public consultation process, which is currently scheduled for late 2021.

We note that the EA, Defra and Ofwat have written to companies about WINEP3 and the potential for companies to defer delivery of some WFD obligations into AMP8. We are not proposing to apply for any deferrals but we think this reinforces the need to review our approach to uncertainty.
Similar to climate change, we think the uncertainty about whether a scheme should proceed or not could be better managed.

Water trading – interconnector

As Defra summarised in 'Building resilient water supplies – a joint letter'[2] the onus is on companies to commit time and money to regional planning and assessing the feasibility of regional and inter-regional solutions, including considering strategic transfers and strategic water storage infrastructure, in AMP7.

We have already initiated this process by exploring – together with Thames Water and United Utilities – options that could allow for bulk transfers of water from our region into the Thames region. A number of water resources options were developed that could deliver water into the river Severn for onward transmission to the river Thames, as part of the wider Severn to Thames transfer. This program of work included technical feasibility studies to identify where resources could be provided without impacting Severn Trent's customers' levels of service and resilience.

Developing some or all of these options raises a number of substantial challenges, including that:

- The lead-time for this kind of investment is considerable in part because of likely construction requirements, but also importantly because of the range of planning and regulatory approvals that would be needed for projects to be able to progress.
- There are substantial uncertainties associated with the project related on both the demand and supply side, including:

[2] A joint letter from Defra, the EA, the DWI and Ofwat received 9 August 2018

- The likely demand for water in the Thames region (and in the South East more generally), given both demand uncertainty and uncertainty over the scope for developing alternatives that may ultimately be identified as providing better value for money.
- The feasibility and costs associated with proceeding with different projects given the novelty and complexity of the issues that it raises (which include, for example, managing the effects of transferring water from one river to another).
- The successful provision and subsequent usage of this type of supply option is like is likely to depend heavily on the effectiveness of coordination between a relatively large number of stakeholders.

In light of the uncertainties identified above, particularly the need/demand for from Thames, and conversely, the increasing expectation from Government to explore interconnection, we believe a real option mechanism offers the best solution for our customers.

8.3.3 Managing uncertainty through real option mechanisms

Our initial planning, reflected in our May 2018 cost adjustment submission, effectively passed on the risk associated with uncertainty to customers. For the supply demand balance claim, customers faced the risk of earlier higher bills if climate change did not materialise in the timescales we had assumed.
There was a similar outcome on the wastewater environmental programme, where customers faced the risk of unnecessarily higher bills in the short term if amber schemes were not required. While customers would receive a 'refund' through a cost adjustment mechanism, it would not be until PR24 (consistent with the PR19 methodology and clarifications).

A better way to manage this risk is through the use of real option mechanisms. Similar to a financial option, a real option mechanism gives the right, but not obligation to act upon a defined trigger. This mechanism would enable parties to wait for more information to reduce uncertainty before proceeding with an investment, and before reflecting the costs of an investment in the bills our customers face. The benefit of this approach is that it helps decouple investment decisions and associated bill effects from the five-yearly price review process, which in some examples can be restrictive because it requires outcomes to be set five years in advance.

We can illustrate a real option mechanism by considering an example in which there is a 50% probability that a treatment works needs to be expanded due to potential housing development. Under the historic approach a company would most likely request additional funding and deliver the capacity, even though there is a 50% chance it isn't needed. An alternative approach would be to request regulatory approval for a real option mechanism that grants funding for the outcome, but makes it conditional on:

- an agreed trigger being met, such as planning permission for housing developments; and
- delivery of the outcome, with this assessed in a pre-defined manner.

The benefit of this approach is that customers do not face the risk of unnecessarily higher bills, but it also supports the company in adopting more efficient and flexible approaches in the face of material uncertainty.

Design parameters of a real option mechanism

In designing real option mechanisms we have identified four parameters that would need to be agreed in advance through the price review process.

- the outcome that may be delivered (to which the uncertainty relates), such as additional water capacity or km of river improved (this would include a maximum level to protect customers);
- the cost of delivering the improvement;
- the event or information that would trigger the option and result in the company proceeding with delivering the improvement; and
- the cost recovery arrangements, which could be through revenues, the RCV or a combination of both.

Although a real option mechanism has many similarities to ODIs, the key difference is the trigger. This is the feature that protects customers from uncertainty by ensuring any new outcome improvement is only delivered based on the best possible information.

The trigger could be designed in a number of different ways, for example it could be:

- a leading indicator that identifies the need for additional outcome improvements;
- the delivery of the outcome (where the uncertainty relates to delivery not the investment driver); or
- a combination of measures with a governance framework, such as EA approval of the need.

We also recognise that real option mechanisms would need a governance process from Ofwat to ensure the cost recovery process is applied appropriately. We note that this could utilise the in-period ODI mechanism, which we discussed in Section 8.3.6.

Below we set out relevant views from Ofwat and the CMA on uncertainty which we consider are highly consistent with the use of real option mechanisms.

Ofwat views

In the PR19 methodology Ofwat has set a clear expectation that companies need to manage risk associated with investment drivers in a more sophisticated manner.

> "For PR19, we want companies to take a long-term approach to significant investments in new water resources; one that considers the physical option value of any decisions and the long-term uncertainty associated with them….. This in turn means making sure companies manage uncertainty effectively over the long term and bear an appropriate share of risk around the delivery of future outcomes.
>
> In PR19 we will fund the anticipated programme, as long as companies propose an appropriate cost adjustment mechanism to account for a potential discrepancy between the scale of the assumed and confirmed programmes"

Further clarity was provided in the PR19 methodology clarification issued on 15 May where Ofwat clearly explained that the adjustment mechanism for uncertainty would be symmetrical and apply to amber[3] schemes and the unit cost would be linked to a readily quantifiable measure.[4]

The key point is that where the driver for the investment is uncertain, companies should not presume to pass on all the risk to customers and request funding upfront. Instead, there is value in creating options that allow the uncertainty to be better managed.

CMA

In proposing the use of real option mechanisms we have also considered the CMA's decision in the Bristol Water appeal following PR14 where the company had requested funding for a new reservoir called Cheddar Two. One of the key drivers for this investment was responding to climate change and creating sufficient capacity under different scenarios. Ofwat did not support the cost adjustment at PR14 and Bristol Water appealed the (wider) decision to the CMA.

In its assessment of the business case, the CMA supported Ofwat's emphasis on the need to consider the probability of different outcomes. The CMA recognised that delivering large schemes could provide greater certainty of security of supply with a potentially lower overall cost. However it noted that such an approach would only be cost effective if the assumed scenario eventuates, which the CMA considered was uncertain and there would be better ways to protect customers.

> "Broadly, we considered that if an intervention was planned to address a shortfall in the future, there could be benefits of delaying a project where there was a significant degree of uncertainty."[5]

The use of real option mechanisms would address the main concern from Ofwat and the CMA by preventing customers from bearing excessive risk. A real option mechanism in the above example would have enabled Bristol to defer the investment decision, and proceeded only as and when an appropriately defined trigger had been met, taking account of improved information over time.

8.3.4 Customer engagement

We have proposed the use of real option mechanisms after undertaking extensive engagement with our customers to understand their views on how to manage risk and the effects it can have on bill volatility.

One of the key themes that comes through in this research and our wider customer engagement is that customers expect that our services represent value for money, are efficient and that we are mindful of the bill impacts of our investment choices.

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[3] An amber scheme means that there is evidence that water company action is needed, there is a clarity or a developing clarity on the required measure and that the measure is considered cost beneficial (where this test is appropriate). But the measure is awaiting a ministerial decision on affordability.

[4] Ofwat Q&A, query 410, https://www.ofwat.gov.uk/wp-content/uploads/2018/05/PR19-final-methodology-queries-and-answers-15-May-batch-7.pdf

[5] CMA page 214, https://assets.publishing.service.gov.uk/media/56279924ed915d194b000001/Bristol_Water_plc_final_determination.pdf

However this doesn't mean customers want us to pursue the cheapest option. As reflected in our deliberative research on supply demand, our customers explicitly want us to pursue best value options. Similarly customers do not want us to ignore risks to future supplies.

Rather what is revealed through our engagement is a much more nuanced view that seeks to balance issues such as affordability, long term sustainability and resilience.

Our engagement on real options occurred through both a deliberative workshop and engagement using our online community. Our Water Forum challenged us quite strongly on the need for the deliberative research to supplement the online community engagement. This is because the potential complexity of the issue and its forward looking nature means it is important to explore whether the results are different when customers have a more informed understanding.

Deliberative research

Our deliberative workshop sought to explore customers views about uncertainty and how we best could respond to the challenges we face. This involved a day long workshop with 24 customers across different socio-economic groups.

- **Location**: Birmingham
- **Sample size**: 24 customers
- **Duration**: 6 hours
- **Demographics**:
  - Spread of customer age and gender (12 men, 12 women)
  - Spread of socio-economic grouping (10 x ABC1, 10 x C2DE), life stage, ethnicity and tenure type
  - 4 customers on low incomes who say they are struggling to pay bills
  - 2 customers who have health a long term illness, health problem or impairments that limits their daily activities
- **Financial arrangements with ST:**
  - Mix of payment types, billing methods and water meter use (7 x metered)
- **All screened on attitudes towards the environment:**
  - Mix of attitudes to the environment, with 1 ranking it as a 'very important' issue facing the country

In the workshop we sought to understand customers' views on a range of issues, including:

- Water Framework Directive (WFD) – explore customers' views about how to manage amber schemes, and preferences for higher bills now with potential for a reduction in the future, compared with lower bills now with a risk of higher bills in the future.
- Supply-demand (S-D) – explore customers' views about different supply and demand side solutions.
- S-D – explore customers' attitudes about how we respond to uncertainty associated with climate change – including the balance between investing now versus investing later.
- Bills - Understand how customers feel about variation in their bill, and their perceptions of acceptable levels of variation.

Overall customers expressed strong support for finding a middle position to manage uncertainty.

On climate change there was a clear desire to protect the environment through the use of demand side measures. Customers did not support large-scale supply solutions, despite the research occurring during a notable heatwave. Instead there was strong support for taking action to prepare for climate change uncertainty but not undertaking significant investment now (i.e., prepare to move quickly).

On the WFD, in principle, customers supported only focusing on confirmed green schemes. When the bill impact of the different options was shown, most customers considered that all green and amber schemes should be addressed, reinforcing the need to support the environment. It should be noted that, in this engagement, we did not offer customers a middle position of doing some amber schemes and early design work.

Finally, our Water Forum challenged us to explore customers' views on bill volatility. This is on the basis that with bills falling at PR19, would customers prefer a lower reduction and more stable bills over time.

Overall customers were quite relaxed about bill movements and were pleasantly surprised to understand bills were falling before inflation. Furthermore, customers considered that bill movements below +/-£3-£10/month would not be viewed as volatile.

Online panel

We used our online panel to test two different options for how we might respond to the uncertainty associated with climate change and the designation of some Water Framework Directive schemes as amber.

This research was undertaken using detailed polling of our online panel with approximately 800 customers taking part. We followed the polls with a discussion thread on the panel to explore customers' views about the approaches to uncertainty, their preferences and why they held the views they did.

Below we set out the survey information that was provided to customers in the polls on supply and demand improvements and on WFD improvements, and then present the results.

Supply and demand improvements - poll

Over the next few years Severn Trent will be investing in a number of schemes to ensure it can meet future demand for water. Alongside these investments, Severn Trent will also be working towards a significant reduction in leakage.

These investments include planning for the effects of climate change on future water resources. The impact of climate change is uncertain, and so some of the models of likely impact may suggest that investment is necessary when it is not. The Met Office is due to publish updated information on weather impacts to support more accurate modelling on climate change in the near future, but this information is not available to use now in our planning process.

Climate change is a long-term problem, its impacts are continuous and gradual. Severn Trent has been investigating whether any climate change is detectable in river flows over time. This has involved undertaking tests in the rivers in the region and using information from 1884 to 2014. The analysis shows that there is no significant observable impact yet.

Some of the solutions to ensuring supply of water (known as supply schemes) can take a long time to put in place e.g. a new reservoir could take 10 years to build but would provide vast capacity to store water.

Alongside that, technology is improving all the time which might change the need for supply schemes like reservoirs and make solutions such as reducing leakage more cost beneficial.
All the unknowns above lead to uncertainty in making decisions on the right investments for the future and acting in the interests of customers now.

The water industry regulator Ofwat, expects companies to consider the best way to manage uncertainty so that customers are not exposed to unnecessary bills.

Making no investment in a building scheme means lower bills but comes with the risk that we are not able to respond fast enough to the impact of climate change. Investing now without better information will impact bills, but runs the risk of building a scheme that is not needed.

Severn Trent has three approaches to put to customers, which would you prefer?
ANSWERS

Invest in building extra capacity now – this will have an impact on bills now, but could be lower cost over the long term if the severity of impact forecasted becomes a reality	1	
Undertake preparation work (running design and feasibility work upfront) that allows the company to move at speed as and when clear information becomes available that indicates investment is needed – this will have less of an impact on bills now than approach one	2	
Do nothing until clear information becomes available that indicates investment is needed – this will have no impact on bills now but runs the risk that Severn Trent is not able to respond to the challenge of climate change quickly	3	

WFD improvements - poll

Severn Trent needs to undertake a number of investments (referred to as schemes) to improve the biological health of rivers over 2020 – 2025. These investments are determined by the Environment Agency/Government and have been classified as:

- 'Green' – meaning the investment is certain
- 'Amber' – meaning the investment is uncertain

In 2021/2022, the Environment Agency/Government will confirm which amber schemes need to go ahead.
Severn Trent will fund the schemes that go ahead through customer bills.
The not knowing how many 'amber' schemes will go ahead creates uncertainty for customer bills.
The water industry regulator Ofwat, expects companies to consider the best way to manage uncertainty so that bills represent value for money.

Severn Trent has two approaches to put to customers, which would you prefer?

ANSWERS

Fund certain investments through customers' bills now, and only request funding for the uncertain schemes once they are confirmed	1	
Request funding for all schemes now, and then if some 'amber' schemes are not required, customers will receive a refund in their bills over 2025 – 2030 through the existing regulatory mechanisms	2	

Results

The headline result is that customers support the use of real option mechanisms.

Over 800 customers completed our first poll (on supply and demand improvements) and 76% expressed support for not funding the uncertain schemes until they are confirmed. Some anecdotal feedback from the discussion thread included:

- Definitely not in favour of refunded bills at a later date - what if you move or die!
- I think there is a middle ground where you try to make an informed calculation as to how many Amber schemes will be confirmed, and cover those rather than each extreme, as this is likely to be nearer the actual situation, and reduce the level of possible refund/additional charge

In relation to climate change, 69% of customers expressed support for our approach to prepare now but to avoid significant investment until further information is available. We also note that 13% of customers supported no activity (including feasibility and design work), whilst 18% supported investment irrespective of the uncertainty. Key feedback from our customers included:

- With the rapid changes in how water should be stored, managed and used, I think that it would be unwise to decide now what approach should be taken
- As a customer and shareholder I am definitely not in favour of large scale investment in one "lump" but feel looking into the requirements for future investment is suitable at this stage
- I'm voting for research and project planning rather than leaping straight into solutions that may be outdated
- I believe it is reasonable to assume the demand for water will increase, not least due to the increase in house building. It therefore makes sense to make a start on building a 'base' provision for anticipated future requirements, rather than being caught on the back foot playing catch-up. Let's get on and make progress.

The results of our second poll (on WFD improvements) are presented below.

Q1) IMPROVING THE BIOLOGICAL HEALTH OF RIVERS OVER 2020 – 2025
Severn Trent has two approaches to put to customers, which would you prefer?

N= 824

Fund certain investments through customers' bills now, and only request funding for the uncertain schemes once they are confirmed	76%
Request funding for all schemes now, and then if some 'amber' schemes are not required, customers will receive a refund in their bills over 2025 – 2030 through the existing regulatory mechanisms	24%

Q2) We have another topic for you to consider
Severn Trent has three approaches to put to customers, which would you prefer?

N= 781

Invest in building extra capacity now – this will have an impact on bills now, but could be lower cost over the long term if the severity of impact forecasted becomes a reality	18%
Undertake preparation work (running design and feasibility work upfront) that allows the company to move at speed as and when clear information becomes available that indicates investment is needed – this will have less of an impact on bills now than approach one	69%
Do nothing until clear information becomes available that indicates investment is needed – this will have no impact on bills now but runs the risk that Severn Trent is not able to respond to the challenge of climate change quickly	13%

Conclusion on customer engagement

The feedback from our customers shows that there is strong principled support for managing uncertainty through an approach such as real option mechanisms. Customers want us to balance a range of factors when making investment decisions, including:

- protect the environment;
- promote affordability by investing only in assets that required; and
- promote resilience by being able to respond to changes or new information quickly.

The results in relation to bill volatility also highlight that even in the extreme event that ALL schemes are needed, customers are unlikely to view the resulting change in bills as volatile.

8.3.5 Our four proposed real option mechanisms

Climate change uncertainty

We have identified a series of uncertainties within our WRMP assumptions. These create a risk to customers because they may be asked to fund actions that turn out not to be needed.

We can mitigate this risk by using a real option mechanism that would give us the right but not obligation to act, given a defined trigger. Use of a real option mechanism supports an adaptive pathway approach that allows for investment to be delivered only where the risk of mal-adaptation is low and after consideration of whether there is sufficient time to implement options if they are shown to be required in the future. This allows for the re-appraisal of decisions iteratively as uncertainty is reduced (i.e. converted to definitive impact or reduced model error) over time. Following an adaptive pathway approach will mean that interventions are more likely to be based on certainty and could change the type of intervention (e.g. favour more demand side measures).

We consider that the material uncertainties used in our analysis are likely to reduce with time. This gives us confidence that the use of a real option mechanism will be in the best interests for customers. Uncertainty can be expected to reduce most obviously as a result of:

- review of the climate change impact implied by the UKCP18 projections; and
- improvements to scheme certainty as we progress through feasibility.

To protect customers we have defined the following components in our real option mechanism:

- the outcome;
- the trigger;
- the cost; and
- how the costs would be recovered if the option was triggered.

We summarise the parameters below before discussing them in more detail.

Parameter	Climate change uncertainty
Outcome	Ml/d capacity 189.7 Ml/d – Strategic Grid 7 Ml/d – North Staffs 55 Ml/d – Nottinghamshire
Cost rate	£2.8m Ml/d – Strategic Grid £1.5m – North Staffs £2.0m – Nottinghamshire
Trigger	PR19: UKCP18 & Water Forum-EA agreement PR24/29: Lead indicators (to be developed)
Cost recovery	Blend (60% revenue; 40% RCV)
Maximum investment	£120m

Climate change: defining the outcome

Our climate change real option mechanism would apply to the schemes that we are not including in our plan but which are identified in our WRMP, as set out in the table below.

Scheme	Benefit (Ml/d)	Time to deliver benefits (years)
[Location REDACTED]	0.9	3
[Location REDACTED]	2	2
[Location REDACTED]	2.5	3
[Location REDACTED]	2.5	3
[Location REDACTED]	2.5	3
[Location REDACTED]	2.7	3
[Location REDACTED]	3.6	2
[Location REDACTED]	7	2
[Location REDACTED]	8	4
[Location REDACTED]	8	2
[Location REDACTED]	9	4
[Location REDACTED]	10	5
[Location REDACTED]	15	5
[Location REDACTED]	17	10
[Location REDACTED]	26	5
[Location REDACTED]	30	4
[Location REDACTED]	30	4
[Location REDACTED]	35	5
[Location REDACTED]	45	10

A key feature of our supply demand deficit is that it relates to three distinct water resource zones with different solution costs. We are therefore proposing that the climate change uncertainty real option mechanism would incorporate a menu to cover the three zones, as shown below.

Water Resource Zone	Schemes	Ml/d
Strategic Grid	16	189.7
North Staffs	1	7
Nottinghamshire	2	55

For these schemes we are taking steps to ensure that we can deliver solutions quickly if the need is confirmed. We have already undertaken desktop feasibility and design on the schemes but will include a further £26m investment in our PR19 plan to develop the detailed design and enabling activity such that we can act quickly if the need is confirmed.

Climate change: Defining the trigger for the real option mechanism

We consider that the best trigger for the real option mechanism would be a leading indicator of climate change. We have engaged extensively with experts from different fields, including the EA, Met Office and wider stakeholders to identify whether any such measures could be applied, unfortunately at present there is no such metric. We are therefore proposing a short term and medium term approach:

- In the short term, we would utilise refreshed data and expert advice from the EA;
- In the medium term (i.e., PR24 and beyond), we would use leading indicators.

PR19 trigger

The trigger for the uncertainty mechanism will be an annual reappraisal of the climate change (and other material) uncertainties that have the potential to drive major investment.

UKCP18 will provide the first refresh of climate data projections in 10 years. We will analyse the effect of these projections on our WRMP using the same climate change and scaling approach (which is in-line with best practice).

The WRMP update document will take account of the following:

- increased level of certainty afforded by the latest information (focusing, but not explicitly, on climate change impact and uncertainty as identified by UKCP18);
- time needed to efficiently deliver required additional supply side capacity;
- advantages of following an adaptive pathway where material uncertainty still remains;
- impact of our demand management assumptions and performance within the AMP. We have ambitious leakage and metering programs that we are committing to delivering for our customers irrespective of the future supply demand challenges we may face. Any outperformance in demand management may negate the need for additional supply schemes, or delay their implementation; and
- wider benefits on delivering supply side capacity early.

This analysis will take at least 12 months to complete, but should provide a more certain baseline of climate change impact and reduced residual uncertainty. Following completion of this analysis, we will present the results and associated investment impacts to the EA for independent challenge and scrutiny.

The EA would effectively act as gatekeepers – as they do on some AMP6 performance commitments – to provide approval for additional supply schemes required in AMP7. The decision would then be presented to Ofwat using the annual ODI process. We discuss the approach in Section 8.3.6.

PR24 - Developing lead indicators

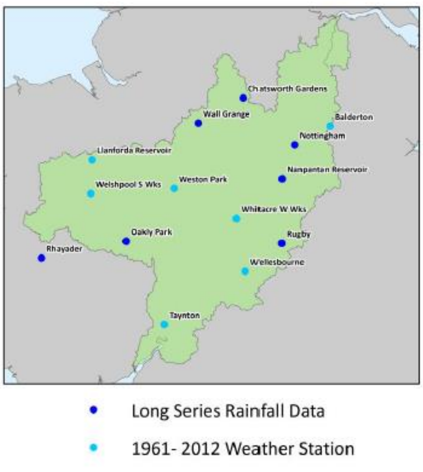
Reflecting on our work on real options, we have been considering how best to involve customers and stakeholders in decisions where there is significant uncertainty. We are considering using the annual performance report to share climate change impacts across a range of metrics but we would need to ensure the information could be easily understood. We believe we can find a way to make it cognitively accessible as we have done for asset health information.

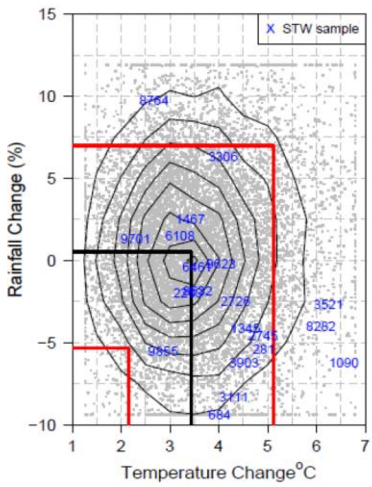
We are considering using leading drought indicators to represent anomalies from a normal situation in a standardised way. Standardised drought indicators have been highlighted as the preferred drought monitoring method by the World Metrological Organisation and the United Nations. The indicators include:

- Rainfall (Standardised precipitation index);
- Temperature (Standardised precipitation evaporation index); and
- River flow (Standardised stream flow index)

We have long duration rainfall and temperature records at fourteen locations across our region. Each year, we could assess the trend compared to the climate change scenarios we've used (represent in the contour distribution plots). Use in conjunction with Met Office State of the Climate UK Annual Report to confirm our analysis is broadly consistent in the national context.

We can use data from 14 sites across our region to assess long term trends





The contour distribution plot shows change in precipitation and temperature for the Severn River Basin, highlighting the location of the WRMP19 UKCP09 scenarios. We could use these to demonstrate change in trends within our region.

In addition, we are committed to working collaboratively with the rest of the industry, our stakeholders and wider experts to explore the potential of developing leading metrics to help expose and track vulnerabilities to future drought. We will be initiating this conversation through WaterUK, UKWIR and other collaborative channels.

Climate change: setting the cost

In setting the incentive rate for the climate change uncertainty option, we have taken the average unit cost for each zone of the schemes that we are proposing to defer, as set out below.

Water Resource Zone	Schemes	Unit rate (m/Mld)	Ml/d
Strategic Grid	16	£2.8	189.7
North Staffs	1	£1.5	7
Nottinghamshire	2	£2.0	55

The costs of the projects which have been selected and included in our plan have been established through the use of the following estimating tools;

- STW cost curves established, updated and refined over the last 15 years for similar activity;
- STW unit rates established, updated and refined over the last 15 years;
- Cost data provided by an independent engineering consultant with specialist cost data sets
- Best practice guidance on understanding and applying an appropriate level of optimism bias within our projects; and
- Market rates where they exist and can be applied to our work.

We have also cross-checked our unit rates against:

- the rates of other companies in their dWRMPs; and
- the unit rate Ofwat allowed at PR14, updated and adjusted for an efficiency challenge.

We recognise that comparisons across Water Resource Zones (WRZ) are difficult because zones, by their nature, have different characteristics and availability of water. Inevitably, there will be variances between unit rates. However the unit rates from Ofwat and other companies provide a useful guide as to whether our costs are within a sensible range, or whether further investigation of outliers is required.

At PR14, Ofwat used a unit cost of £2.9m/Mld (2012/13 prices) in its supply demand unit cost model. Updating for an assumed efficiency challenge and allowing for indexation, we can assume that an analogous approach would retain a £2.9m/Mld unit rate but in 2017/18 prices (i.e. absorbing the impact of inflation for 5 years).

Climate change: cost recovery

If the real option mechanism is triggered, we would need to recover the cost of the investment(s). This could be achieved in three ways as per the regulatory framework:

- fast money – by adding the cost to customer bills in the following year that the costs are incurred as occurs for in-period ODIs;
- slow money – by adding the cost to the RCV and depreciating that over time, as occurs for some end of period ODIs;
- hybrid – reflecting a combination of both, as occurs in our submission (i.e., 59% fast money and 41% slow money).

Given the long-term nature of the projects that could deliver large-scale water transfers, there is a strong case for 100% capitalisation of costs. This would allow costs to be spread into the future and better align them with customers who are likely to benefit from such developments.

Real option mechanism - metering uncertainty

The uncertainty with metering relates to the extent to which we can increase meter-uptake rates, which would represent around a three-fold increase on 2017/18 rates. We could respond to this uncertainty by simply scaling back our meter installation plans, and assuming a smaller increase. However, metering is a key part of our best value approach which recognises the need for a strong demand-side approach alongside the bringing forward of new supply-side initiatives.

We recognise the risk this approach could pass onto our consumers - bills would be increased during AMP7 regardless of the meter take-up actually achieved. We could include a true-up mechanism that returns money to customers if full delivery of our PR19 policy for AMP7 is not achieved, but that would still mean that customer bills in AMP7 would be higher than necessary. As we highlighted above, our customers have indicated strong support for the use of mechanisms that allow an intermediate approach to be adopted in these circumstances that reflects the uncertainties involved.

The table below shows the key parameters of our proposed real option mechanism.

Parameter	Meter volume uncertainty
Outcome	Number of meters installed above the annual profile set out in Table Appointee 1 up to a total of 493,765 for AMP7.
Cost rate	£205 per meter installed
Trigger	This would be an automatic trigger based on the number of meters we installed above the profile across AMP7 and reported in our Annual Performance Report
Cost recovery	Revenue
Reduced investment	£35m removed from programme

Metering: defining the outcome

As was set out above, our PR19 policy aim is to install 497,878 meters during AMP7. We have reflected uncertainty associated with the achievability of that by including the installation of an average of 65,000 meters per year in our plan.

This fits with the priority we are giving to increased meter installation to support a greater focus on water efficiency by including a level for AMP7 that is around double our current rate. However, it reflects uncertainty over what is achievable by defining outcomes of between 325,000 and 493,765 meter installation as to be addressed though our real option mechanism, and so to only affect bills to the extent that levels of meter installation within this range are actually achieved. It offers customers symmetrical protection by ensuring downside uncertainty returns an equivalent rate per meter to customers through the mechanism.

Metering: setting the unit cost

We are proposing to set the metering rate at £205 per meter, representing our benchmarked cost of installation, including the cost of the meter. This was derived assuming that 90% of meters would be fitted externally, and two-thirds involving a new boundary box dig. We applied an 8% reduction to reflect efficiencies we aim to achieve, including through the use of localised campaigns to increase uptake in order to seek to secure economies of density benefits in our installation work. The resulting rate of £205 per meter looks a challenging rate when compared with our own meter installation cost information, and with Annual Performance Cost figures provided by other companies.

Metering: defining the trigger for the real option mechanism

We propose using our Annual Performance Report as the basis for determining whether an allowance should be triggered under this real option mechanism. Specifically, the cost rate would apply per meter to any meter installation presented in the Annual Performance Reports for years within AMP7 that is above the profiled 325,000 meters as set out in Table Appointee 1. Similarly an underperformance penalty would apply for any meters under the annual profiled target that were not delivered.

Metering: form of cost recovery

For the metering real option mechanism, given the relatively small value of money, we would propose to use a revenue adjustment to bills consistent with the majority of our ODIs and Ofwat guidance.

Real option mechanism – wastewater environmental programme

Our cost adjustment claim submitted to Ofwat in May includes all green and amber schemes. However, the ongoing uncertainties with the government-approved scale of the environmental programme create a risk that customers' bills during AMP7 will be higher than they should be because our price limits over AMP7 would include an allowance for all amber schemes. If the Government decides that some of these schemes are not appropriate, they would not then be delivered in AMP7, and the money would need to be returned to customers in AMP8.

Although customers would theoretically be no worse off, there is a timing issue, which would mean customers were paying in advance. In our research a number of customers indicated this wasn't desirable for reasons including:

- affordability – with a desire to avoid unnecessary bill increases; and
- personal circumstances – with potential for customers to be moving out of our region.

We consider that there are varying degrees of uncertainty with regards to 'amber' schemes in WINEP3. We have therefore sought to differentiate between those that deliver multiple benefits – which we consider are more certain – and those that do not. This process has helped us identify a subset of amber projects that do not deliver wider benefits in our plan and that we would not want to proceed with until we receive formal Ministerial approval.

Schemes to meet WINEP3 WFD and related drivers require £463m capex investment. Within this £401m contributes to the WFD performance commitment, the rest being investigations and no-deterioration obligations. £121m of this has been assessed as less certain as described above. It is uncertainty in relation to these schemes and this investment that our real option mechanism for wastewater environmental quality primarily seeks to address. The key parameters are summarised in the table below:

Parameter	Wastewater environmental quality – physical option
Outcome	Improvement in WFD status measured by the points system introduced at PR14.
Cost rate	£1.42m per point
Trigger	Ministerial confirmation (2021)
Form of cost recovery	Totex blend – 59% Revenue and 41% RCV
Reduced investment	£121m removed from programme Remaining enhancement programme = £280m (brings this to a total of £401m capex)

Wastewater environmental programme: defining the outcome

Our approach to outcome measurement uses the points measurement system that we adopted at PR14, and have been applying throughout AMP6. This system was developed in order to provide a more sophisticated means of defining outcome improvements than, for example, km of rivers improved. Importantly, the points system captures the fact that 'improvements' can differ both in terms of extent, and of the parameters to which they apply.

The points system work by defining a set of parameters of water quality (e.g. BOD), and categorising condition in relation to those parameters into five bands (from bad through to high). Given a base classification of quality against these parameters and bands, improvements can then be measured in terms of points. Under the approach, a one band increase (e.g. from poor to moderate) in relation to a particular parameter (e.g. ammonia content) is counted as one point. This approach allows relative improvements to be captured in a standardised manner (note that as the core WFD objective is to reach good status, improvements from good to high are not counted).

In total, the WFD schemes included in WINEP3 have been identified as giving 278 points of benefit.

- The green and high-certainty amber schemes account for 193 points and have been included in our business plan assumptions as a performance commitment.
- The remaining 85 points relating the less certain amber projects will be accounted for using the real option mechanism.

Since water quality and improvement levels will depend to some extent on the actions of other users, the points system is applied by agreeing with the EA what our 'fair share' is, in order reflect the contribution that our actions have towards environmental improvement. This points approach, and the Environment Agency's role in defining and assuring points, is now well established, having been developed and applied in relation to our PR14 ODIs.

Wastewater environmental programme: setting the cost

The unit cost has been developed from the cost of the schemes categorised as uncertain amber (£121m) and the identified number of environmental benefit points (85 points). This overall £121m cost is consistent with our cost adjustment claim, and gives a unit rate of £1.42m per point.

Wastewater environmental programme: trigger for exercising the option

The trigger for the real option mechanism will be the confirmation of the wastewater environment programme. This occurs when the Secretary of State signs off the Cycle 3 River Basin Management Plans in 2021. Once the final set of approved schemes is known, in conjunction with the EA we will confirm the environmental improvement points they would be expected to result in. We will then deliver these points over AMP7.

We are currently working with the EA to trial a new approach to engagement for the transition of schemes from amber to green. This would involve enhancing the extent and form of our customers' participation in the process through which River Basin Management Plans (and the schemes within them) are approved.

Our approach involves building on our existing engagement processes in order to provide a richer form of customer involvement in, and input into, the process through which the case for turning amber schemes to green is assessed, including – importantly – in relation to issues of affordability.

We believe this can be done in an efficient and effective way by utilising our online community of 15,000 customers. As many of the issues raised are quite complex, we envisage the use of deliberative methods forming an important part of our overall approach. They provide an opportunity to first explain and familiarise our customers with the underlying environmental issues being tackled, and the processes through which options to address those issues are developed and assessed. This can provide for more effective and informed engagement in the consideration of specific improvements. We are working with the EA to try to provide for their involvement in these customer engagement processes.

This initiative responds to the real appetite for more involvement in assessment processes that our customers have shown, particularly in relation to environmental improvements. It provides an opportunity to build on engagement successes that were developed within the price review process, and to apply them in a broader and more integrated way. By extending the use of these processes in the River Basin Management Plan approval arrangements, we are seeking to provide a coherent and efficient basis for our customers to engage across a broader range of decision making that affects both the bills they face, and the quality of the environment.

Wastewater environmental programme: cost recovery

Consistent with our approach at PR14, the element of cost that is recovered though the ODI will be done so on a revenue basis. The proportion that comes though the totex sharing mechanism will be treated on the basis set out in the above table.

Real option mechanism – interconnector

There is strong consensus amongst stakeholders on future water shortages in the South East of England. In response, companies have been considering a range of solutions, including more demand-side interventions and developing new water sources and water reuse.

Regional groups in the South East have also been looking at options which transcend regional boundaries, supported by analysis which shows that such solutions could provide a resilient and cost-effective outcome. However, we need to recognise that there are important environmental and social constraints which could limit the feasibility of such a solution. To make greater interconnection between companies viable, we need to commit time and money to regional planning and assessing the feasibility of strategic transfers – as recently noted by Defra, EA, DWI and Ofwat.

We've been working with Thames Water and United Utilities over the last two years looking at how to take forward a potential Severn to Thames raw water transfer. We've made some good progress and identified a number of ways of increasing water available for transfer without impacting service or resilience of supply for our customers. We believe over 150 Ml/d could be available through options such as transferring treated final effluent from our sewage treatment works via river systems and transferring available abstraction licence capacity.

In terms of the interconnector itself, the outline scope considered involves a 1.5m diameter pipeline of around 90km in length and capable of carrying 300 Ml/d from the river Severn [REDACTED] to the river Thames [REDACTED]. The initial scope covered the river intake, pre-treatment [REDACTED] to treat for phosphorous, mussels, suspended solids and algae, construction of a pumping station, break tank and outfall, with Thames Water using their existing facilities to treat to drinking water standards.

Our analysis included looking at the viability of a gravity-only options, direct pipeline options and other options to balance gravity and environmental impacts. The initial preference was for an abstraction REDACTED with transfer via interconnector. Our analysis showed the criticality of balancing technically feasibility with environmental acceptability and cost.

[REDACTED]

While we've made good progress and verified the viability of moving water from the North West down to the South East using an interconnector, we've also identified a number of barriers that need to be addressed, including:

- customer acceptability;
- environmental issues, for example water availability, environmental impact, flood risk, losses and environmental (including WFD) compliance;
- river regulation and confidence that inputs to the system can be reliably abstracted downstream;
- ensuring other parties – for example, abstractors on the river Severn and other water companies – could participate openly in this new market; and
- designing the commercial model to enable access to the lowest cost finance and procurement.

- Our progress to date has also confirmed the benefits could take a long time to materialise due to the construction period and the range of planning and regulatory approvals that would be needed, and we would need to develop an effective system operation with better co-ordination between stakeholders.

We understand that Thames Water's preference is to further develop and assess the feasibility of its supply scheme solutions. Although it has indicated that the proposed Severn to Thames transfer could be feasible, it does not appear to be as cost beneficial as alternatives and, as such, may not be needed for many years.

In light of this uncertainty, we have not included activities associated with developing this water trade in our PR19 totex submission. Our Customer Challenge Group (the Water Forum) strongly supports this position – having challenged us that in light of the current position from Thames, there is a risk that our customers may not benefit from any expenditure. Instead we have been challenged to reduce the uncertainty before undertaking more extensive feasibility and design work.

<u>However we also recognise that there is a strong call to action from Defra, EA, DWI and Ofwat.</u>

We have therefore developed a real option mechanism that would allow for this water trade to be further progressed through design and feasibility work. This would support a more comprehensive options appraisal, which is particularly important given the potential significant cost of the Thames solutions.

Our water trading real option mechanism is designed to support a more robust and thorough assessment of Severn to Thames solution. This includes undertaking feasibility studies and improving the accuracy of the costs estimate so that Thames and Ofwat can better assess which solution is in the best interests of customers. It also includes looking at commercial and operational arrangements given the unique nature of this transfer.

Real option issues arise in at least two different ways when investment in these activities is being considered: Investment in these activities has the potential to materially increase option values, by improving the information base against which future investment decisions (in relation these options and others) will be made, and reducing the lead times that may associated with proceeding with a number of options. That is, undertaking these activities has the potential to materially increase the likelihood of better decisions being made in the future in a context where those decisions may have very major economic consequences. However, the value of undertaking these activities is itself highly uncertain, and that uncertainty may diminish materially during AMP7. Importantly, the value of this further work is likely to be heavily dependent on a range decisions that different parties will take during AMP7 that will affect both demand and supply-side prospects given the interdependencies involved.

This means that there may be a strong case for proceeding with more preparatory work during AMP7, and that if that case emerges, then there may be significant benefits associated with being able to respond in an effective and timely manner, not least because the case for others to engage in related work may itself be influenced by our responsiveness. This highlights a potentially serious coordination problem that could arise in this context: the effects of a lack of timely responsiveness from one party can be magnified as it can increase the likelihood of delay from others. Overall progress may be stifled even where the case for further preparations is strong.

But that strong case for proceeding with further investment is not yet made. Given this, it does not seem appropriate for customers to be asked to contribute to this work on the basis that it may happen: our customer research has strongly pointed against such an approach, and to customers wanting us to explore intermediate possibilities. In line with this, we consider that it appropriate to put in place a real option mechanism to address this issue.

We summarise the parameters of our proposed real option mechanism below.

Parameter	Water transfer options uncertainty
Outcome	Completion of preparatory work on feasibility studies and outline design to enable a third party to develop detailed design and construct a viable (physically and commercially) regional transfer via an interconnector
Cost rate	Capped at £40m, with costs subject to independent assurance at the outset (proposal stage) and verification of successful delivery (completion). These costs will be treated outside of the totex sharing mechanism, such that 100% of costs would be recovered through the ODI.
Trigger	Ofwat approval of trigger having been hit and/or of our approach to trigger assessment
Cost recovery	100% RCV
Maximum investment	£40m

Interconnector - outcome

To make meaningful progress, we believe a ceiling of £40m is required to deliver the necessary feasibility reports, covering the spectrum of environmental, ecology, geotechnical, water resource, water quality, hydraulic, electrical, process, landowners, planning, permits, utility providers and outline technical engineering information. This will also allow us to investigate the scope for system operation to facilitate a regional transfer, one which is open to all market participants (not just water companies).

If these studies demonstrated that the Severn to Thames solution is the best for customers, these reports and preparatory work would allow a third party to develop the design and construct a viable regional transfer via an interconnector.

Interconnector - unit cost

Given the nature of the work involved (planning, feasibility) and the challenges this poses for assessment (in a context where the ultimate consequences of decisions may not arise for many years, and even then may remain unclear), there look to be significant risks associated with an approach that seeks to apply some kind of incentive rate. That is, such an approach may have unwanted consequences that only become apparent (potentially) many years in the future.

In recognition of this, we propose that a maximum cost of £40m, [REDACTED]. This estimate is considerably more than typical unit cost for new water sources given the wholly different nature of the work being undertaken. It aligns with the early pipeline-only cost of [REDACTED] developed with a third party and is in line with feasibility for the Birmingham Resilience Scheme. We would provide assurance about the efficiency of the costs through the following checks:

- our initial schedule of expected costs would provide a benchmark against which identified costs could be compared.
- relevant identified costs would be subject to appropriate third party assurance which could then be reviewed by our Water Forum;

- Our identified cost levels and contracting processes would prove a basis for Ofwat to review the appropriateness of the arrangements at PR24.

Interconnector - triggers

Defining the trigger in an appropriate manner is not straightforward. If Thames Water were to commit, in a credible manner, to proceed with one or more of the options under consideration, then that would provide a clear trigger. In practice, however, it looks highly unlikely that such a clear-cut signal will be received. Rather, an assessment will need to be made as to whether undertaking further preparatory steps is considered sufficiently valuable to proceed.

The interdependencies upon which such an assessment would be likely to rely upon makes it difficult for us to clearly identify an appropriate trigger point, and raise risks of undue delays emerging as a result coordination failures. Given this, we consider that one or both of the following approaches is likely to be appropriate:

- There was a material change to Thames Water's WRMP, and - following consultation with Thames Water, United Utilities, Ofwat, the Environment Agency, Natural Resources Wales, and the UK and Welsh Governments – that change was found to increase the likely value of proceeding with further preparatory work on water transfer options; or
- Ofwat informed us that the real option mechanism should be triggered.

The consultation process under condition (1) reflects the extent to which the value of our actions depend on those of other parties, and provides a means of ensuring that we only trigger the real option mechanism as part of a coordinated response to a material change in circumstances.

Condition (2) provides a means for Ofwat to formally trigger the mechanism as part of a centrally coordinated response. This second approach might be justified whereby Ofwat has to adopt a form of coordination role in relation to planning and feasibility work, using the information it has from multiple sources to conclude on whether the next stage of work is justified, and on what implications that may have for the progress that would be desirable/should be expected from other parties.

Interconnector - cost recovery

Given the long-term nature of the projects that could deliver large-scale water transfers, there is a strong case for 100% capitalisation of costs. This would allow costs to be spread into the future and better align them with customers who are likely to benefit from such developments.

As the water transfer scheme would be expected to primarily provide a means of supplying water to customers outside the Severn Trent region, there is an argument that Severn Trent customers should not have to contribute to it (including preparatory phases). In practice, though, while there may be commercial investment opportunities over time that could be progressed without customer funds, the case for such investment at this stage of a potential project is likely to be very weak.

We also consider the broader ‘network’ benefits of the kind of preparatory and feasibility work that is envisaged may be relatively significant. This is particularly so as extensions to interconnectivity can provide material benefits, in terms of resilience for example, that would accrue to within region customers, even where the expected flows are (currently) predominantly out of region.

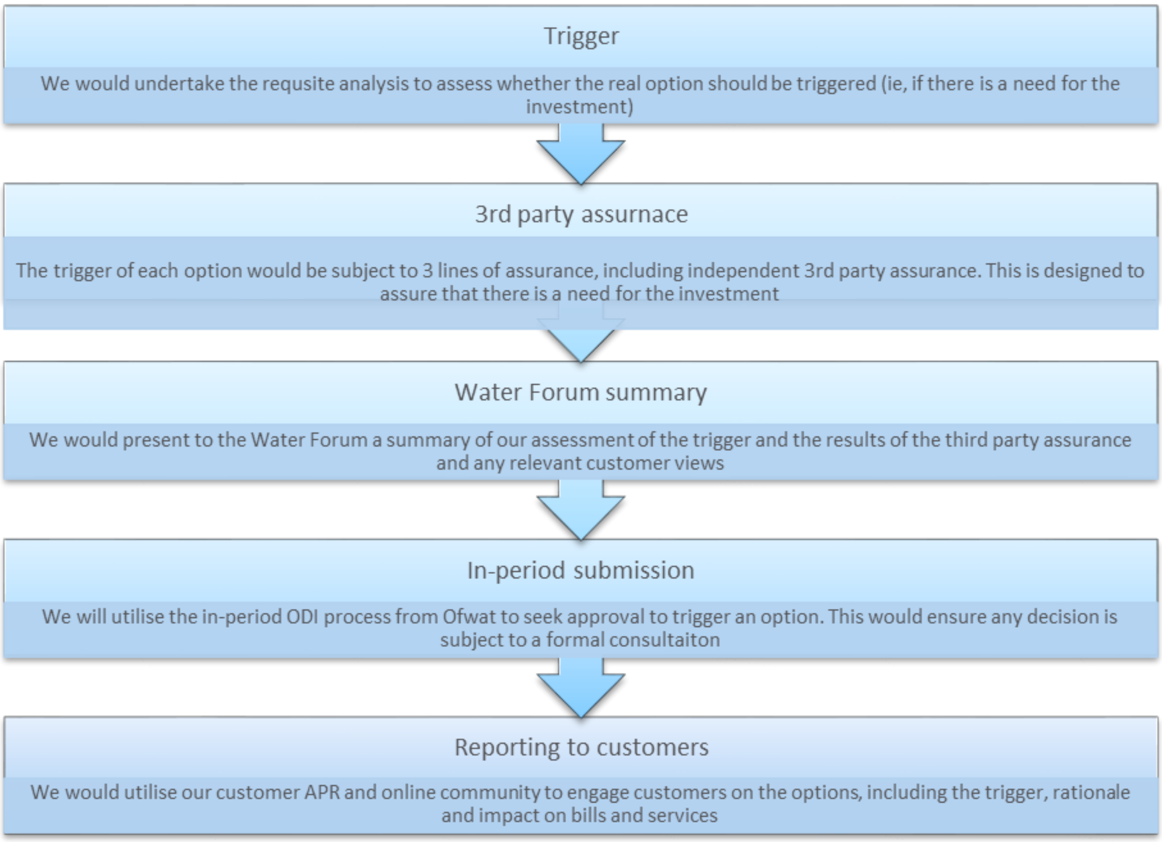
To ensure customers are protected and benefit from any subsequent water trades, we will separately report on the costs associated with the development of the interconnector. We could then ensure that if and when the interconnector starts being used we can robustly demonstrate the direct benefit to our customers from water trading, through lower bills (in addition to the network benefits).

8.3.6 Governance

One of the key factors differentiating real option mechanisms from ODIs is the trigger, which creates the optionality characteristic. The governance of the trigger is therefore important to ensure that options are only exercised when in the interests of customers.

In the figure below we have illustrated our 5 part process for triggering an option and engaging customers. A key feature of our approach is that we propose to utilise the existing in-period ODI application process to finalise the trigger of an option. We consider this is a pragmatic solution as we will be submitting an application each year. Therefore the inclusion of the real option mechanisms would have minimal impact on workload, but with the added benefit that any decision is subject to a public consultation.

In the figure below we summarise the 5 part process. We note that this would be overseen by our Board and the final application would be subject to Board approval.



8.4 WHOLESALE ENHANCEMENT CASES

In this section we present the evidence for all material enhancements, including summaries for the four areas where we believe cost adjustments are required. The evidence on costs, assurance and customer protection is described throughout our plan as we've focussed this narrative on the need and describing why these are enhancements.

The following index, consistent with the tables in Section 8.1, provides a guide to our enhancement expenditure and how we've grouped the evidence: -

Section	Enhancement	Totex £m	Note
8.4.1	Supply demand balance	302.4	Includes cost adjustment claim Two real options mechanisms apply
[REDACTED]			
8.4.3	Resilience	147.4	Includes cost adjustment claim
8.4.4	Drinking water quality	60.8	
8.4.5	Lead	16.8	
8.4.6	Drinking water aesthetic	22.4	
8.4.7	Environmental performance	18.4	
8.4.8	Low pressure	10.1	
8.4.9	Developer services (water)	258.2	This is gross expenditure, as in Table WS2
8.4.10	Wastewater environmental programme	426.2	Includes cost adjustment claim One real options mechanism applies
8.4.11	Sewer flooding	140.8	
8.4.12	Sewage treatment growth	80.6	
8.4.13	Wastewater Network Plus Legacy	47.7	
8.4.14	Bioresources	29.3	
8.4.15	First time sewerage	17.4	
8.4.16	Developer services (wastewater)	70.6	This is gross expenditure, as in Table WWS2

Interaction between enhancement expenditure and cost adjustment claims

In this section we've presented evidence for all material enhancements including summaries for the four areas where we believe cost adjustments are required. The four areas – supply demand balance, water framework directive, security and supply resilience – are consistent with our 3 May 2018 submission to Ofwat. The full cost adjustment claims are included in Section 8.7.

We've identified all material programmes items of our enhancement expenditure and have:

- explained why the expenditure is classified as enhancement and not as base, including identifying the drivers of the expenditure and the benefits; and
- provided evidence to support the need for the expenditure and how customers are protected. Efficiency of the costs are covered in Chapter 20: Security cost efficiency, with supporting benchmarking annexed to this appendix in section 8.8.

To reduce the risk of confusion between enhancement expenditure and cost adjustment claims, and to ensure all material enhancement have been evidenced, we've mapped the evidence cases to enhancement purposes used in the data tables and our performance commitments, clearly identifying where the cost adjustment claims fit in.

Developing enhancement cases

Our enhancement cases include a wide range of inputs and data sources including:

- interpretation of current and future legislative and regulatory requirements as well as customer expectations;
- reference to associated current and historic performance baselines;
- overview of intervention options developed and estimation approaches used;
- assessment of benefits delivered from different intervention options; and
- sensitivity of investment to customer protection mechanisms.

In line with Ofwat's guidance, we have reviewed the criteria set out in the cost adjustment pro-forma and PR19 final methodology. We have identified the components which we consider are specifically relevant to an enhancement business case. Where certain criteria are best articulated at a business plan rather than individual business case level, we have set out the information holistically or identified where it can be found elsewhere in the business plan. These are set out below.

Ofwat cost adjustment criteria	Relevance of cost adjustment criteria to a making a robust enhancement business case	Key themes considered in each enhancement business case
Need for investment	Specific relevance – A fundamental component of any business case	• Why do we consider this investment to be enhancement (i.e. driven by statutory increase, clear customer support or change in external conditions acting upon us)? • What is the current level of service and how will it change?
Best option for customers	Specific relevance – A fundamental component of any business case	• Does the proposed intervention deliver what customers / the statutory obligation want/require? • Is the programme optimal? Is it cost beneficial (discretionary investment) or cost effective (statutory investment)? • What is the opportunity for a range of potential interventions within the programme? • What is the scope for wider benefits that will result?
Robustness and efficiency of costs	Specific relevance – A fundamental component of any business case. However, generally justified at a company level as per cost efficiency chapter.	• What is the basis for estimating the identified expenditure? • As per the cost efficiency chapter – What confidence do we have that estimation methods are accurate and efficient relative to external benchmarks? • How have we used wider information to understand additional opportunities for further efficiency?
Customer protection	Specific relevance – A fundamental component of any business case	• How is the expenditure covered by proposed Performance Commitments and Outcome Delivery Incentives (as set out in the relevant chapters)? • What wider statutory / regulatory mechanisms will hold us to account for non-, under- or late- delivery?

Ofwat cost adjustment criteria	Relevance of cost adjustment criteria to a making a robust enhancement business case	Key themes considered in each enhancement business case
Affordability	Wider relevance – Best considered at a business plan rather than individual business case level.	• As per affordability and risk/reward chapters – Is the business plan affordable?
Board assurance	Wider relevance – Best considered at a business plan rather than individual business case level.	• As per board assurance statement – Has the expenditure within the business plan been subjected to appropriate governance?
Need for cost adjustment	Not relevant– Business cases do not make any assumptions as to how Ofwat will independently assess the need for the identified expenditure.	NA
Management control	Not relevant– Business cases consider the basis for all relevant enhancement expenditure rather than identifying reasons variance relative to a generic benchmark.	NA

Enhancement business case summaries

Read more:

- Chapter 20 securing cost efficiency and Section 8.8: provides evidence to support accuracy and efficiency of business plan expenditure.
- Part 2 designing better outcomes: describes the research we've carried out to understand the expectations and view of our customers, how we've developed our performance commitments and how we've ensured our plan is affordable.
- Part 3 delivering better outcomes: provides contextual information on the drivers of expenditure, customer and stakeholder views and performance commitments.
- Chapter 23 securing trust, confidence and assurance: sets out wider governance of our plan.

8.4.1. Supply demand balance business case

Our customers rely on a safe supply of water every day and they have told us that they want us to ensure that we have sufficient water available to provide this for them, now and into the future. They are content with our present level of protection against a 1 in 200 year drought but want us to ensure that we abstract water in a way that protects and sustains the environment. This business case describes our plans to secure sustainable water supplies during AMP7 and in the longer term.

Our draft Water Resources Management Plan (dWRMP) showed the potential scale of the challenge we face – a deficit of 164Mld at the end of AMP7 increasing to 320 Mld by the end of AMP8. Since the publication of our dWRMP, WINEP 3 and all other companies' dWRMPs have been published. We have used this to refine and benchmark our analysis, which has informed our Statement of Response (SoR), our PR19 plan and our final WRMP. As a result of this, the deficit is now projected to be 133Ml/d at the end of AMP7 and 334Ml/d by the end of AMP8.

This shortfall reflects two key drivers:

- reductions in our abstraction licences relating to WINEP3, a legal requirement;
- the known impact of climate change on our abstraction sources; and
- the corresponding uncertainty about future climate change impacts.

Since the publication of our dWRMP, WINEP 3 and all other companies' dWRMPs have been published. We have used this to refine and benchmark our analysis, which has informed our Statement of Response (SoR), our PR19 plan and our final WRMP.

This analysis identifies three water resources zones where pressures are expected to cause a supply demand deficit. For each of the three zones, the reduction to our supply capacity (to the nearest Ml/d) for each of the contributory factors is shown below.

Cumulative reductions (Ml/d) from base year 2016/17 by water resource zone

Ml/d Impact in the Strategic Grid zone	2020	2025	2030
Environmental (WINEP3)	0	5	90
Climate change	8	18	28
Climate change uncertainty	53	125	169

Ml/d Impact in the Nottinghamshire zone	2020	2025	2030
Environmental (WINEP3)	0	0	38
Climate change	13	28	43
Climate change uncertainty	1	1	2

Ml/d Impact in the North Staffordshire zone	2020	2025	2030
Environmental (WINEP3)	0	36	36
Climate change	2	4	6
Climate change uncertainty	1	2	3

We have a fourfold approach to tackling this deficit whilst abstracting in a sustainable way and protecting the environment:

- Undertaking our largest ever investigations program in AMP7;
- Preventing deterioration at current abstraction points by mitigating the impact of our activities;
- Committing to our most ambitious demand side programme ever, targeting a 15% leakage reduction and increasing meter penetration across our region from 51% to 65% by the end of AMP7.
- Where absolutely necessary, building new supply scheme solutions to ensure we have water where customers need it.

These interventions will ensure a safe, secure and resilient supply of water for our customers, now and into the future. This is a fundamental need that we must deliver. The table below sets out the interventions we have identified to achieve this.

AMP7 Interventions, costs and benefits

Intervention	AMP7 Benefit (Mld)	AMP7 Enhancement Totex (£m)	AMP7 Cost adjustment (£m)
Investigations and Mitigations	-	84.2	60.3
Demand - Leakage	64.0	30.4	-
Demand - Metering	10.2	66.6	38.4
Demand – Water Efficiency	2.1	4.6	-
Supply schemes	68.5	116.6	41.6
Total	**154**	**302.4**	**140.3**

Understanding customers' views on supply/demand has been pivotal

There is a clear expectation from customers that Severn Trent should have plans in place to ensure a continuous water supply, both now and in the future - and our research consistently shows that customers take their water supply for granted, and ensuring water is always there is a basic need that, once met, is not given much further thought. As part of this customers expect Severn Trent to be prepared to address any long term challenges which could affect the water supply, such as climate change or population growth. Customers also expect Severn Trent to meet their statutory obligations, including those related to restoring unsustainable abstraction and ensuring no environmental deterioration.

Protecting our customers in the face of uncertainty

To meet these challenges, we have followed a twin track approach that considers demand and supply interventions and also considers the implications of managing uncertainty using adaptive pathways. Our demand management solutions are significantly more ambitious than ever before and we've included progressive implementation of supply schemes where our analysis shows that there is an unequivocal need to act. We are confident that this approach aligns with our wider statutory, regulatory and customer driven expectations.

Alongside our demand side solutions, we have identified the need for 22 supply schemes in our final WRMP over the 25 year planning period (the same as our dWRMP, which included a similar programme of demand-side interventions).

We have tested the sensitivity of these identified schemes to major uncertainties, including:

- Climate change uncertainty (variance around the central view of climate change impact) and
- Scheme uncertainty (the Ml/d that the schemes will deliver, the cost of the schemes and the construction time required).

If climate change does not lead to a reduction in deployable output at the pace and scale predicted then customers would face higher bills. This is because the supply schemes have a degree of irreversibility. Furthermore if we can identify cheaper solutions to reducing leakage it would change the balance of solutions, potentially leading to more demand side measures at PR24 and beyond.

However we recognise that there are uncertainties associated with both the speed and magnitude of the impact of climate change and also the willingness of customers to voluntarily adopt metering in such a large step-up.

Climate change uncertainty

We have identified a series of uncertainties within our WRMP assumptions. These create a risk to customers because they may be asked to fund actions that turn out not to be needed.

We can mitigate this risk by using a real option mechanism that would give us the right but not obligation to act, given a defined trigger. Use of a real option mechanism supports an adaptive pathway approach that allows for investment to be delivered only where the risk of mal-adaptation is low and after consideration of whether there is sufficient time to implement options if they are shown to be required in the future. This allows for the re-appraisal of decisions iteratively as uncertainty is reduced (i.e. converted to definitive impact or reduced model error) over time. Following an adaptive pathway approach will mean that interventions are more likely to be based on certainty and could change the type of intervention (e.g. favour more demand side measures).

Metering uncertainty

There are two key uncertainties associated with metering:

- whether it is possible to increase metering installations rates as quickly as planned; and
- whether the increase would deliver the forecast 10.2 Ml/d reduction in demand.

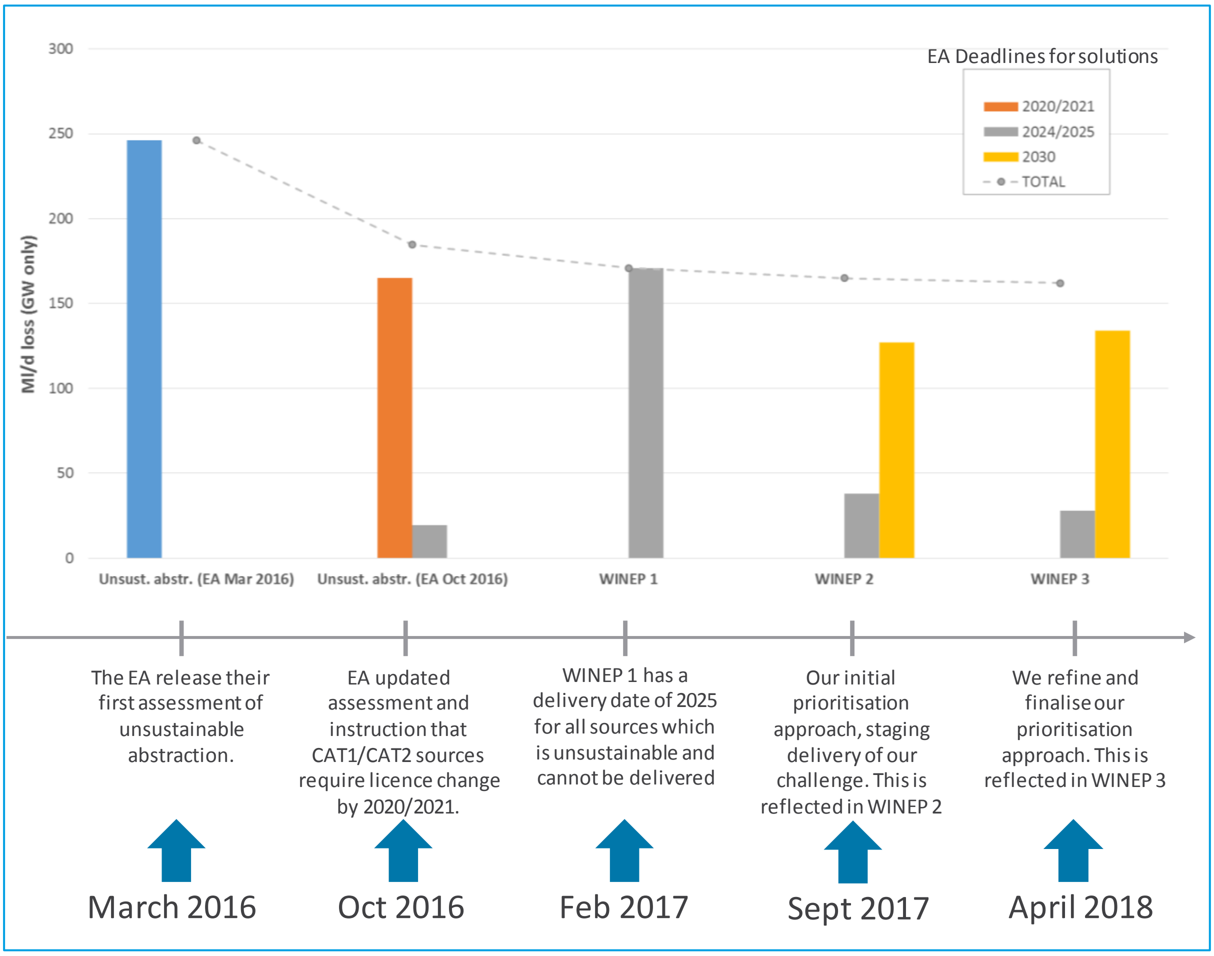
Our view is that we should manage the uncertainty associated with the scale of the demand reduction that can be achieved through delivering our metering programme. However we do think there is material uncertainty over whether the metering programme can be delivered in full due to the level of ambition.
To protect customers in these two areas we have reduced the totex in our plan and used the existing ODI framework to create two uncertainty mechanisms, which have defined triggers to that allow investment to be recovered. These are detailed in appendix A8.3 – Real options and in the full cost adjustment claim.

Our research found that customers were in support of real options. In relation to climate change uncertainty specifically, 69% of customers expressed support for our approach to prepare now but to avoid significant investment until further information is available. We also note that 13% of customers supported no activity (including feasibility and design work), whilst 18% supported investment irrespective of the uncertainty. Further details are in Chapter 6 – Engaging customers, appendix A1 and appendix A8.3.

Working collaboratively to achieve the best outcome for customers

We have worked closely with the Environment Agency (EA) to deliver the environmental objectives of the WFD in the most affordable way for our customers without putting security of supply at risk. Through our creative and collaborative approach we reduced the volume at risk by around 100Ml/d. In combination with population growth and climate change, this means that we and our customers face a deficit of 133Ml/d (around 7% of our deployable output) by the end of AMP7, impacting the supply to around 7 million people. Addressing this requires ambitious and fundamental changes to our water supply and demand strategy and plans, at a scale beyond anything we have seen in the past. Options to use local, low cost groundwater sources to address the problem are no longer available as they would also cause harm to the ecology and environment.
The reduction in scope is illustrated below.

How we have reduced the scale of WFD impacts on our AMP7 programme



Our plans deliver multiple benefits and our most ambitious demand management programme to date

Our investment delivers multiple benefits for customers and the environment. As a consequence of the interventions that will be delivered, our customers will benefit from:

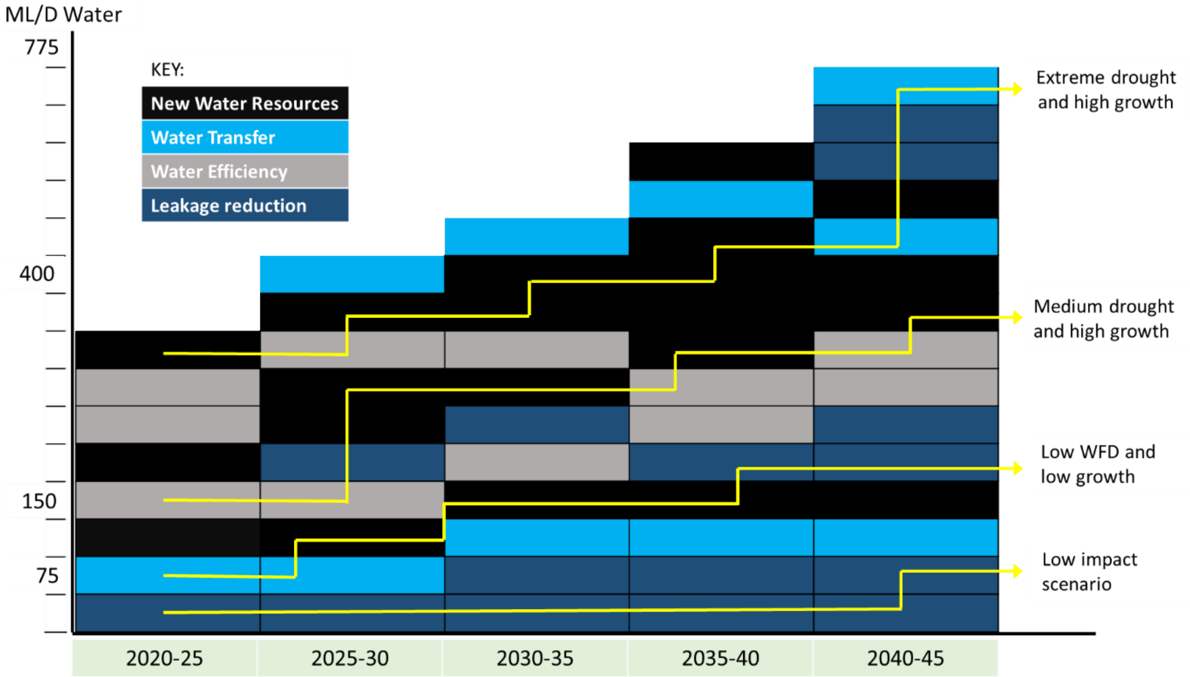
- our lowest ever levels of leakage – with a 15% reduction over the next AMP;
- more help for customers to reduce their demand, giving them greater control over their usage;
- an accelerated programme of domestic metering – increasing coverage to 68% (against our previous AMP7 projections of 55%);
- the restoration of sustainable abstraction;
- no future environmental deterioration as a consequence of our abstraction (under the WFD); and
- the restoration of river habitats and greater ecological resilience.

Our leakage and demand management targets are explicitly driven by our supply / demand needs and clearly we will be focussing AMP7 activity in the zones that have the most acute water resource pressures and that are expected to go into deficit. Regardless of the risks and uncertainties around these options, prioritising leakage and demand management in these zones form part of our most certain solutions because we know that sustainable water supplies will become increasingly scarce in these zones over future AMPs.

Delivering the best option for customers

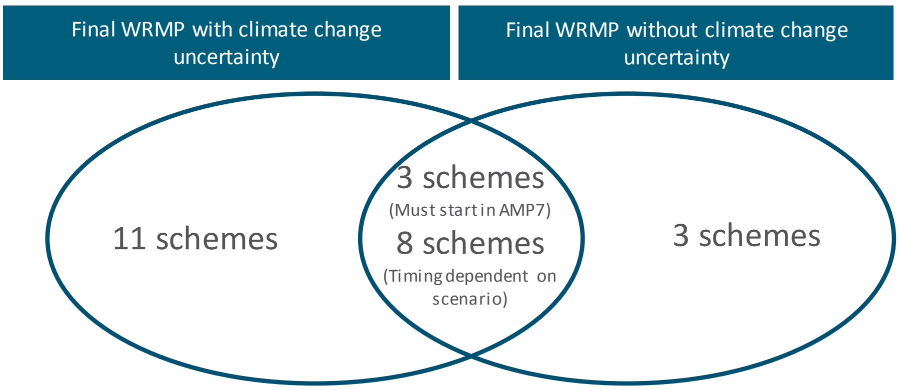
Using our investment optimisation tool we have been able to model a large number of alternative supply / demand scenarios to examine how sensitive our investment decisions are to any uncertainty around costs and benefits of scheme options as well as different supply / demand planning assumptions including uncertainty around climate change. Below we show a pictorial view of our adaptive pathways planning.

Adaptive pathways planning



Our analysis shows that there is a high level of certainty that three supply schemes will need to start in AMP7 in order to solve spatially distinct deficits driven by WINEP3 abstraction reductions which cannot be solved by company-wide demand side solutions.

Sensitivities show when supply schemes are selected



The three schemes are required in AMP7 irrespective of any assumption made on climate change uncertainty. These schemes are included in our PR19 plan (see our supply-demand enhancement business case).

There are also eight supply side interventions selected in both scenarios but these have a choice on start time depending on whether climate change uncertainty is included or not.

The selection of the remaining schemes is dependent on core climate change uncertainty and scheme specific assumptions. This means that there is an elevated risk that the delivery of these schemes may not lead to the most economic or efficient solution to customers.

In this business case, we are proposing to invest in the three “certain” schemes, and deliver them in AMP7. If additional supply schemes are required, then we can use trigger and uncertainty mechanism to deliver them.

Read more: Further details of this business case are in the supply demand cost adjustment claim business case included in section 8.7 of this appendix.

8.4.2. Security business case

We have a good track record of investing in to protecting our assets against malicious attack. This has historically been overseen by adherence to the mandatory Security and Emergency Measures Directive (SEMD) Advice Notes. However, we foresee that the security challenges we will face in the future are likely to vary significantly. New threats and emerging technologies have been seen to erode the protection provided by traditional security mechanisms. This is being reinforced by a changing set of requirements to which we will be required to respond to in the future:

- Protective Security Guidance (PSG 2020) – Relating predominantly to physical security
- Network and Information Systems Directive (NIS) – Relating predominantly to cyber security

During AMP6 we completed a comprehensive review of our security strategy. This was prompted by the increasing level of terrorist activity and capability, better awareness of customers’ expectations, and our status as one of the small number of water companies with substantial critical national infrastructure (CNI) and national infrastructure (NI). Working proactively alongside the Centre for Protection of National Infrastructure (CPNI) we pioneered a holistic risk based approach. This has now been embedded in the new Protective Security Guidance (PSG) 2020. We also identified the emerging threat of cyber-attack on the operational technology that controls assets.

This business case sets out a step change in expenditure that we have identified as necessary to respond to the anticipated new legislation (PSG 2020 and NIS) and deliver for customers in line with their expectations. However, we’re confident that work undertaken to date, understanding the risks we face and responding in a risk based way, stands us in good stead to act in an efficient and effective way in AMP7. Our risk based approach allows us to set the scope of mitigation measures in a proportionate way given the threat environment at the site. Having invested in the physical security upgrades to the highest risk CNI sites (Category 3) during the current and previous AMPs, our AMP7 programme will provide the following outcomes:

[REDACTED]

[REDACTED]

What is driving the need for this enhancement investment?

We own and manage a complex network of assets to provide safe, clean drinking water to our customers and treat sewage to protect the environment. In order to provide this service we store hazardous chemicals, employ thousands of people in offices and on operational sites, as well as having sites which are considered critical to the UK National Infrastructure. Our asset base is listed in the table below:

[REDACTED]

The statutory guidance to which we must respond is changing in response to new security threats
Since AMP4 we have been investing in line with current SEMD Advice Notes provided by Defra. The advice notes will be replaced in April 2020 by the Protective Security Guidance (PSG) and Water UK Security Standards (WUKSS) once approved by Defra. These new standards and guidance provide advice on a security risk-based approach for the security protection of 'Critical National' and 'National' Infrastructure sites.

Defra has provided early sight of PSG 2020 to water companies to allow for inclusion in PR19 business plans. We have been actively involved in the development of these guidance documents to ensure they reflect the need for a more risk based approach to security design and implementation - as opposed to a more traditional prescriptive standards based approach. A risk-based approach seeks to ensure interventions are proportionate to the actual risk. This means that they have the potential to be much more cost effectively applied than prescriptive standards.

The new PSG is more expansive in its approach than the current advice notes. Its requirement for a strategy framework, assessment of sites, and the inclusion of cyber and people security, mirrors the approach we have already undertaken in our strategy review and improvement roadmap during the current AMP.

We have reviewed the impact of the new guidance and drawn on expert advice from CPNI security advisors where appropriate. In summary, the new requirements now account for a larger number of sites and threats (taking greater account of NI sites) and require a quicker and more robust response (actions to be initiated in less than 10 minutes). Changes from the existing SEMD Advice notes are set out below.

Interpretation of changes in obligation driven by PSG2020
[REDACTED]

Customer support to enhancing security provision
Although our programme of work is driven by future statutory requirement, and informed by latest intelligence, the outcomes it will deliver are consistent with our customers' preferences and priorities.
On the topic of Severn Trent's cyber security, customers expressed concern about their personal data being stolen or compromised, but struggled to make any further connections between cyber security and challenges to the water system. Customers tended to see this as a threat facing all major organisations, rather than

something specific to their water company. They feel that Severn Trent should be taking all the necessary precautions to protect against it. Some see this as a risk that, unlike an 'act of God', can be avoided if given adequate investment and attention.

[REDACTED]

We believe there is good evidence to suggest that our approach is congruent to our customers' preferences – as far as is possible to elicit.

We have made sure that this business case aligns with these customer expectations. Coupled with our cost benefit assessment, we are confident that the proposed interventions are supported by customers (irrespective of the statutory need underpinning this proposal).

How have we made sure that we are delivering the best option for customers?

We have a good track record of protecting the core services that we deliver to our customers from malicious security threats. Our early adoption of a risk based approach to assessing security risk and implementing interventions means that we are in a good place to respond to the anticipated new obligations that will be placed upon us by PSG and NIS.

To ensure that the protection we offer our customers in the future is fit for purpose, we have undertaken an extensive review of both the challenges that we face and the optimal way of responding to them. This has included close engagement with our key stakeholders such as national policy owners (including Defra, CPNI and NCSC), the Water UK Security Steering Board, Our Water Forum Infrastructure sub-group and our SEMD auditor.

We have used this information, alongside our bespoke customer engagement to show that our risk based proposals are both fit for purpose, future proofed and cost beneficial.

Our journey in security investment so far
We have been investing in improving our security over successive AMPs so that we ensure alignment with legislative requirements or guidance at the time. Historic, current and planned investment (AMPs 7 and 8) is set out in the table below.

Investment over successive AMPs to meet the prevailing legislation/guidance
[REDACTED]

Our fundamental review of preventative security strategy during AMP6 has enabled us to produce a roadmap addressing priorities holistically in the three areas of physical, cyber, and personnel security. The approach was developed with CPNI involvement and commended by them. Overall, our approach since AMP4 ensures that the cost of securing our sites is spread across AMP periods, minimising the impact on customers' bills, while managing the security risk to our customers and the environment to an appropriate level.

Risk based investment
During the current AMP period our fundamental risk based review of security strategy took a holistic approach to protective security. It considered each of the three elements i.e. Physical, Cyber and Personnel. The principles of Deter, Detect, Delay, Mitigate and Respond were applied at a site level to identify a set of interventions that best manage the risks faced. This is in line with the PSG requirements and offers a significant saving if compared to a standards approach where the interventions are not identified with reference to the risk faced.

[REDACTED]

We have subjected our plans to detailed scrutiny
We have been sharing our cost adjustment proposals with Water Forum investment sub group (ISG) as they have evolved. The ISG comprises members from: the Environment Agency; Natural England, Consumer Council for Water; Confederation of British Industry; the West Midlands Combined Authority; and two from industry leading engineering consultancies. In total almost 100 challenges have been raised by the ISG and responded to. The Water Forum's customer research sub-group has also challenged our approach to research, and the performance commitments sub-group has reviewed our proposals for customer protection.

In order to proportionately shape this investment proposal, we collaborated with a significant number of relevant stakeholders, taken account of Defra audit findings and sort additional advice of National Counter-Terrorism and Security policy owners and advisors. We have also consulted with the Water UK Security Steering Board our Secretary of State approved SEMD auditor.

Using cost benefit analysis to ensure customer value

We have undertaken detailed cost benefit analysis to support our decision making, using it to identify best value for money for our customers and to select our preferred solutions.

[REDACTED]

The change in risk has then been valued and presented in terms of net present value (NPV benefits-costs) and the cost benefit ratio. We conclude from this analysis that, notwithstanding the statutory need to invest, the interventions have good cost benefit ratios. They remain cost beneficial across a range of assumptions and the sensitivity analysis does not alter the preferred option.

How are customers protected (to ensure that they get the benefit that they have paid for)?

Defra have advised us that they will check alignment with PSG 2020 and also impose penalties and fines for lapses of insufficient security. In order to confirm to Defra that the required activities will have been undertaken we will be required to undertake an annual audit by an independent certified auditor, approved by the Secretary of State.

While legislative enforcement in itself affords customers with protection against non-delivery, we also propose to capture this obligation in a performance commitment. Our Water Forum discussed our approach to customer protection and recommended alignment with Defra. We have responded to this input from the Water Forum and developed a performance commitment that shadows the statutory requirements.

8.4.3. Resilience business case

Every day our customers trust and expect us to deliver a continuous supply of safe, clean drinking water to their taps. To be able to deliver these fundamental water service expectations, we need sufficient water resource, treatment capacity and distribution capability as and when it is called for. This requires; (a) long term water resources planning, and (b), a resilient set of assets, systems and networks that can deliver core service irrespective of the shocks or stresses placed upon them. This business case considers the latter of these two fundamental requirements – the resilience of our asset base.

Assets, systems and networks, by their very nature, will deteriorate with time, be subjected to external shocks and stresses and could eventually fail. To mitigate the customer impact of asset failure, interventions can be undertaken that will ensure that this risk is kept at an appropriate level. This can be either through investing to reduce the likelihood of failures occurring or minimising their impact on customers when they do.

Sustainable maintenance programmes are designed to maintain a stable risk profile though time. However, resilience enhancement interventions are required where the current level of risk is assessed to be too great and needs to be systematically and permanently lowered. This business case identifies the need to make resilience enhancement interventions across several different types of strategic assets. They have been developed where our analysis shows that current levels of risk are out of step with customer expectations.

Together the proposed interventions (totalling £135m) will deliver a step change in the resilience of water service delivery for the customers who presently receive less resilient supplies than those in other parts of our region.

Summary of proposed investment cost by area

Investment area	Central estimate of AMP7 costs	Customers benefiting from enhanced service resilience (reduction in risk of supply interruption lasting at least 1 day)	Business case coverage
Strategic sections of assets	£29m	98,000	Resilience of strategic assets
Large surface water treatment works	£54m	442,000	
Network response to a treatment work failure	£21m	383,000	
Trunk Mains	£10m	92,000	Resilience of local network assets
Groundwater sites	£14m	94,000	
Distribution Resilience	£7m	N/A	
Birmingham resilience scheme	£12m	N/a – related to AMP6 capex	AMP6 scheme additional operating costs in AMP7
Total	**£147m**	**1.1 million**	

Resilience of strategic assets

What is driving the need for this enhancement investment?

Better understanding the current risk faced

We experienced first-hand the devastating impact that strategic asset failure can have on our customers following the catastrophic failure of Mythe water treatment works in July 2007. This event has subsequently been the catalyst for a twin track approach; to better understand how risks we face are changing, and to also take steps to better manage or reduce those risks.

Many aspects of our understanding of resilience are well established and can be calculated with a high degree of accuracy (such as the impact of asset deterioration on service), while others are less well understood or uncertain (such as the impact of climate change). Our journey has improved our understanding by gathering and analysing data about the performance of our assets. This allows us to better understand how they respond to the external shocks and stresses and impact on service to customers. A key component has been to quantify the risk to service given our existing system resilience, rather than considering each individual asset in isolation. This helps to guard against duplicating or overstating risk.

In addition to our improved understanding, we have also been systematically reducing the risk associated with the loss of supply from our critical assets, including aqueducts and our surface water treatment works. Our AMP6 plan included our Birmingham resilience scheme – which is a major component of our Strategic Grid. Once completed the scheme will deliver a step change in resilience for customers in the Birmingham region.

Understanding the tolerance to the current level of risk

The acceptability of the current level of resilience inherent within our asset base is requires clarity of what a resilient service should entail and a robust understanding of how we perform against this expectation.

The catastrophic failure at Mythe water treatment works in July 2007, subsequent supply interruptions, and the research undertaken for the AMP6 Birmingham resilience investment gives a growing body of evidence on resilience related issues. It gives us a much clearer insight into our customers' attitudes towards risk, and the level of service they expect should be maintained in the event of a failure. It all suggests that expectations are higher than those assumed when investment decisions were made in earlier AMP periods. We have further tested this in specific PR19 deliberative customer engagement.

We now have a clear understanding that:

- interruptions of longer than 24 hours are not acceptable;
- prolonged periods of discolouration for some customers are tantamount to a supply interruption;
- an equivalent minimum level of resilience for all customers should be provided; and
- interruptions in supply caused by a single point of failure are unacceptable.

Customers have also been clear our traditional measure of resilient water supply (i.e. having a second source of water) is not meaningful to them – they care only that water can be delivered to the tap, in such a way that they do not notice any difference in the event of normal service being interrupted. This has allowed us to implement different solutions to a traditional second source water supply and cost effectively extend the number of customers who will receive a resilient service.

In summary, in the eyes of our customers, resilience means they expect any interrupted service to be recovered quickly and certainly no longer than 24 hours with very little or no discolouration. We consider that this offers a strong mandate to act where we can demonstrate that current performance does not meet these expectations and that interventions will provide value for customers.

Current customer facing risk derived from our strategic assets

We have carried out an extensive risk analysis across a range of asset types. This has covered a wide range of failure modes and consequences. It has given us a thorough understanding of which assets are not resilient today. The analysis has identified a number of systems and assets that we have prioritised for enhancement investment so that we can meet customer resilience expectations.

Where any systems and assets have been designed (or modified) to provide this level of customer resilience but currently do not, they have been excluded from this business case.
For each strategic asset type, we have assessed the extent of customer impact during an asset failure. We have used this in order to identify and prioritise areas were we need to invest in AMP7. We have then calculated a likelihood of failure to allow customer facing risk to be monetised exposing the benefits that customers will receive following intervention. This is summarised below.

Asset type	Identified highest priority interventions	Customers not receiving a resilient service	Calculated annual failure likelihood
Strategic distribution links within the Strategic Grid	[Location REDACTED] . . . .Identified as having the greatest number of customers suffering supply failure.	98,000 currently at risk of 2 day interruption (of which 25,000 currently at risk of 42 day interruption)	Theoretical asset based calculation: 0.1% - 4% per structure System risk calculation ([Location REDACTED]): 5%.
Large surface water treatment works	4 WTWs where failure would lead to interruption of >24hours ([Four locations REDACTED] . .)	442,000 currently at risk of a 2 day interruption (of which 387,000 currently at risk of 10 day interruption)	Based on SWIFT failure analysis: 3.3%
Network response to a treatment work failure	19 network assets not currently assessed as capable to deliver resilient alternative supplies in the event of WTW failure (can be deployed without causing discolouration or >24hour supply interruption)	2,694,000 customers impacted by assets 766,000 currently at risk of discolouration (of which 383,000 currently at risk of 2 day interruption	Based on WTW SWIFT failure analysis: 3.3% System risk approach being developed
Trunk Mains	10 network locations where failure would lead to interruption of >24 hours.	92,000 currently at risk of a 1 day interruption	2.9%
Groundwater sites	8 borehole sites where failure would lead to interruption of >24 hours.	94,000 currently at risk of a 1 year interruption	2.2%

This case for resilience enhancement primarily focuses on different components of our Strategic Grid. This is where we have the greatest understanding of the risks we face and the largest potential customer impacts. The Strategic Grid is the principal treated water transfer system in the Severn Trent region supplying approximately 5 million of the c.8 million people we serve. It comprises an integrated system of aqueducts, pipelines, reservoirs, resources, water treatment works and control systems.

The strategic grid enables us to move water within a large geographical area in a flexible and sustainable way, allowing us to effectively manage changes in the supply/demand balance. At 1,200km in length, it spans from Derbyshire in the north of our region, down the eastern side of our region and across into Gloucestershire in the south of our region. It has been developed over the last 40 years from a series of standalone assets. Our customers have benefited significantly from this interconnectivity.

How have we made sure that we are delivering the best option for customers?

Following identification high priority assets and systems that require intervention to satisfy customer resilience expectations, we have sought to ensure that the method on increasing resilience is both optimal and cost beneficial. We have also re-engaged with customers and the water forum to ensure that the proposed programme is appropriate.

Optioneering to identify an optimal solution
We have considered resilience using the four principal strategic components of resilience (Cabinet Office guide - Keeping the country running: natural hazards and infrastructure, 2011). We have appraised our solutions using the four principal options of resistance, reliability, redundancy, and response and recovery outlined in the document and adopted a number of solutions using these strategic components to minimise investment whilst maximising resilience benefit.

The hierarchy of options range from:

- Increase interconnectivity to provide a supply from an alternative source, removing single source dependency.
- Dual streaming of water treatment works, removing single points of failure.
- Relocation of critical or vulnerable equipment/assets to a safer location.
- Providing alternative supplies through contingency plans (tankers, bottles, bowsers, etc.)

The extent of our work in formulating this business case includes many thousands of hours of engineering and customer research time. For each asset type our optioneering has been extensive. We have scoped, designed and costed over 60 different schemes.

Using cost benefit analysis to ensure customer value
We have undertaken detailed cost benefit analysis to support our decision making, using it to identify best value for money for our customers and to select our preferred solutions.

Our cost benefit analysis considered a wide range of benefits associated with each solution. Customer facing benefits were quantified using willingness to pay data triangulated from a range of sources. While we consider that it is appropriate to include avoided private costs of failure and avoided wider economic damage when considering the merits of an intervention, the cases remain cost beneficial when considering the customer service benefit alone.

We used our system risk assessment to arrive at robust estimates of likelihood of failure on complex interconnected network systems taking full account of existing provision for resilience. The analysis has also accounted for the different residual risks associated with each intervention. This has allowed us to identify pre and post intervention risks. The change in risk has then been valued and presented in terms of net present value (NPV benefits-costs) and the cost benefit ratio. Acknowledging potential uncertainty, we have undertaken sensitivity analysis on our most material assumptions (reducing probability of failure, interruption length and customer valuation by 25%). The investments remain cost beneficial and this sensitivity analysis does not alter the preferred option.

Customer validation of proposals

Our customers have told us they are willing to pay for the interventions we set out below. Having discussed in detail with our customers, and exposed a previously unknown risk, they support and expect us to take action. The outcome of our choices research – which allowed customer to prioritise investment in the context of other priorities in our plan, and potential bill impacts - found that 78% of household customers and 76% of non-household customers support our investment proposals in relation to resilience.

Summary of optioneering and cost benefit analysis

The table below sets out a summary of the optioneering we have undertaken in each of the interventions that we have prioritised. It shows how we have used CBA to derive the chosen interventions that have then been included in our enhancement plan.

Asset type	Prioritised interventions	Annualised properties at risk (pre-intervention)	Intervention options	Chosen intervention	Annualised properties at risk (post-intervention)
Strategic distribution links within the Strategic Grid	[Location REDACTED]	42 day failure of supply: 542 2 day failure of supply: 1516	Local network enhancement to provide alternative supply (Expenditure £29.4m, Cost benefit ratio 1.83, NPV £23.3m) New pipeline between [Location REDACTED] – full (Expenditure £147.6m, Not cost beneficial) New pipeline between [Location REDACTED] - partial (Expenditure £34.4m, Not cost beneficial)	Option 1 – Local network enhancements to provide alternative piped supply Enhancement to trunk main/distribution network to provide an alternative water supply to customers directly fed from [Location REDACTED]. (Expenditure £29.4m, Cost benefit ratio 1.83, NPV £23.3m) [Location REDACTED]	42 day failure of supply: 11 2 day failure of supply: 30
Large surface water treatment works	[REDACTED]	10 day failure of supply:1284	23 options including: Duel streaming of WTWs Bulk transfers Increased grid connectivity	Dual streaming of WTW Retain partial WTW capability in event of component failure (Expenditure £21.3m, Cost benefit ratio 1.08, NPV £2.5m)	10 day failure of supply: 77
	[REDACTED]	10 day failure of supply:1839 2 day failure of supply: 767	New treatment processes / WTW CBA across a range of options will explored, with the most cost beneficial option been progressed.	Dual streaming of WTW Retain partial WTW capability in event of component failure (Expenditure £15.9m, Cost benefit ratio 2.56, NPV £39.0m)	10 day failure of supply:110 2 day failure of supply: 46
	[two locations REDACTED]	10 day failure of supply:2245		Grid Connectivity between WTWs Bi-directional connectivity between two works to enable mutual support (Expenditure £16.3m, Cost benefit ratio 4.09, NPV 47.4m)	10 day failure of supply:135
Network response to a treatment work failure	Network assets not currently able to provide R4 level of performance - i.e. avoid 24 hour supply interruption and discolouration (19 assets)	2 day failure of supply: 5320	Improve All network assets to R2 standard (Expenditure £5.2m) Improve all network assets to R3 standard (Expenditure £15.4m) Improve all network assets to R4 standard (Expenditure £20.6m, Cost benefit ratio 1.35, NPV £23.5m)	**Option 3 – Intervention at all 19 assets** Interventions will improve the capability of these existing assets to an R4 category standard so as to meet the needs of our Customers. It will include a total of 19 interventions linked to nine water treatment works. (Expenditure £20.6m, Cost benefit ratio 1.35, NPV £23.5m) We consider the R4 category to be the appropriate standard having listened to our customers. They can be deployed when required without the risk of failure – e.g. a supply discolouration or supply interruption.	2 day failure of supply: 160

How are customers protected (to ensure that they get the benefit that they have paid for)?

We are proposing a performance commitment to protect customers, which focuses on delivering a service level that they expect – percentage of customers whose service to the tap can be restored within 24 hours of a single failure event in their normal supply route. This will commit us to reducing the number of customers that do not have a resilient service (i.e. at risk of a supply interruption of more than 24 hours) as set out in the performance commitment.

This proposed performance commitment builds on our AMP6 equivalent (which covered only the failure of customers' sources of treated water) by combining the two elements of a resilient water service: (i) source of treated water resilience; and (ii) network resilience thus providing confidence in our source-to-tap service.

Resilience of local distribution assets

This business case sets out the investment that we are proposing to enhance the level of resilience that our local distribution assets provide to customers. This is a subset of the wider resilience expenditure that we have included in our business plan. The remainder considers interventions at our more strategic assets such as Strategic transfer assets, major water treatment works and trunk mains. The business case for these components is set out separately in the cost adjustment chapter expenditure.

Business case	Distribution resilience Groundwater sites Trunk mains
AMP7 enhancement Capex	£31m (Note – WS2 contains flow through of £12m opex costs relating to AMP6 Birmingham Resilience coming on line 2019/20)
AMP7 enhancement Opex	£0m
Price control	Water Resources Water Network +
Ofwat enhancement cost drivers	Table WS2, Line 14: Resilience (part of)
Sensitive performance commitment	Supply interruptions Mains Bursts Complaints about water quality

What is driving the need for this enhancement investment?

We have a strong body of evidence which identifies that customers are willing to pay to reduce the risk of supply interruptions and discolouration. We have identified a series of network interventions that will deliver a step change in the level of resilience that our levels of service currently deliver. Therefore, we consider that the investment in this business case closely aligns with customer expectations.

Customer support

The ability to reliably supply water is a primary condition of our licence. Our customers expect us to be able to deliver a good quality and consistent product every time they turn the tap.   This is reaffirmed by our statutory obligations as set out in the Water Industry Act 1991 and the Water Supply (Water Quality) Regulations 2016.

Customers also state that they trust Severn Trent to make the correct decisions to ensure that the enabling infrastructure is a lasting legacy for future generations. This need to leave a lasting legacy is reinforced further with a stated preference of long term solutions to issues rather than short term mitigations.

Customers believe that our investment in network resilience should both anticipate the challenges we may face and be well prepared to respond when things go wrong. A continuous supply of wholesome, clean water is a core expectation – failing to provide this erodes the trust that our customers have in us. Interruptions due to failure of our assets are deemed less acceptable. The level of acceptability also deteriorates rapidly with increasing interruption duration. Short duration interruptions are viewed as an inconvenience, whereas long duration interruptions are unacceptable especially if the cause is a single point on failure on our network.

The current and future levels of resilience provision

We have invested to address local network design deficiencies benefitting over 800,000 of our customers throughout AMP5 and 6. This has led to improvements in our supply interruptions performance being realised throughout AMP5 and maintained during the first two years of AMP6. This business plan continues this local resilience investment activity into AMP7. However, we have recently seen a number of large supply and associated discolouration events that have had a significant impact on localised performance. This has reaffirmed that we need to continue to improve our network resilience.

The business case includes three programmes of work designed to enhance the performance of our network and therefore increasing the level of supply resilience we provide to customers.

- Local resilience interventions to resolve inherited network vulnerabilities.
- Targeted reduction in transient pressure waves.
- Enhanced network conditioning
- Improvements to our trunk mains
- Enhancing our groundwater sites

Local resilience

The identified AMP7 local resilience programme continues ongoing work to reduce the number of customers impacted by a localised asset failure. Our programme for AMP7 will include some 6,000 different network interventions, including cross-connections and additional valve locations, to increase the number of network operation options we have. Our modelling suggests that these interventions will result in around 500,000 fewer customers being impacted by supply interruptions greater than 3 hours.

Pressure transients

We will roll out our emerging research findings on mitigating pressure transience. The pressure transient reduction programme will reduce the inherent stress on our network assets by making bespoke interventions at booster pumping stations. Our trial analysis has demonstrated that this technology will lead to fewer mains bursts which in turn will help reduce the risk of supply interruptions and leakage. To date we have implemented a limited number of interventions on the network, therefore it is difficult to accurately quantify the exact benefit.

Enhanced network conditioning

Conditioning the network automatically through the use of dynamic control valves is an innovative way of reducing the risk of flow changes in the network causing discolouration events and increasing our ability to automatically rezone during interruption events. In AMP7 we propose to complete a full scale regional rollout to prove the theory in a live system. We anticipate that it will reduce customer water quality complaints (by conditioning the network to more variable flows, reducing the risk of material mobilisation as a result of a network perturbation) and supply interruptions performance (due to the greater ability to automatically rezone DMAs). It will also have several operational benefits: reducing the need for DMA flushing and providing more flexibility to optimally control the way in which we move water around the network.

Trunk mains

A long duration supply interruption is experienced in the same way for customers regardless of the mode of failure that causes the interruption (surface water treatment works failure, groundwater site failure, trunk main failure). It would not meet our customer needs if we addressed surface water and storage reservoir sites but excluded trunk mains.

With this in mind we have modelled over 1million pipes across our company and appraised their vulnerability to long duration interruptions (>24hrs), principally reviewing the risk of structural failure, failure caused by natural hazard or failure caused by 3rd party. We have simulated the impacts of failure and the options we have to provide resilience from elsewhere in our system. This has resulted in reducing our list to only 2,699 mains which do not have the capability to avoid an interruption to supply for longer than 24hrs in the event of a failure.

We have further assessed if any redundancy or resistance options exist, should exist or have ever existed for these mains. Where they do, those mains do not form part of this proposal. Additionally we have assessed where the main can, should or ever could accommodate the failure mode whilst operating within its design parameters. Where they do, those mains do not form part of this proposal. Finally if redundancy, resistance or reliability does not exist we have looked at our response and recovery options to maintain supply. Where the number of customers served by the main is less than 1,500 properties we have excluded these from this proposal.

Beyond this limit it is not practicable to sustainably and cost effectively deploy tankers. This filtering process has resulted in only 10 sites we are unable to restore to avoid 24hr (or longer) interruption; [REDACTED] .These mains supply water to over 220,000 customers.

Groundwater sites

Similarly, we have reviewed all 108 of our groundwater sites and appraised their vulnerability to long duration interruptions (>24hrs), principally reviewing the risk of aquifer pollution and/or mechanical or electrical failure, power failure and extreme flooding. We have assessed sites using the same process flowchart contained in the main body of the document (Figures 2 and 3) to ensure consistency of approach.

We have simulated the impacts of failure and the options we have to provide resilience from elsewhere in our system or elsewhere on the site. This has resulted in our list of sites which do not have the capability to avoid an interruption to supply for longer than 24hrs in the event of a failure. We have assessed if any redundancy or resistance options exist, should exist or have ever existed at these sites. Where they do our sites do not form part of this proposal ([REDACTED]

Additionally we have assessed where the site can, should or ever could accommodate the failure mode whilst operating within its design parameters. Where they do our sites do not form part of this proposal. Finally if redundancy, resistance or reliability does not exist we have looked at our response and recovery options to maintain supply. Where the number of customers served by the site is less than 2500 properties and we have good tanker access to distribution reservoirs or the number of customers served by the site is less than 1600 and we have good access to network injection points we have excluded these from this proposal ([REDACTED] . . . .) Beyond these limits it is not practicable to sustainably deploy tankers. This has reduced our long list of potential groundwater sites from 108 to only 12.

[Location of six sites REDACTED] .supplying water to almost 100,000 customers will provide the main focus of our investment plans in groundwater sites in AMP7. During AMP7 we will also review the remaining other 4 sites; [REDACTED] to identify the most cost beneficial option to provide long term resilience at these sites with delivery planned for AMP 8 .

How have we made sure that we are delivering the best option for customers?

This business case consists of a spectrum of interventions that will enhance network resilience provision in line with customer expectations. Between them, they vary from innovative to tried and tested solutions. We consider that this is an appropriate way to protect customers now whilst also progressing future opportunities for efficiency and delivery.

Local Network Resilience

The local network resilience programme will reduce the impact of local network bursts by increasing our ability to isolate discrete parts of our network. This will reduce the number of customers impacted in the event of bursts on the local distribution network. In order to ensure that we have selected an optimal programme, we have reviewed 116,000 potential isolation locations. For each location, impacts vary in duration, extent and likelihood. The interventions have been ranked based of the likely reduction in service interruptions.

The size of the programme has been determined by reviewing the cost and benefit of intervening at an increasing number of locations. This will be delivered by adding 6,000 additional isolation valves into the network. Alternative programmes of interventions were considered, a scenario that reduced the risk of supply interruptions further was costed at £45m whilst all possible network interventions would cost far in excess of £200m.

Other interventions that could deliver the same benefit would have to either address the reliability of the assets, reducing the likelihood of an event or implementation of new technologies that would significantly reduce the time to repair/restore following an asset failure. The reliability of the asset is a function of its condition. Asset renewal is the most effective way of doing this, however, modelling has shown that this is not a cost effective way of reducing supply interruptions if it is the sole approach considered.

Pressure Transients

Our pressure transient work is an innovative approach that is in addition to the traditional pressure management and network calming activities. We have worked with research institutions and specialist technology companies to improve our knowledge of how pressure transients negatively affect the asset health of a network through burst mains and associated supply interruptions.

We now have a better understanding of the causes of, impact on pipe failure rates from, and cost effective solutions to, pressure transients. On average, we should see a 15% reduction in burst mains as a result of transient reduction activities. In some situations, this can be much higher resulting in an even quicker return on investment. One example of this has been realised by the work we have carried out at Caunton booster station. We have observed a 70% reduction in bursts in the area with a return on investment of only 3 months as a result of reduced reactive repair costs.

We are proposing a company-wide roll out of a custom pump ramp profile across our booster pumping station estate. Installation costs will be dependent on the amount of preparatory activity needed to install and use the technology on a site by site basis. Based on our information to date, an average installation will cost around [REDACTED].

Enhanced network conditioning
Traditional flow conditioning on trunk mains is an effective way of delivering network resilience improvements. However, establishing these flow regimes requires the installation of flow control assets on critical assets at significant disruption, cost and maintenance requirement.

We are developing a new approach by utilising dynamic DMA boundary valves. This negates the need and complexity associated with installation on trunk mains and reduces the criticality of each asset to delivering a successful outcome. By focusing DMA demand onto different sections of trunk main through automatic and scheduled DMA rezoning, we are able to increase conditioned flows to identified trunk mains in a controlled manner. Similarly, as the demands are passed through DMA's, there is an additional flushing effect on the DMAs themselves. This will further reduce the discoloration risk of an area without the need for any traditional cleaning.

The valves also give an increased level of supply resilience to the system. Dynamic control valves are pressure sensitive and therefore able to rezone areas automatically in the event of a pipe failure whilst still protecting the areas that they usually supply.

This business case relates to the initiation of a £2m full regional roll out to prove the technology and validate the theoretical analysis that we have already completed. It will identify an optimal location, install the assets, and derive the operational regime required. This will be used to assess how the approach can be best rolled out company wide.

Trunk Mains
Our proposals to address these risks comprise a mixture of redundancy, resistance and response and recovery approaches set against a background of logistics and cost effectiveness. Investment will represent first time investment to improve the site to provide a new performance level for customers.

Specifically they include;

- dual mains at high risk sections;
- short length duplication;
- diversions;
- new valves to permit speedier isolation and retain pressures; and
- cross connections to allow mains to operate independently.

We have sought and modelled the most appropriate cost beneficial solution options to deliver resilience to these at risk sections of our network. There are sites where we have large diameter mains in close proximity to railway lines, canals, rivers, where these occur we will seek every opportunity to work towards efficient and effective solutions with asset owners, for example Network Rail HS2 crossing points. All these savings have been factored into our investment proposal.

Groundwater sites

Our proposals to address these risks comprise a mixture of redundancy, resistance and response and recovery approaches set against a background of logistics and cost effectiveness. They include:

- off-site network improvements such as increasing connectivity to other groundwater sites (to provide system level resilience as opposed to site level resilience);
- removing single points of failure at the site, where system level resilience is either not available or not cost effective to implement;
- working with farmers to encourage them to alter their activities to reduce the risk of aquifer pollution; and
- purchasing of a mobile treatment plant to address risks where the above options are not cost effectively available.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for local distribution resilience we have followed the company wide approach. We do not repeat the approach hear.

How are customers protected?

Regulatory mechanisms

We have a general duty in the Water Industry Act s37 to maintain our water supply system. In the event that the Secretary of State, via Ofwat as the enforcement authority, deem that we are contravening the Act they can take direct enforcement action under s18 of the Act.

Performance Commitments

Customers will also be protected through the following performance commitments:

- G01 – Water Supply Interruptions – financial underperformance penalties apply
- G04 – Mains bursts – financial underperformance penalties apply
- H02 – Water Quality Complaints – financial underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.4. Drinking water quality business case

Business case	Drinking Water Quality
AMP7 enhancement Capex	£34m
AMP7 enhancement Opex	£26.8
Price control	Water Resources Water Network +
Ofwat enhancement cost drivers	Table WS2, Line 13: Investment to address raw water deterioration (THM, nitrates, Crypto, pesticides, others)
Sensitive performance commitments	Water Quality Compliance (CRI),

Business case	Drinking Water Quality
	Water Quality Complaints, Farming for Water

What is driving the need for this enhancement investment?

Our research consistently shows that delivering safe drinking water is our customers' highest priority and a fundamental part of their core expectations of us. Anything which alters their perception of the safety of their drinking water will drive dissatisfaction. Our customers expect us to be able to deliver a good quality and consistent product every time they require it. In research conducted with customers on our online community, we found that 56% of respondents are very concerned or sometimes concerned about the quality of their tap water.

Our customers' needs are also reflected in the framework of statute and regulation created to protect them. Our statutory obligations are set out in the Water Supply (Water Quality) Regulations 2016. They require drinking water to be 'wholesome' – as defined by standards for a wide range of substances, micro-organisms and properties of water. The Drinking Water Inspectorate (DWI) is the statutory enforcement authority for the regulations.

The Drinking Water Quality enhancement expenditure elements of our business plan seek to address either; a deterioration in raw water quality, or a change in regulatory standards. Both are necessary in order deliver wholesome water to customers in accordance with our duties under the Water Industry Act 1991 as interpreted by the drinking water regulations. Consequently, the need for investment is determined and enforced by the Drinking Water Inspectorate. Specific investments have been identified to respond to:

I. Metaldehyde and other pesticides (primarily addressed through Catchment Management)
II. Cryptosporidium & Bacteriological risks
III. Deteriorating groundwater quality in localised areas (Nitrate, Arsenic, Selenium, Sodium/Taste & Odour).

The investment either, relates to specific schemes supported by DWI through final decision letters, or is subject to DWI undertakings already in place.

Metaldehyde and Pesticides

We currently have DWI Undertakings in place to address non-compliance with standards for pesticides (including metaldehyde, clopyralid, carbetamide and propyzamide), many of which are not easily removed by existing water treatment processes.

In March 2018, the DWI confirmed that our Undertaking will be extended until 2025. This followed confirmation of Defra's intention to consult on a targeted ban on metaldehyde use. The DWI will provide guidance on revised undertakings when Ministers provide more information on the potential use and extent of a targeted ban.

A failure to invest would lead to on-going non-compliance and elevate the risk place on customers. This will increase the risk of escalating regulatory enforcement and statutory prosecutions, impact on the CRI, and add pressure to future treatment costs.

Cryptosporidium & Bacteriological risks

In its Final Decision Letters, the DWI have supported nine UV plant schemes for inclusion in our enhancement plan. These are for sites where existing treatment and mitigating actions are not appropriate given our increasing understanding of the cryptosporidium and microbiological risks identified through our DWSPs and Catchment Risk Assessments.

We have a large proportion of groundwater sites that were historically classed as low risk and therefore have the minimum level of disinfection (marginal chlorination). At PR14, we set out a phased / strategic approach to addressing these risks. Enhancements are scheduled to be implemented at 23 sites in AMP6. The AMP7 programme of nine UV disinfection plants, is a continuation of this approach. It will allow us to deliver our strategy of moving away from marginal disinfection, as has been the industry approach.

Groundwater quality deterioration

The DWI have endorsed or provided final decision letters for the following specific enhancement schemes for localised issues at some of our groundwater sites.

- Two nitrate schemes where rising nitrate concentration is predicted to exceed legal limits by AMP8. Potential catchment solutions have been investigated but considered inappropriate given the nature of the aquifer and estimated nitrate plume travel times.
- Treatment solutions at one site where rising concentrations of Arsenic are likely to lead to be in exceedance of legal limits in AMP8 or potentially sooner.
- Blending solutions at two sites where rising concentrations of Arsenic and Selenium are likely to be approaching legal limits in AMP8 or potentially sooner.
- A treatment scheme to address naturally high levels of Sodium, Chloride and Sulphate at one site following a marked step change in regulatory taste and odour failures since 2012.

How have we made sure that we are delivering the best option for customers?

When developing Drinking Water Quality enhancement schemes we have followed the process set out in the DWI's long term planning guidance (DWI Information Letter 03/2017). In seeking technical support for our new improvement schemes, the Inspectorate required us to demonstrate the need for each proposal and that the risk is significant enough to take action at this time.

This has included identifying and evidencing the following.

- The most appropriate technical and cost effective options to mitigate each named hazard and thereby achieve compliance with the regulatory requirements.
- Robust capital costs and the net additional operating costs, as part of the overall total expenditure (totex), of each of the options considered.
- The preferred option and the rationale for choosing that option and reasons for discounting all other possible options.
- That the preferred option will adequately mitigate the risk and deliver the required outcome within an appropriate timescale, and that the solution is sustainable, and improves resilience.

We are confident that adherence to this process will deliver a cost effective programme that delivers against both our customers' expectations and our regulatory obligations. On 22nd June 2018 the DWI confirmed their support for 14 of our schemes with formal Regulation 28 notices. The 15th scheme, a blending solution for arsenic, was commended to support with no legal instrument.

Metaldehyde and Pesticides

Our customers have told us that we should focus on maintaining the high standards of general water quality and using catchment management to improve raw water quality where possible whilst mitigating the risk of it not being effective. In line with DWI guidance, the continuation and enhancement of our AMP6 catchment management activity will be our first choice solution to tackle pollution issues. We are confident that this will reduce the number of drinking water failures and minimise or delay high cost future treatment interventions. Our experience of catchment management in AMP6 has helped us to understand its potential, learn how to make it a success, and ensure that customers are protected from the risks associated with this behavioural based method of protecting raw water sources.

Whilst our AMP6 approach has focussed on understanding how to successfully engage with the farming community, the approach in AMP7 will look at measurable changes in the quality of raw water within the catchments that are a priority. We are targeting demonstrable improvements in raw water quality in 16 catchments.

Cryptosporidium & Bacteriological risks

This programme is a continuation of an approach started in AMP6. Consequently the selection of sites has been identified from our DWSP and catchment risk assessments subsequent to the delivery of our AMP6 programme.

We have considered a range of possible solutions:

- A treatment process consisting of Ultrafiltration membranes – Super-chlorination – De-chlorination has been shown to provide effective risk mitigation for Cryptosporidium and bacteriological hazards however the whole life cost of this two stage process is greater than an alternative treatment option.
- UV disinfection treatment with marginal chlorination
- Abandonment - Five of the nine identified sites within the programme are categorised as being of the highest criticality for supply to customers. This is defined as 20,000 or more people are dependent on the source to balance supply and demand. Abandonment would change our baseline planning assumptions, and could create new localised supply shortfalls over and above the material deficit challenges already being addressed in our Water Resource Management Plan (WRMP). Consequently, we do not consider a source abandonment option relative to the deployment of UV treatment to be tenable or economic.

In all cases the option of UV disinfection with marginal chlorination was considered the most cost-effective solution.

Groundwater quality deterioration

For locations identified for a nitrate intervention, as well as one of the two identified for arsenic intervention, we have considered a range of options; management through the catchment, nitrate treatment and blending. We have considered the effectiveness of each process, intervention costs, additional benefits and the time lag before the benefit will be delivered.

- Catchment Management can be an effective option for nitrate risk mitigation and we are discussing the suitability for catchment investigations in AMP7 through the Environment Agency's National Environment Programme (NEP). However, even if the investigation outcomes indicate a viable catchment solution, there is likely to be a substantial travel time lag from time of implementation to realising the benefits at the source. Our prior experience suggests that, in our Permo-Triassic sandstone aquifers, such lags are likely to persist for a number of decades. This means that the benefits would not be seen until after the predicted failure dates. Catchment management is not feasible for Arsenic risk mitigation, as the risk is a function of the underlying geology rather than land use.

- Nitrate and Arsenic treatment plants have been assessed as a sustainable solution to mitigate increasing nitrate and Arsenic risks. However, the whole life cost of this option is higher than the blending option for these sites. This is because it produces a waste stream that must be processed.
- Abandonment was considered but rejected as discussed previously on basis that this would impact on our baseline supply demand planning assumptions.
- Blending is our preferred option; it has a life expectancy of at least 10 years from commissioning and the whole life cost of this option is lower compared to treatment. We also consider that blending solutions will improve asset connectivity and therefore deliver additional resilience benefit.

Where blending and catchment solutions are not feasible to reduce arsenic as the risk is a function of the underlying geology rather than land use, and blending options have been exhausted, a treatment solution is the selected option.

Regarding the location identified for intervention due to selenium risk, there is no currently available treatment solution and the only plausible and cost effective option is blending. Catchment solutions are not feasible as the risk is a function of the underlying geology rather than land use.

We have considered four options for the site that has been identified for interventions based on taste and odour risk.

- Blending has currently been discounted as it would require additional 3.7ML/D from a local surface WTW. This would put further pressure on supplies during periods of high demand, thus impacting our water resources planning and not making use of an already environmentally sustainable source.
- Ion Exchange treatment is a potential innovative solution. However, further research and development would be required to establish suitability of an Ion exchange process for the removal of the Sodium and Chloride believed to be causing taste and odour failures.
- Abandonment of site has discounted due to the impact on our baseline supply demand assumptions as set out earlier.
- Reverse Osmosis/membrane Treatment is our preferred option. This is proven to be effective in removing sodium and chloride salts, and would provide our customers with a blend of water more similar in nature to other local sources. This would therefore likely reduce customer contacts as well as regulatory failures.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for drinking water quality we have followed the company wide approach. Below we note some specific comments relating to catchment management and treatment interventions.

Catchment management interventions
We have used our existing catchment management work as the basis for costs in this business plan. Expenditure is built up from a number of components:

I. Monitoring and staff: Sampling and laboratory costs are based on our experience to date.
II. Advice: includes engagement costs for a demonstration farm including a farm trial in each catchment
III. Subsidies to use an alternative product: Based on cost difference between metaldehyde and the replacement product).

Our schemes are designed so that we only fund 50% of any farm infrastructure or product substitution costs, with the farmer providing the match funding. This ensures we have a long term buy in from the farmer and also the desired behavioural change needed to deliver water quality improvements as well as ensuring greater value for our customers. Benchmarking against other water companies shows that the scale of our ambition is greater than many of the other water companies and, by guaranteeing the farmer contribution, our unit costs are lower.

Treatment

All schemes have been costed following our company wide approach to cost estimating. Our cost estimates for these are based on the lean delivery approach we set up for AMP6, which we have worked up with our supply chain. Our vision is to outperform our efficiency challenge and to do this through a Factory Thinking approach, focussed on improving our productivity, our procurement and our planning. This has proved effective in AMP6 and will be carried forward to our AMP7 delivery.

We have gained experience in AMP6 of delivering 23 new UV plants efficiently. To do this we challenged standards and sought productive efficiencies through batching and planning for teams to move from site to site so lessons learnt could be embedded and enabling works could be reused. We have also significantly increased the use of factory built assemblies and sought collaborative and coordinated delivery across tier 1 and tier 2 suppliers.

How are customers protected?

Regulatory mechanisms

A failure to deliver our drinking water quality obligations will lead to enforcement proceedings as set out in the Water Industry Act s68 and Drinking Water Quality regulations. Compliance with the Acts is enforced by the Secretary of State through the Drinking Water Inspectorate which have the power to prosecute and enforce regulatory undertakings or administer fines.

Performance Commitments

Customers will also be protected through the following performance commitments:

- H01 – Water Quality Compliance (CRI)
- H02 – Water Quality Complaints – financial underperformance penalties apply
- H03 – Farming for Water – financial underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

[REDACTED]

8.4.5. Lead enhancement business case.

Business case	Lead
AMP7 enhancement Capex	£16.4m
AMP7 enhancement Opex	£0.4m
Price control	Water Network +
Ofwat enhancement cost driver	Table WS2, Line 6: Meeting lead standards
Sensitive performance commitment	Water Quality Compliance (CRI), Protecting our schools from Lead

What is driving the need for this enhancement investment?

Lead pipes were widely used until the 1970s for both the water pipes owned by companies up to the boundaries of customers' properties (communication pipes) and customer owned supply pipes on their side of the property boundary. Lead pipes can be expensive to replace and customers are often unwilling or unable to spend the money to replace them. The required maximum lead concentration at the customers tap was reduced from 25µg/l to 10µg/l under through Water Supply (Water Quality) Regulations 2016. The regulatory change has been mirrored by the increasing societal pressure to do more on removing lead from the network.

This increased service requirement creates the need for enhancement expenditure.

Exposure to lead through drinking water is a public health hazard, particularly for children. Recent, high profile reports of lead in drinking water (notably in Flint, Michigan, USA) have led to an increased awareness of this public health hazard. In research conducted through our online forum, Tap Chat, we found that 79% of customers are aware of lead pipes and of these just over half are concerned about it.

The DWI requires us to keep our lead risk assessments under constant review, and identify an appropriate integrated package of measures to mitigate any risks identified (as listed below).

- Risk assessing supply zones in terms of customer exposure to lead in water supplies.
- Enhancing plumbosolvency control measures at treatment works.
- Replacing lead communications pipe and consideration of the benefits of replacement of the consumer service pipe. The regulations state that we must replace or reline lead communication pipe where the standard of 10µg/l is not met.
- Working with local authorities and health protection teams to identify vulnerable consumers, and to identify appropriate solutions, including the replacement of lead pipes in public buildings, schools and nurseries.
- Implementing a communications and education strategy to make consumers, and other stakeholders, aware of the risk of lead in tap water, what can be done to mitigate the risk, and who has responsibility for lead pipes.

The move to a 10µg/l this AMP has been seen through increased plumbosolvency at treatment works and through targeted communication pipe replacement where failures persist after a treatment solution has been implemented.

In response to the tightening of the regulations, our implementation strategy is to proactively deliver 95% compliance with the 10µg/l lead standard in all Water Quality Zones (WQZs). We are currently operating at or above this target in 187 out of the 191 WQZs (with 114 achieving 100% compliance). Therefore, we consider that our strategy is working well. Guided by our DWSP monitoring, we do not foresee the need for further proactive treatment based (phosphate dosing) solutions in AMP7. We will continue to optimise and maintain existing phosphate dosing as part of our base expenditure programme. We consider that this will deliver complete coverage against our 95% target.

However, we will require ongoing AMP7 enhancement expenditure for lead communication pipe replacement when regulatory failures occur.

How have we made sure that we are delivering the best option for customers?

We are required to take a risk-based approach to achieve compliance with the current 10µg/l lead standard, targeting 95% compliance in all zones and 100% compliance where it is economical to do so. We have shared our plans to comply with the current regulations, including our new performance commitment, with the

Drinking Water Inspectorate in a series of PR19 meetings. This has given us confidence that our proposed business plan will deliver against our obligations and thus promote benefit for our customers.

Our strategy to date has been to proactively manage the risk of lead through treatment based mitigation (orthophosphate dosing) to ensure 95% compliance in every WQZ followed by targeted network management in higher risk areas. Whilst the AMP5 and 6 dosing programmes have been successful, we do have some first time dosing programmes due to come online within AMP7. This will lead to an additional 300,000 customers receiving orthophosphate dosing protection.

The primary network intervention we have used historically has been to remove and replace the lead communication pipe with a preferred material such as MDPE or barrier pipe. However, we are now exploring how these tried and tested methods can be supplemented by innovative lining alternatives. Such techniques have received support from the DWI in their latest guidance. We are confident that a programme that optimises lining and renewal interventions will improve programme efficiency at the same time as offering the same level of customer protection. We will be incorporating lead lining into our AMP7 tool box to maximise customer protection where this is cost-beneficial and appropriate to do so.

We also strongly believe that our AMP7 proposals will help to ready us for future changes in regulation or legislation. This should enable us to follow an adaptive pathway unlocking future efficiency and benefit for customers. The DWI has advised that there are no proposed changes in drinking water quality standards in the next five years. However, there is still a level of uncertainty regarding the long term requirements of lead enhancement expenditure:

- We are aware that the EU is currently consulting on tightening the lead standard in the Drinking Water Directive from 10ug/l to 5ug/l to be achieved within a decade. Assuming current approaches, this would be extremely costly – our initial estimate for compliance against a tighter standard would require additional phosphate dosing schemes and up to £65m of lead communication pipe replacement across 30 water quality zones.
- Ownership of supply pipes by companies could provide long-term accountability for lead compliance and ensure that a long-term strategy for lead replacement could occur in a risk based manner. Such as change would require legislation, and even if this was to transpire, it would take several decades and up to £1 billion of investment to replace what we currently estimate to be around 600,000 supply pipes. Consequently, the focus for the short/medium term needs to be on innovation, synergistic benefits from planned work on the distribution system and improved collaboration, particularly to ensure vulnerable customers are better protected.

We plan to identify and target high risk areas and consumers for lead pipe replacement, as determined by our DWSP. A key limiting factor for planning potential future programmes is the imperfect asset data records on communication and supply pipe material and location. As part of our AMP7 planning, we have created GIS based risk mapping which uses data gathered when we have replaced/separated common supply pipes, also using housing age, postcodes and water quality failures. This provides broad areas where lead is most likely to be so we can target investment and communications. Our future enhanced metering strategy will also provide an additional opportunity to record and map where lead pipes are thus improving the precision of any future lead reduction strategy.

The specific locations for our AMP7 interventions will be identified through regular compliance sampling, targeted hotspot failure areas (at street level or zonal level) as well as vulnerable locations such as schools (as highlighted in our new performance commitment). This programme will help to inform the practicalities of large scale pipe replacement programmes that may be required where more stretching or larger deployment is required in subsequent AMPs.

The AMP7 programme will also provide increased insight on:

- the general corrosion inhibition benefits from the phosphate dosing to understand if alternative treatments would be required; and
- the implications to water supply resilience if phosphate dosing ceased in target areas

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for drinking water aesthetics we have followed the company wide approach. We do not repeat the approach here.

How are customers protected?

Regulatory mechanisms
A failure to deliver our drinking water quality obligations will lead to enforcement proceedings as set out in the Water Industry Act s68 and Drinking Water Quality regulations. Compliance with the Acts is enforced by the Secretary of State through the Drinking Water Inspectorate which have the power to prosecute and enforce regulatory undertakings or administer fines.

Performance Commitments
Customers will also be protected through the following performance commitments:

- H01 – Water Quality Compliance (CRI)
- H02 – Water Quality Complaints – financial underperformance penalties apply
- H04 – Protecting our schools from lead – financial underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives.

8.4.6. Drinking water aesthetic business case

Business case	Drinking water aesthetic
AMP7 enhancement Capex	£0m
AMP7 enhancement Opex	£22.4m
Price control	Water Resources Water Network +
Ofwat enhancement cost drivers	Table WS2, Line 5: Improving taste / odour / colour
Performance commitment	Water Quality Complaints

What is driving the need for this enhancement investment?

Safe, clean drinking water is consistently one of our customers' highest priorities. In particular customers have identified that changes to the aesthetic quality of the water can undermine the trust that our customers have in the product, even if those changes do not affect the quality of the water itself. We also have direct support from customers to tackle the causes of discolouration, taste and odour complaints.

We've been worked closely with the Drinking Water Inspectorate to understand how our plan needs to respond to its guidance on long term planning for the quality of drinking water supplies. We are expected to take a source to tap approach that ensure we always meet our statutory obligations, consider inter-generational issues during planning and for containment and recovery from potential events.
We have also reviewed how the underlying geology of our region can impact on the effectiveness of the treatment processes at reducing discolouration complaints. At the request of our Water Forum we engaged expect consultants, ESI Limited, to undertake a technical review of spatial factors controlling water discolouration in England and Wales. The report was submitted to the Water Forum to provide independent verification of the issue.

Discoloration of water in public water supplies can arise from ineffective treatment of dissolved manganese or corrosion of iron water mains (amongst other things). Treatment for manganese removal from raw water can be compromised if the water is soft, and/or it has high dissolved organic carbon concentrations. Corrosion of iron mains can be promoted by low pH and soft waters.

Spatial distributions of these risk factors have been mapped and reviewed. A clear divide is seen in that the waters of the north and west of England and Wales tend to have high manganese concentrations, low hardness, higher dissolved organic carbon, and lower pH. In addition, intermittent runoff from the steep slopes of the north and west lead to more variable water quality. Higher variability can lead to more frequent breaches of drinking water standards for a given level of treatment.

The main cause of all these factors is the underlying geology - the rocks of the north and west of England and Wales are older and have been subjected to high temperatures and pressures within the Earth's crust. This has led to these rocks becoming hard; they are resistant to erosion, so the topography is steeper. Aquifer properties of these rocks can also be poor so economic levels of groundwater abstraction cannot be developed. Therefore, rainfall runs quickly off the ground surface and is captured in surface water reservoirs.

In the south and east of England the rocks are younger and have only been lightly altered. Topography is less steep, so groundwater recharge is higher, and better aquifer characteristics mean that groundwater can be exploited for public supply.

As rainfall infiltration passes through soils the pH increases, and as the resultant groundwater passes through the subsurface the water becomes more mineralised and less soft. Dissolved organic carbon may also be lost.

Hence the factors that compromise manganese treatment are lessened with residence in the subsurface. This then, favours the south and east of England as an area where manganese treatment is less likely to fail.

Geological factors also control the distribution of manganese-rich groundwater in water supply aquifers. The Permo-Triassic Sandstones of the Midlands and North West England are particularly prone to high dissolved manganese concentrations compared to other aquifers.

Notwithstanding this, we are seeking to enhance the level of service we provide to our customers in AMP7 by continuing to drive down the levels of dissatisfaction with our product. There are a number of new challenges we will face in the future over and above those experienced in AMP6 which will require additional investment. Namely these are:

- Increased work in catchments to drive down the level of metaldehyde at source
- Localised changes in water source due to the operation of the new source at Frankley to allow maintenance of the Elan Valley Aqueduct

In order to deliver further improvements in the level of service, as well as meet the expectations of the DWI, we need to take a multi-track approach. This will include working at source to tackle raw water issues, a sustained increase in the number of District Metered Areas (DMAs) that we routinely flush on an annual basis and improved customer communications and education. This has a direct increase in resource requirements in both staff costs and the additional water required to flush the system. This increase in activity is over and above the levels required in previous AMPs to deliver equivalent performance.

How have we made sure that we are delivering the best option for customers?

Our source to tap approach means that we have considered interventions across all business units and services that could deliver the improvements. This includes schemes to install new treatment processes to remove manganese and iron, or high valve trunk mains cleaning in our more densely populated areas.
The table below summarises the four key elements of our approach: stop, remove, prevent and inform.

STOP: Removal at Source	REMOVE: Prevent Accumulation	PREVENT: Minimise Disturbance	INFORM: Customer – predict and prevent
• Control WTWs performance to limit iron and manganese input and control pH corrosivity • Replacement of unlined iron mains experiencing low flow conditions	• Management of flows to prevent deposition through appropriate network design • Prevent/remove accumulation in trunk mains and distribution mains • Removal of discolouration material through mains cleaning and localised flushing	• Minimise disturbance in the network that can trigger discoloration events • Preventing bursts and leaks • Sensitive valve operations • Jobs on the network	• To better predict to customer complaints though data insight & network modelling • prevent complaints by proactively engaging and educate our customers

Stop

We are increasing our focus onto optimising WTWs for discoloration/aesthetics particularly at our Western and Northern works of [REDACTED] The trials we have undertaken using low manganese content lime suggest that wider scale use of these processes could reduce discolouration in areas where we receive over 40% of the total number of complaints. This could be done without the need for expensive second stage treatment processes being installed at a cost of over £30m. Our proposals for AMP7 take this trial technology and implement it on a wider scale across 20 of our main water treatment sites.

Remove
Expansion of our programme to line or replace old cast iron mains which have been linked to either discolouration and taste complaints or regulatory failures. Whilst replacement is a more permanent solution, slip lining is a much more cost effective approach and ensures we can deal with more of the problematic mains within the cost allowance. Replacement is then focussed where slip lining is not possible or the structural integrity of the pipe suggests a full replacement is required.

Alongside this our programme of mains flushing will help reduce the build-up of sediment in the network which can become disturbed leading to discolouration issues.

Prevent
Our plan includes innovative dynamic flow control valves to allow flow conditioning at key trunk mains in our Central/Birmingham area which accounts for almost 40% of our discoloration complaints. Feasibility studies have shown that the automated systems with actuated valves allow:

- Automatic flushing programmes
- Automatic rezoning capabilities
- Cost effective trunk main conditioning
- A more open and flexible network system without DMS leakage disbenefits.

We have been working on an innovative approach to pressure transients with Imperial College, where we can now monitor short-lived pressure spikes which cause bursts and consequently discoloration. An initial trial showed a potential reduction in bursts rates of up to 70%. This technology is still being developed but an application has been submitted for UK patent on transient surge elimination.

Inform
In order to inform our customers about potential issues we have improved our proactive text messaging capabilities – those customers who opt in will receive alerts when problems on the network could impact on their water quality aesthetics. At the same time quick fix ideas are provided to them, as well as on our website and social media, to give them advice on what to do.

To support this we have remodelled our network to run scenarios following simulated large bore pipe failures – this looks at the impact on water availability, pressure and aesthetic quality to trigger the proactive message system.

Birmingham Resilience Programme Impacts
In AMP7 we will begin our programme of shut downs and maintenance of the Elan Valley aqueduct utilising our new source from the river Severn to supply customers. We know this will lead to short term changes in water aesthetics which could lead to customer concerns about quality and potential complaints. We've been working with our customers to understand the appropriate blending ratios that limit the changes in taste, communicating the importance of the work in advance and will focus on proactive communication to those impacted during AMP7 before and during shutdowns.

Source to Tap
The above examples demonstrate that there is no single solution to the issue and that a combination of treatment, prevention, operational stability and education is required to really drive down the number of water quality aesthetic issues.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for drinking water aesthetics we have followed the company wide approach. We do not repeat the approach here.

How are customers protected?

Regulatory mechanisms
Water Industry Act s68 – duty to provide wholesome water as enforced by the Secretary of State through the Drinking Water Inspectorate
Water Supply (Water Quality) Regulations 2016 – enforced by the Drinking Water Inspectorate

Performance Commitments

- H01 – Compliance risk index – regulated by the Drinking Water Inspectorate
- H02 – Water quality complaints – direct financial implications for underperformance.

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.7. Environmental enhancements (WINEP and biodiversity) business case

This business case sets out investment needed to deliver against environmental commitments not already addressed in the Supply Demand Balance cost adjustment case. It should cover all water service enhancement expenditure that delivers environmental performance improvements outside of that designed to protect against or respond to future abstraction reductions (as per our WRMP planning). This expenditure is allocated to lines 1 to 3 in business plan table WS2. It does not account for expenditure allocated to line 17-20, as these are covered by the interventions proposed in the Supply Demand Balance adjustment case.

We also discuss the potential for delivering further bio-diversity improvements beyond our statutory and regulatory requirements. Whilst no expenditure for this additional activity is included in our business plan (or this business case), we have identified a significant customer willingness to pay for such enhancements. Therefore, we have developed an ODI to enable additional benefits to be delivered for customers where it is economic to do so.

Business case	Water service environmental improvements (WINEP and biodiversity)
AMP7 enhancement Capex	£10.9m
AMP7 enhancement Opex	£7.5
Price control	Water Resources Water Network +
Ofwat enhancement cost drivers	Table WS2, Line 1: WINEP/NEP Making ecological improvements at abstractions Table WS2, Line 2: WINEP / NEP Eels Regulations (measures at intakes) Table WS2, Line 3: WINEP / NEP Invasive non-native species
Sensitive performance commitment	C03 – Biodiversity

What is driving the need for this enhancement investment?

The investment identified in this business case covers a subset of the schemes named in the statutory Water Industry National Environment Programme (WINEP). Those that have been identified here do not directly impact on the balancing of future supply and demand. They are underpinned by a range of environmental obligations. These are discussed in turn. In each case, the identified expenditure is driven by sequential implementation of environmental obligations as governed by the WINEP process which is managed by the EA and confirmed by the Secretary of State. The investments are in addition to previous expectations and therefore enhance the level of service that we will deliver to the environment in AMP7.

The Eels (England and Wales) Regulations 2009
The regulation sets a requirement to screen abstractions and outfalls to prevent the entrainment of eels and salmon. In AMP6 we will largely address the obligation through the PR14 National Environment Programme to deliver eel protection works at 'High priority' intake sites by 2021. In AMP7 we will complete the final year of programme to address high priority intake sites as well as deliver a new scheme at our Chester intake on the River Dee, which was included in the PR19 WINEP for Dee Valley Water. EA PR19 guidance for medium or low priority sites states that interventions should be should be undertaken if capital works or maintenance are planned in AMP7. A notional level of investment based on AMP6 activity has been allowed for in the plan for this purpose.

EU Invasive Alien Species (IAS) Regulation 2014 and GB Non Native Species Strategy
The regulation sets a requirement to investigate and guard against the movement of invasive species at water transfer assets. Invasive, non-native species (INNS) is a new WINEP commitment for PR19. While Invasive species control works is already undertaken when required through our operational maintenance, the requirement for PR19 is to understand the pathways of spread from our business activities - in particular raw water transfers. Investigations at 10 strategic assets are listed in WINEP as well as companywide pathways assessment, and included in the AMP7 business plan. Each will entail an investigation and options appraisal, followed by the implementation of any small scale mitigations identified. Investment of any larger scale mitigation measures required at our transfer assets will be delivered in AMP8 following the outcome of the investigation and options appraisal.

Environmental permitting regulations
The regulations set out a requirement for MCERTs certified discharge flow monitoring to be installed at identified Water Treatment Works. This is to allow for the monitoring of discharge consent compliance from water treatment processes. The activity identified for AMP7 is to install 9 MCERTS compliant flow meters at WTW discharge points and is a small component of the investment in this business case.
Natural Environment and Rural Communities Act 2006

This legislation requires us to have regard to conserving biodiversity as part of our policy or decision making. WINEP specifically sets out a requirement to develop a Biodiversity action plan including the audit, protection and restoration of associated species and habitats. Our existing AMP6 biodiversity programme is limited to interventions that impact Sites of Special Scientific Interest (SSSIs) & Special Areas of Conservation (SAC) sites we are responsible for. We are on track to deliver 585 hectares of SSSI in 'favourable' condition – outperforming our AMP6 target of 409 hectares.

For AMP7, the scope of the requirements has been expanded to include biodiversity enhancements on both land we own and third party's land. It will also protect, restore and enhance any species and habitats identified in the NERC Act. It also sets an expectation to support partnership projects and where appropriate work on 3rd party land which aim to enhance and protect biodiversity species and habitats in catchments where the water company operates. We are required to prevent deterioration of species populations and habitats, or make provision for offsetting deterioration through replacement habitat creation.

By the end of AMP7 we will have enhanced the biodiversity potential of an additional 1090 hectares of land - giving a total of 1675 hectares in favourable condition. The enhancement will be delivered either at the remaining SSSI sites which we own but are not currently in a favourable condition for biodiversity (23 hectares) or through interventions as set out in the WINEP. Interventions will be underpinned by required site biodiversity action plans. We are also committing to maintain the benefit already generated in AMP6; however, this will be accounted for in our maintenance, rather than enhancement, plan.

How have we made sure that we are delivering the best option for customers?

The investment proposed in this business case is identified in WINEP and derived from a range of associated legislation or regulations. We are obliged to deliver them in order to meet the expectations of our regulator. However we a confident that environmental improvement and biodiversity investment is strongly supported by our customers.

We have conducted both quantitative and deliberative research with our customers into the wider basis for biodiversity expenditure. This quantitative and deliberative research reveals that they would like to see a more stretching approach to improving biodiversity. Customers acknowledged the importance of the issue and the recognised the wider environmental benefits that would accrue; such as regulation of our climate, purification of water resources and pollination of crops. Through challenges from the Water Forum and Natural England, we have also extended the scope included within our proposed plan and subsequently identified in WINEP.

The customer research revealed a WTP figure of £6,205 and £3,267 per hectare per annum. We estimate that the marginal cost of enhancing a hectare for biodiversity is in the range of £4,760 to £3,035 per hectare per annum. This gives confidence that the basis and scope of the programme we have included in our plan is supported by customers, and that there may still be opportunities to go further still. To facilitate this ambition, we have developed an outcome delivery inventive so that we can act where the delivery of further benefit would be economic and valued. Following triangulation with comparable proposals, the value of land and the costs of improving it, we have concluded that the lower incentive rate will offer a sufficient incentive and deliver value for money.

In most cases the breadth of possible interventions is limited as the location and specification may already specified. Therefore, when developing the programme to satisfy the required scope, we have been able to make use of the work that we have already undertaken. Consequently, we consider that the interventions proposed are robust and optimal for customers. Our approach for scoping each part of the programme is set out briefly below.

- The Eel Regulation interventions are largely to conclude NEP5 programme that is being delivered in AMP6. Therefore, we have specified the interventions as per the current programme. The Chester intake scheme listed in Dee Valley WINEP budget has been specified following an AMP6 investigation which identified the best practice screening measures. The scheme is cost beneficial based on EA's CBA methodology.
- The INNS driven activity in AMP7 will entail site investigation and options appraisals. Whilst we have not undertaken this type of investigation before (as it is a new obligation in WINEP), the specification of these investigations has been based on NEP water resource environmental investigations undertaken in AMP6. We consider that this assumption is appropriate given the common activities

anticipated, for example, collection of environmental information, assessment of risk and/or impact and appraisal of options.

- Whilst MCERTS gauges are have not been previously installed at WTWs, we have installed several MCERTS compliant flow gauges at wastewater treatment works in previous AMPs. The AMP7 specification for installation at WTWs has been based our previous wastewater interventions.
- We have been able to use our AMP6 biodiversity investment to inform the proposed AMP7 NERC driven programme. The interventions will be implemented subject to independent expert corroboration and partnership with bodies such as Natural England and local Wildlife or Rivers Trusts. Changes to management practices on land that we don't own will delivered through partnership working with the agricultural community. This will be limited to a predefined set of qualifying measures that will be agreed with Natural England. Validation that the agreed interventions have been implemented will be through our catchment team's inspections.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for drinking water aesthetics we have followed the company wide approach. All the schemes have been costed from bottom up based on project estimates, based on previous AMP budgets.

How are customers protected?

Regulatory Mechanisms
A failure to deliver the requirements set out in WINEP will lead regulatory intervention from the Environment Agency. It would affect our EPA score and might lead to regulatory failures and prosecutions.

Performance Commitments
Customers will also be protected through the following performance commitments. ODI penalty functions will be activated if the anticipated benefits that interventions set out to deliver do not materialise:

- C02 – Improvements to WFD criteria – Financial underperformance penalties apply
- C03 – Biodiversity (Water) – Financial underperformance penalties apply
- C04 – Biodiversity (Waste) – Financial underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.8. Low pressure business case

Business case	Low Pressure
AMP7 enhancement Capex	£10.1m
AMP7 enhancement Opex	Nil
Price control	Water Network +
Ofwat enhancement cost drivers	Table WS2, Line 4: Addressing low pressure
Sensitive performance commitment	Customers suffering from persistent low pressure Resolving low pressure complaints

What is driving the need for this enhancement investment?

Customer expectation to go beyond a UQ level of performance
We are obligated to deliver water to the customer's tap at a defined level of pressure. In comparison to the rest of the industry, performance in 2017/18 showed we are performing well with 0.57 properties per 10,000 below the minimum standard compared to an average of 1.64 properties per 10,000. However, as exposed through our research, our customers are highlighting that it remains a key issue were we need to do more. Indeed, it was identified as the most experienced service failure for our customers.

Low pressure, or changes in pressure, is an emotive issue which can create significant customer dissatisfaction. Social media interactions back up our customer research showing poor pressure can be a major cause of dissatisfaction and cause disruption to our customer's lives. Customers tell us that even short term pressure issues disrupt their lives and drive dissatisfaction. It is clear that the duration and persistence of low pressure can significantly affect the extent to which customers are impacted and inform how best to respond.

We consider that there is an opportunity to go beyond our existing obligations. This will ensure that customers that suffer from chronic and other atypical low pressure issues are appropriately considered and valued when identifying how and where to intervene when managing low pressure performance. This should closer align the wider level of service we offer with customers' expectations on pressure performance

Limitations of current metric to deliver in accordance with customer expectation
The current low pressure performance commitment relates to ensuring that the number of properties on the low pressure register is below a defined level at the end of the report year. The current commitment is 250 properties as informed by previous regulatory serviceability requirements. Properties are added to the register when they receive, and are likely to continue to receive, low pressure for more than five days in a rolling 12 month window. Low pressure is defined as being below the 15mHd reference level.

It is becoming clear that adding properties on the low pressure register does not necessarily identify or differentiate the full range of pressure issues experienced by customers. Atypical low pressure impacts can vary from properties that are only affected during extreme demand to those that continually receive a lower level of service. These will not necessarily trigger addition onto the register or expose the full extent of customer impact when identifying programmes to mitigate it.

From the feedback we have from customers, there is a clear message that we need to do more to substantively address the full range of low pressure issues that customers may suffer. These include delivering for those customers experiencing chronic pressure issues and improving our communication and customer engagement during more short term transient pressure issues.

How have we made sure that we are delivering the best option for customers?

Making sure that our Performance commitment matches our customers' expectations and delivers for those that are impacted the most
Historically the low pressure measure (DG2) benefited large numbers of customers who suffered occasional poor pressure rather than those who have long standing pressure issues. This is because the number of incidences of poor pressure is not included as part of the measure once the DG2 trigger had been met.

We are proposing to enhance the service that we offer by changing the way that we identify and consider the impact of low pressure. We are moving from a commitment that is sensitive to protecting properties to one that considers the number of property days solved. We will identify properties on a low pressure register as previously (increased to 25 days of low pressure in any rolling five year period). The baseline and performance commitment will then consider the total number of days of low pressure suffered by properties on the register. This places increased focus on properties that suffer chronic low pressure where interventions may otherwise be not economic if considered on a property removed basis.

The baseline has been set equivalent to our current committed level of service (i.e. the number of property days that currently correspond to properties on the register). We are then committing to reduce the current performance by 20% in AMP7 rather than retain current levels. This will reduce that number days that customers suffer from low pressure from 24,500 to 20,825 by 2025. In line with customer expectations, this will enhance both the company wide level of service currently delivered, and provide greater focus on those properties that have the largest service impact. This should deliver much fairer levels of service to the wider customer base.

Ensuring that the programme of interventions can optimally deliver the required level of performance
Poor pressure can be caused by a number of reasons, these need to be understood to ensure that the proposed solution is appropriate and sustainable. We have a number of potential interventions to resolve typical, transient (i.e. non chronic) low pressure performance. For each potential intervention, a full cost benefit assessment is undertaken to identify the optimal solution once the locations are place on the register and cause is understood. These include but are not limited to:

- installation local service booster stations;
- renewal of lengths of pipework to allow those areas suffering poor pressure to be rezoned onto other areas;
- upsizing of pipework that is causing poor pressures due to high head-loss at peak demands; or
- optimisation of existing network assets and operations.

We are continually seeking innovative ways of delivering low pressure interventions. Our new performance commitment will likely lead to a change in the type of interventions we need to deploy. In anticipation, new solution that dramatically reduces the cost to address chronic issues affecting small numbers of customers has been identified. These are small cut in pumps that will be able to locally lift the level of service above the required reference level. They will prove to be very important in AMP7 as they will allow to address issues that are only impact a limited number of properties that previously would have been considered not cost effective enough to resolve.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for drinking water aesthetics we have followed the company wide approach.

The programme expenditure is derived from our current cost for low pressure intervention schemes currently being delivered in AMP6 and the marginal costs that will be required to deliver substantive solutions for the properties that suffer from low pressure that we know will not be addressed through the current performance commitment.

We have worked hard to lower the unit cost of capital low pressure interventions. This is evidenced by our work to deliver innovative solutions for isolated properties that suffer long term chronic low pressure performance. This has led to a reduction in cost unit cost of 30%. However, despite these improvements, programme costs are projected to increase because of a reduction in the percentage of impacted properties that can be resolved with low cost operational interventions and the rising complexity of capital solutions.

The added complexity of delivering low pressure mitigation is being driven by the fact that we have solved the majority of low pressure issues. Consequently, we are now embarking on a program to resolve increasingly difficult, costly and complex schemes so that we can deliver a more consistent level of service to all our customers regardless of geography.

How are customers protected?

Regulatory Mechanism
Water Industry Act s38 allows the Secretary of State to take enforcement action against undertakers the fail to deliver defined standards or performance.

Our Code of Practice ensures that customers who receive less than 7 meters head pressure for more than one hour twice within 28 consecutive days under normal operating conditions receive a compensation payment under our Guaranteed Standards of Service scheme.

Performance Commitments

- G08 – Persistent low pressure: underperformance penalties apply
- G11 – Resolution of low pressure complaints: underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.9. Developer services business case

Business case	Developer Services and Network Reinforcement
AMP7 enhancement Capex	Net £146m (Gross £258m)
AMP7 enhancement Opex	£0
Price control	Water Network+ (100%)
Ofwat cost drivers	Table WS2, Lines 11, 12
Sensitive performance commitment	N/A

What is driving the need for this enhancement investment?

We have a duty under the Water Industry Act 1991 (s37) and our water supply licence to ensure that our raw water resources, treatment processes and distribution network is capable of meeting the demand for water. As part of discharging this duty we need to ensure that we can provide a connection point for new properties, that there is sufficient water to supply these properties and that there is no detriment caused to existing connected properties as a result.

The investment that we make in doing this is broadly split into 2 areas:

- The on-site work of laying new water mains and providing a connection to the existing network (that may involve the requisition of a new connection main) as well as any cost incurred in adopting new mains that have been built.

- The off-site work to reinforce the existing network to ensure there is sufficient supply to cope with the increased demand.

This is an enhancement investment because it is creating new assets, or assets with additional capacity that leads to us being able to serve additional customers.
We are legally required to invest in the on-site works to connect the new development to our existing network as this is a statutory duty.

There is some degree of optionality around how and when we reinforce our network to ensure new customers can be supplied without detriment to existing customers. However, not investing in network reinforcement would result in deteriorating supply interruption and low pressure performance due to demand exceeding supply constraints. Supply interruptions and low pressure are both a high priority for our customers and stakeholders with preferences for improvement. Any deterioration would be unacceptable to them.

We submitted a modelling adjustment claim to Ofwat in May 2018 relating to the water service developer services costs. We submitted the claim as we believe the data used by Ofwat in its initial cost models was inconsistent between companies, with the result that the modelled allowance does not allow for the appropriate spend. We believe this is due to the complexity of developer services costs and income resulting in different interpretations of the reporting guidelines, leading to differences in the input data provided to Ofwat. We also note that Severn Trent has one of the largest volumes of new connections in the industry and therefore we are effected more significantly in relation to this cost.

The changes to the charging rules for English companies which are being brought in over the next two years, also add to the complexity of the input data, as past data may look very different to that for the future. As the changes to the charging rules are implemented companies will be working on projects and collecting income under both the old and the new charging regimes for most of AMP7. We also note that these changes do not currently apply in Wales creating further differences across the industry and making any cost modelling more difficult.

Finally, the level of infrastructure network reinforcement cost could vary significantly between companies depending on the spare capacity in the existing network, local planning policy and the level of engagement between companies and developers in each region.
We set out below how the costs and income from the relevant data tables (App28 and WS2) interact to assist Ofwat in its approach to modelling these costs and incomes across the industry. We hope that this additional data collected will enable more robust cost modelling, but our claim is referenced against the models published in early 2018.

Firstly we look at the costs included in the plan:

WS2			20/21	21/22	22/23	23/24	24/25	*AMP7*
11	New developments	£m	38.8	40.8	38.0	33.9	33.3	**184.8**
12	New connections element of new development (CPs, meters)	£m	13.3	14.2	15.0	15.3	15.5	**73.4**
	Total Developer services capex	**£m**	**52.1**	**55.0**	**53.0**	**49.2**	**48.8**	**258.2**

The total capital costs forecast in our plan as shown above are £258.2 in AMP7. This is in contrast to Ofwat's published model for gross costs which suggested an allowance for Severn Trent of £110-£140m.

By using the data on App28, the 'new developments' line above can be split between onsite costs (Requisitions and asset value payments) and infrastructure network reinforcement (offsite costs).

			20/21	21/22	22/23	23/24	24/25	AMP7
6 (App28)	*Total infrastructure network reinforcement expenditure for new water connections*	*£m*	*12.2*	*15.6*	*16.2*	*13.0*	*13.3*	***70.3***
	Requisitions costs	*£m*	*16.9*	*18.1*	*19.2*	*19.6*	*20.0*	***93.9***
	Asset Value Payments	*£m*	*9.6*	*7.1*	*2.6*	*1.3*	*0.0*	***20.6***
	Total (as per WS2)	***£m***	***38.7***	***40.8***	***38.0***	***33.9***	***33.3***	***184.8***

Historically the onsite new development costs include Asset Value Payments (AVPs). These AVP will no longer apply for any sites where the application is approved after 31 March 2020. However, AVPs will still be made on sites approved before 31 March 2020. Currently AVPs make up approximately 40% of our onsite 'new development' costs as reported in WS2, but we anticipate this will reduce to nil by the end of AMP7.

Secondly we look at the income streams shown on App28
The total grants and contributions include three developer services income streams (in bold below) which relate to the enhancement spend above. None of the other income shown on App28 relates to the developer services enhancement capex included on WS2.

The diversions income and "other contributions" offset against IRE (infrastructure renewals expenditure), and MNI (maintenance non infrastructure) spending and are not related to developer services enhancement capex costs.

	Grants and contributions		20/21	21/22	22/23	23/24	24/25	AMP7
7	**Connection charges (s45)**	**£m**	**9.6**	**10.7**	**11.2**	**11.6**	**11.7**	**54.8**
8a	*Infrastructure charge receipts gross*	*£m*	*13.0*	*13.3*	*14.1*	*13.9*	*13.5*	*67.7*
8b	*Less income offset*	*£m*	*-24.2*	*-22.9*	*-19.8*	*-19.0*	*-18.2*	*-104.2*
8	**Infrastructure charge receipts (s146)** *[Net]*	**£m**	**-11.2**	**-9.61**	**-5.8**	**-5.1**	**-4.7**	**-36.4**
9	**Requisitioned mains (s43, s55 & s56)**	**£m**	**16.9**	**18.1**	**19.2**	**19.6**	**20.0**	**93.9**
10	Other contributions (price control)	£m	0.0	0.0	0.0	0.0	0.0	0.0
11	Diversions (s185)	£m	34.5	26.0	9.6	9.8	10.0	89.9
12	Other contributions (non-price control)	£m	7.0	2.8	0.6	0.0	0.0	10.3
13	Total grants and contributions ~ wholesale water service	£m	56.8	48.0	34.9	35.9	36.9	212.5

The total net developer services income is therefore £112.3m, being the sum of lines 7-9 shown above. This results in a net cost of £146m in our plan, which is explained in the table below.

	Cost	Income	Difference	Reason
Requisitions	£93.9m	£93.9m	-	100% recovered from developers
New connections	£73.4m	£54.8m	£18.6m	£3.7m of discounts forecast.
Infrastructure network reinforcement	£70.3m	£67.7m	£2.6m	Timing difference (before income offset)
Income offset		(£104.2m)	£104.2m	
Asset Value Payments	£20.6m	-	£20.6m	Payment to SLPs
Total	**£258.2m**	**£112.3m**	**£146.0m**	

Therefore of the total cost, £143m, (the ne value above less the timing difference) is the value we believe should be funded through totex. We note this net value is similar to the 'gross costs' per the Ofwat published model.

When comparing income to cost, we note that:

- New connections costs are assumed to be recovered 100%, less discounts applied where developers install water saving devices in properties as they are built. Currently these discounts are made against the infrastructure charge but as the income offset leaves no net infrastructure charge we plan to include this discount against new connection charges in future.
- Gross infrastructure income is assumed to recover 100% of costs over a rolling 5 year average, and therefore the total income in AMP7 is slightly lower than the costs due to the timing differences between the in-year cost and the 5 year average income charge (£2.6m). The Income offset of £104m (calculated based on the current 12 years of revenue methodology, forecast forwards to maintain the balance between what developers and customer pay) is then applied to the infrastructure charge, resulting in a net cost of £36.4m being recorded in App28.
- Asset Value Payments of £20.6m will be incurred in AMP7 with no income which offsets against these costs.

How have we made sure that we are delivering the best option for customers?

The need for the investment is statutory but we do have options around how, where and when we provide connections and additional capacity. There are a number of ways in which we do this to ensure that we provide the most cost effective or cost beneficial option:

- We engage with developers at an early stage in the planning process to discuss site layout and possible connection points such that the impact on our existing network is minimised where possible.
- We consider whether there are any linkages to other capital maintenance or enhancement needs within the area. For example we may be able to deal with existing low pressure issues at the same time as catering for the new development or there may be additional resilience that we can add into our system as part of the solution, which reduces the total costs borne by developers due to the synergy savings realised.
- We evaluate wider system options and well as local options. For example there may be a more cost effective option of providing a cross connection from another District Metered Area (DMA) rather than upsizing local capacity.
- Where there are multiple development sites in an area we consider them holistically and look at whether a strategic level capacity solution may be more cost effective than accommodating development piecemeal.
- We always look to optimise our existing network before considering solutions that require additional capacity. This could be interventions such as altering the operation of a valve or a booster pump or targeting the area to improve water efficiency or leakage to reduce demand.

We have worked with developers and local councils to understand their local plans and obtain the best available information. However, there is still an element of uncertainty in this as development is frequently driven by macro-economic factors and Government policy. The forecasts used for our new development and network reinforcement investment are consistent with those used in our long term Water Resource Management Plan (WRMP).

How have we demonstrated that the costs are robust and efficient?

Firstly, the vast majority of costs for developer services are contestable, meaning that we are competing for work with 'Self-lay Providers' (SLPs) and therefore our work is competitively priced and in line with market rates. We have benchmarked our costs and this has shown that we are one of the best in the industry in this area. However, we note that we are facing pressures (as outlined in the Arcadis report) due to the high demand for skilled workers.

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency.

How are customers protected?

Regulatory Mechanisms
As described above, we have statutory duties under the Water Industry Act to allow connections to our network and to ensure our water supply system is able to accommodate new developments. In the event of non-compliance enforcement action via the Secretary of State will be triggered.
For the non-contestable work (of which the infrastructure renewals is the major part), we can demonstrate that our costs are efficient, and as set out above, we proactively work with developers and local authorities to try and ensure these costs are minimised.

Performance Commitments

- D-Mex – underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.10. Wastewater environmental programme

The investment proposed in this business case will help our region's environment to flourish and makes an important contribution to our 'thriving environment' outcome. It also ensures we play our part in delivering the government's objective to protect and improve our nation's water environment. It relates only to enhancements under our wastewater networks plus control. While this investment is driven by statutory environmental obligations, which all companies must comply with, there is strong customer support for the investment we propose to undertake in improving the environment.

The specific enhancement requirements we are obliged to deliver are set out in the Water Industry National Environment Plan 3 (WINEP3), issued by the Environment Agency in March 2018. This defines the necessary interventions needed at both our sewage treatment and sewerage network assets. We have worked extensively with the Environment Agency (EA) over the last 2 years to optimise the environmental requirements and associated interventions included in WINEP3 so as to ensure value for money and maximum use of innovative solutions. Due to the misalignment between the statutory Water Framework Directive (WFD) timeline and this Periodic Review, some elements of WINEP3 are subject to final confirmation by the Secretary of State in 2021, upon completion of the WFD Cycle 3 River Basin Management Plans.

To address uncertainty regarding the final extent of the statutory obligations, we have split the investments into those where there is a high degree of certainty (interventions graded by the EA as Green, or Amber schemes that deliver multiple benefits), and those with a greater level of uncertainty. We have included the higher certainty projects in our business plan but made use of a real options mechanism for the remainder. This is to protect customers from funding components of the latest version of WINEP that may subsequently prove to be unnecessary. Additional customer protection against higher certainty projects not being confirmed in 2021 is provided by our WFD ODI penalty mechanism.

The investment we are planning will achieve the following benefits:

- There will be no deterioration in our region's waterbodies resulting from serving our customers.
- Building on the 1500km of river quality improvement achieved in AMP6, we will improve the condition of a further 2,100km of rivers (assuming the real options mechanism is deployed in line with current WINEP3 scope).
- We will further protect our rivers and make our service more resilient with improved performance of intermittent discharges at our Combined Sewer Overflows during storm events.
- The condition of several Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSIs) across our region will be enhanced.
- Treatment upgrades necessary to comply with the requirements of the Urban Wastewater Treatment Directive will be delivered.

Summary of proposed investment and interaction with the real options mechanism

Investment driver	Expenditure to deliver as per WINEP3	Lower certainty expenditure removed from plan but subject to real options mechanism	Higher certainty expenditure included in business plan
Water framework directive and associated directives	£463m	£121m	£342m
Urban Wastewater directive and associated CSO investigations	£42m		£42m
Total	£505m	£121m	£384m

What is driving the need for this enhancement investment?

Statutory drivers of investment

Two main statutory drivers underpin the need for the wastewater quality enhancement investment: the Water Framework Directive and the Urban Waste Water Treatment Directive.

- Water Framework Directive (WFD) – Ensuring 'no deterioration' to waterbodies as a consequence of our activities and achieving improvements ('good ecological status') – where it is technically feasible or does not incur disproportionate cost.
    - Associated directives and legislation includes the Habitats Directive and the CRoW Act that provide statutory protection to 'Protected Areas' such as SACs and SSSIs
- Urban Waste Water Treatment Directive (UWWTD) – Protecting our environment from potentially detrimental wastewater discharges through;
    - Designating rivers with high nutrient levels as 'sensitive' where any significant discharges will require the implementation of more stringent discharge permits.
    - Limiting the discharges through the storm overflow route at our treatment works and the impact of spills from combined sewage overflows (CSOs) across our network.

Implementation of both directives is managed by the EA on behalf of DEFRA. Delivery of all WINEP3 obligations is monitored by the EA and forms part of their annual Environmental Performance Assessment (EPA). The EA will also issue revised discharge permits and monitor performance against the revised conditions to ensure that environmental enhancements are sustained.

Customer support for environmental improvements
We carried out extensive stakeholder and customer engagement on the environment for PR14. This revealed a strong desire from both customers and stakeholders for Severn Trent to invest in river water quality improvements. For PR19, we've made further improvements to how we engage with customers on these issues. These changes represent a step change in the depth, and quality of our research.

Our extensive research catalogues, compiled using many data sources and over many years, tell us customers take their wastewater service for granted until something goes wrong. Given this background, we re-designed our approach to customer engagement in PR19 so that we could ensure our customers could contribute in a meaningful, informed way on these matters. We have supplemented our more traditional research methods (tracker analysis and valuation studies) with revealed insight (social media 'scraping' and customer contacts) with a programme of deliberative research with a representative cross section of customers. The outputs from the deliberative research demonstrate that customers are able to engage in, and understand, complex issues and comment in a meaningful and informed. We gained specific insight into the options we should consider, what preferences customers have and how quickly we should deliver.

These improvements have given us more nuanced and, we believe meaningful insight. But the overall sentiment of customers remains unchanged from PR14. This consistency gives us further confidence that our proposals are supported by customers.

Material changes relative to the past
We believe the wastewater quality enhancement programme we have proposed is materially different in size and characteristic to that seen in previous AMP periods. Consequently modelling based on the geographical distribution of past expenditure is not likely to be representative.

The current WINEP3 requirements are of a scale that is much greater than the historical requirements.
The complexity of required interventions are not analogous to those seen historically. This is as a result of the lower effluent concentrations required to meet WFD objectives set at 'technically achievable' limits. These have been revised down by the EA following technology trials during the current period.

The environment programme is bespoke to each company and reflects the environmental requirements in their region. Therefore it needs to be considered alongside the improvements made to date and the remaining interventions needed.

How have we made sure that we are delivering the best option for customers?

We have strived to balance the time needed to get the best possible information (on need and solution) with the impact phasing will have on bill volatility and the need to deliver obligations within the 2027 mandated WFD timescales. The work that we've done to investigate the need, define innovative solutions and align with other drivers and lever in additional benefits gives us confidence that the activities planned for AMP7 efficiently deliver for the environment in accordance with customers' wishes and our statutory requirements.

We have invested over multiple previous AMP periods on both UWWTD and WFD obligations and have an excellent track record of delivering environmental improvements. Our current AMP6 programme will deliver improvements in at least 1,500km of rivers in our region – a commitment that we are on track to outperform. We have achieved the Environment Agency's top 4* EPA rating three times in last five years, and have delivered 100% of our NEP obligations in each of the last 5 years.

In AMP6 we have made significant progress on WFD and by 2020 will have delivered over 35% of the total improvements required of us to deliver WFD objectives by the 2027 backstop date. We have had strong focus on technical innovation, as exemplified by our phosphate removal test bed at Packington STW, and are now able to reap the rewards of this work. We have also worked very closely with the EA, utilising our systematic 'source to estuary' catchment approach, to ensure that solutions will be delivered at the optimal time. This combination of innovation and strategic vision has enabled us to drive down costs and fully integrate our enhancement work into the wider investment programme to deliver multiple outcomes. The strategic approach agreed with the EA will facilitate transition into AMP8 in a way that smooths the impact on bills as far as possible whilst also ensuring we can meet the statutory 2027 WFD deadline.

Cost benefit and delivery of wider benefits

Where investment is subject to achieving cost-benefit criteria, we've used willingness to pay data to ensure our programme is underpinned by the value customers place on improvements. Customers do value and support environmental improvements but they are also concerned that the affordability consequences should be managed. A large part of our investment is associated with the WFD and this must be delivered by 2027, we have therefore phased our investment to make sure bills are affordable across AMP7 and the first two years of AMP8.

We've also responded to customer and stakeholder feedback that we should exploit the potential for multiple benefits for the communities we serve. We analysed over twenty sub-catchments in our region to look at the interactions between environmental requirements and other service areas to identify opportunities for wider benefits. As we have developed this sub-catchment approach we included a trial for the use of natural capital appraisals and how this changes the type of solutions we consider. This is a useful way of quantitatively considering the wider benefits that in the past have been intangible. This approach is ongoing, but at this early stage it means that, we can identify where our investment will deliver additional benefits over and above the statutory driver.

Challenging the scope and cost of required environmental enhancement interventions by deploying a sub-catchment approach

Whilst our wastewater quality programme is driven by statutory requirements, we've not been complacent nor taken the view that costs are outside of management control. We've challenged ourselves to scrutinise the basis for every need and cost, first at a granular level, and then as an overall programme of work. We adopted a holistic river catchment approach through which we have been able to link sites to develop holistic solutions to deliver the desired environmental outcome. Our approach has allowed us to make successive reductions in the proposed programme costs.

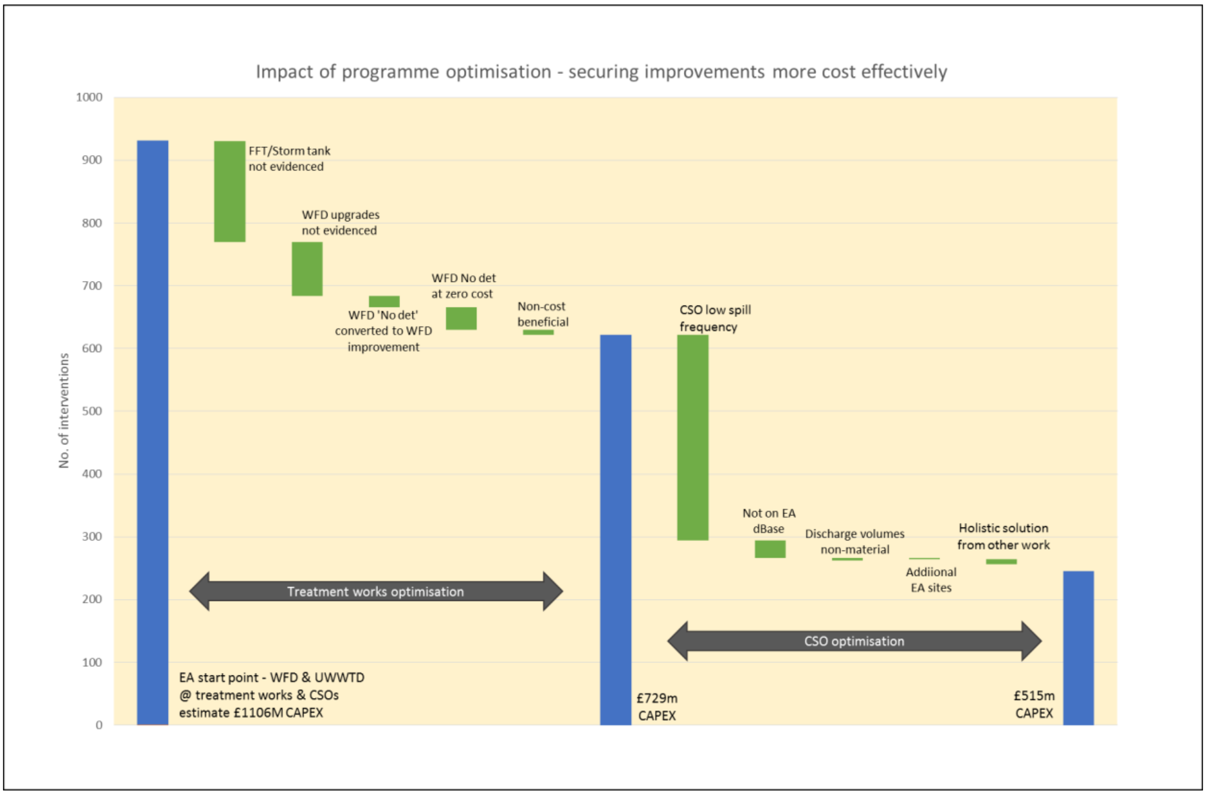
To achieve these savings for our customers, we've worked collaboratively with the EA. This includes iterative reviews of the EA's evidence of the need to intervene, a combined approach to river quality modelling and joint review of our proposed catchment solutions. We have also worked constructively with the EA on the timing of these interventions. – the table and figure below show the impact of this work.

Successive reductions in scope

Driver	Area	Initial needs assessment (from mid-2015)	Revised needs (March 2018)
WFD	No deterioration	62 standalone schemes	8 standalone scheme
	Improvement – good ecological status (treatment works)	247 site upgrades	154 site upgrades
	Improvement – good ecological status (CSOs)	421 schemes	55 schemes

Driver	Area	Initial needs assessment (from mid-2015)	Revised needs (March 2018)
	Protected Area legislation - Habitats Directive and CRoW Act	N/A	9 site upgrades
UWWTD	Improvement (storm overflows at treatment works)	258 flow to full treatment increases |	13 flow to full treatment increases
		82 storm tank capacity increases	26 storm tank capacity increases
	FFT monitoring	545 new flow monitors	60 new flow monitors
			211 flow investigations
		545-1090 new event duration monitors	179 new event duration monitors
	Improvement (nutrient removal)	N/A	14 site upgrades (2 no cost implementations)
	CSO investigations (on our network)	351 Storm Overflow Assessment Framework investigations (stages 1-3)	351 Storm Overflow Assessment Framework investigations (stages 1-4)

Successive reductions in scope – number and rough estimate of cost savings (including investigations to inform AMP8 CSO programme, £10m)



This approach helps to ensure that we are addressing issues to get the best possible value for our customers, but without compromising on the outcomes that will be delivered.

Appropriate planning of investment to allow alignment of different expenditure drivers

We have sought to plan investment to achieve the maximum possible synergies with our maintenance programme and growth programmes. This contributes to both lower costs and greater benefits to other service areas. For example investment at sewage treatment works driven by WFD obligations will also have a positive impact on our asset health measure on treatment works compliance. Where need is also driven by maintenance and growth, only investment associated with delivering the enhanced service is included in this business case. Proportional allocations to maintenance and growth are allowed for elsewhere.

Using innovation to derive customer value

In AMP6 we have doubled our investment in R&D and made changes to the structure to create a new team who have driven a culture of innovation at all levels across the organisation. The need for this step change was particularly important when faced with the challenges of standards tighter than previously seen by us or across the industry. The drive and focus of the innovation team have improved our investigations and understanding of the need.

Our research and development has also resulted in technological innovation which has moved the frontiers of what is cost efficient and technically achievable., Over the course of AMP 5 and AMP6 we've invested c. £4 million in trials of new technologies (in addition to our contribution to the national water industry trials) to target lower phosphorous permit limits. The success of these trials will have twofold benefits for customers and the environment in AMP7; we can confidently deliver to the Environment Agency's reduced 'technically achievable limits'; and deliver more cost efficient technological solutions. We have already started to deploy these advanced technologies on our AMP6 NEP schemes, enhancing our capability to efficiently deliver our challenging AMP7 obligations.

How are customers protected (to ensure that they get the benefit that they have paid for)?

Protecting against uncertainty

Despite our close and ongoing engagement on the development of WINEP3, we recognise that there is uncertainty over full scope of investment required until the WFD improvement schemes are approved by the Secretary of State as part of River Basin Management Plan 3 in 2021. To mitigate this risk for customers, we have only made provision for enhancements in the business plan that we consider to be of higher certainty. By this we mean interventions in WINEP3 currently graded by the EA as Green, or Amber projects that deliver multiple benefits.

For the remaining less certain projects, we have developed the real options mechanism that will be triggered when the programme is finally confirmed. This is to protect customers from funding components of the latest version of WINEP that we consider may prove to be unnecessary. The mechanism calibrates both the certain and uncertain aspects of proposed programme to the environmental improvement they will deliver. This allows a rate per environmental improvement currently in the WINEP to be calculated. When the statutory programme is confirmed, the required environmental improvement will be re-assessed and the real options mechanism triggered to allow for any necessary additional expenditure over and above the high certainty projects that have been included in the plan.

Protecting against under-delivery

Customers will be protected from the risk of under-delivery by either statutory enforcement action, or in the case of WFD improvements, a specific performance commitment. This builds on the existing WFD performance commitment.

The current measure was used to accommodate AMP6 changes in the EA's National Environment Programme 5 (NEP5), which was finalised and issued twelve months after the PR14 submission. Due to additional bodies of evidence and improved river quality models being available, 15 of the original 89 schemes proposed were removed and substituted with 32 replacement projects (as agreed by the EA). As a result of these changes, customers will benefit from improvements in an additional 244km of river in 2015-20 at no extra cost.

Our proposed WFD performance commitment for PR19 will retain the ability for project substitutions to deliver the same overall outcome. However, where suitable substitutions cannot be agreed with the EA, we will return unused resources to our customers via an ODI penalty.

8.4.11. Sewer Flooding business case

Business case	Sewer Flooding
AMP7 enhancement Capex	£139.4m
AMP7 enhancement Opex	£1.3m
Price control	Waste Network +
Ofwat enhancement cost drivers	Table WWS2, Line 30: Reduce flooding risk for properties
Sensitive performance commitment	F01 – Internal Sewer Flooding F04 – Risk of Flooding in a 1 in 50 year Storm F05 – External Sewer Flooding F07 – Public Sewer Flooding F08 – Green Communities F09 – Collaborative Flood Resilience

What is driving the need for this enhancement investment?

We have a duty under the Flood & Water Management Act 2010 to make sure our systems have the appropriate level of resilience to flooding, and maintain essential services during emergencies, maintain and manage our sewerage systems to manage the impact and reduce the risk of flooding and pollution to the environment.

We also have a duty under section 94 Water Industry Act 1991 to ensure that the area we serve is "effectually drained", work with developers, landowners and LLFAs to understand and manage risks – for example, by working to manage the amount of rainfall that enters sewerage systems and work with the Environment Agency, LLFAs and district councils to coordinate the management of sewerage systems with other flood risk management work.

In addition to this statutory duty, the sewer flooding enhancement is primarily driven by our customers. Our research consistently shows that a sewer flooding incident is the worst service failure that customers can experience. While most customers have not had direct experience of flooding – and they accept it is relatively rare - they do empathise with those that have.

> "It turns your whole life upside down. Your house is not yours anymore" – Customer, no experience of flooding"

In both our deliberative research and our willingness to pay research we found that the emotional impact of having experienced the trauma and distress of flooding has a major bearing on customer attitudes. How we deal with and support customers who have experienced flooding is equally important as the number of incidents.

Our customer research tells us that the need to reduce flooding is multifaceted and goes beyond purely reducing incidents of flooding. Customers expect us to do all of the following:

- reduce incidences of sewer flooding;
- improve our response to flooding;

- reduce repeat flooding;
- prioritise roads and highways as well as gardens / curtilages; and
- tackle flooding where we have a joint responsibility.

Reducing incidents of flooding is a high priority for customers
Whilst many customers have not had direct experience of flooding they do empathise with those that have, and reducing flooding has consistently (across time and multiple research projects) been a high priority for customers. For example, our Willingness to pay (WTP) research tells us that reducing internal flooding is the second highest prompted priority for customers. Our contextualised WTP with customers who had been affected by flooding shows that experience does affect WTP, with these respondents reporting higher valuations for both internal and external flooding. In the “budget game” reducing internal sewer flooding is the fifth highest priority for respondents, and in the choices research it is the third highest priority.

We have triangulated the evidence from these sources to determine overall valuations for improvements in service. The results of the triangulation are that customers are willing to pay £107k to resolve an internal sewer flooding incident and £48k to resolve an external sewer flooding incident.

In our choices research, customers recognised that internal sewer flooding is rare, but potentially “soul destroying” when it happens. It was prioritised for improvement based on the emotional reaction and the instinctive disgust of the aftermath and empathy for those affected. Customers also considered the health impacts of sewage and clean-up costs. We also found that businesses, where members of the public use the premises, are much more sensitive to any issues which might paint their business in a negative light (such as issues with the wastewater service). Given the importance of the issue, 87% of customers agreed with targeting upper quartile performance. External sewer flooding was also prioritised for improvement due to potential health risks and impact of sewage pollution, despite the low incidence of events across the customer base.

Our response to flooding is as important as the number of incidents
As well as targeting a reduction in flooding, it is also important to consider how we respond to flooding incidents. As part of our customer needs research, we talked to customers who had suffered from service failures, including sewer flooding. These customers were unsure whether the responsibility for their flooding incident was Severn Trent’s or the council’s and felt that communication surrounding the incident could have been improved.

Our research finds that customers who have experienced flooding want empathy, understanding and accessibility in their interactions with Severn Trent. They describe the experience as stressful and traumatic and want to be able to access personalised customer service quickly in the aftermath. Our best in class customer service research tells us that customers have high expectations for timescales for attendance (within 2 hours) and resolution of sewer flooding (within a day). Unsurprisingly, our tracker research tells us that experiencing sewer flooding has a significant impact on trust in Severn Trent and on customer satisfaction.

Repeat flooding is particularly distressing for customers
Customers also recognise that repeat flooding is particularly distressing. In our willingness to pay research we asked customers if they would be willing to contribute an additional to tackle repeat incidents. We found that 55% of customers supported paying a small amount to reduce the risk of repeats (and only 25% disagreed).

Customers find flooding on roads and highways equally important

Until relatively recently, our focus has been to reduce sewer flooding to homes and gardens. However, we recognise that sewer flooding in roads and highways can also be highly disruptive and concerning for customers, and 68% of household customers, and 67% of non-household customers feel it should have equal focus to flooding in gardens and curtilages.

Customers aren't always sure who is responsible for flooding, but expect us to play our part
Flooding can have a heavily detrimental effect on people's lives as well as community prosperity. Our deliberative research and depth interviews found that there is confusion about who is responsible for flooding – local councils and the Environment Agency are more likely to be seen as bearing responsibility rather than Severn Trent. Further, the range of organisations involved in dealing with flooding also raises concerns about how effective action will be. Where Severn Trent has some responsibility, customers expect us to play our part in the solution.

In our research, personal experience of flooding was found to have a major bearing on how customers responded to the issue. Those with no personal experience felt the current risk-based approach feels intuitive and sensible, and there was little appetite for Severn Trent to do more in areas where other organisations are primarily responsible. However customers with personal experience felt that tackling flooding should be an urgent priority and were alarmed that Severn Trent might only focus on areas of highest risk.

Our investment will enhance the level of service provided to customers
We are forecasting that we will achieve our performance commitments by 2020 and be delivering upper quartile performance for both internal and external sewer flooding incidents. Over AMP6 we will have delivered a 41% improvement in the number of internal incidents, and a 58% improvement in the number of external incidents.

Our proposal is to invest £140m which will deliver an enhanced level of service for customers by alleviating hydraulic deficiencies in the sewerage network which result in sewer flooding during heavy rainfall. This investment contributes to the performance commitments for flooding that we are making in our plan.

Without this investment the risk of sewer flooding would gradually increase as a result of pressures such as climate change and population growth increasing the peak flows entering our network. The "Report on Future Impacts on Sewer Systems" shows that this could increase sewer flooding by 51% by the 2030s unless intervening measures are taken. Our customers recognise this – in our deliberative research it felt intuitive that this is an issue that may get worse in the future, and climate change, building on green belt and urban creep (although customers didn't use this terminology) were all identified as contributing factors.

How have we made sure that we are delivering the best option for customers?

Our delivery approach is shaped by our customers
Our sewer flooding investment programme aims to respond to the customer need by investing in creating additional capacity in the sewer network to reduce the risk of flooding. The investment will include a mix of activities including both traditional sewer upsizing and construction of underground tanks to store excess rainwater, but with a focus on sustainable management of surface water inflow through the construction of SuDS. This reduces the risk of communities being subjected to flooding from the public sewerage system and makes the network more resilient from the impacts of climate change.

Our approach is shaped by the views of our customers, through our most extensive customer insight programme to date. In addition to establishing the relative priority of reducing flooding compared to other service improvements, we have used a deliberative approach to explore solution options, customer views on how we prioritise sewer flooding investment and the role customers feel we should have in resolving other sources of flooding.

To determine the optimal plan we have considered a range of improvement options
The overall size and scope of our sewer flooding programme has been directly informed by customer WTP and affordability constraints.

We have considered a range of intervention options. The projects from our Hydraulic Flood Risk Register were grouped together into a range of benefit categories to test different levels of investment. Our final scenario included a mixture of high, medium and low risk profile projects to ensure we provide a more balanced package of solutions.

In total the plan commits to reducing internal flooding incidents by ~13% and external incidents by 8% as well as addressing high consequence highway flooding.

Customers value our engineering expertise and trust us to decide on matters of technical detail
In our deliberative research we discussed both options for dealing with hydraulic flooding and flooding other causes with customers. Whereas the number of blockages caused shock and customers engaged on our proposed response, customers did not have strong views on potential options to prevent hydraulic flooding. Severn Trent is broadly expected to be the expert on these technical matters and is trusted to define the best solution.

We will provide a mix of mitigation and permanent solutions
Where it is possible, we will always try to protect our customers from immediate flooding risks by using low cost flood mitigation measures, such as non-return valves, flood doors and flood gates. These measures will not resolve the root cause of the flooding but will minimise the impact when it does occur whilst permanent, more capital intensive solutions are designed and implemented. Our benefits methodology takes into account the risk reduction provided by mitigation and ensures that we prioritise those properties that we can't protect (potentially because the flood water would be displaced to other nearby properties) or where the underlying risk is so high that a capital scheme is still the right long term solution.

In addition to mitigation solutions we will be providing capital solutions for properties on our Hydraulic Flooding Risk Register. All benefits are calculated in a true risk based approach which means we assess both likelihood and consequence with benefit values being weighted accordingly.

Likelihood is based on the frequency at which we predict a flood event to occur. This can be based on historic data or the latest sewer modelling techniques, or a combination of both. Consequence is based on the depth of flooding and the area it affects, such as inside a property, in the garden, in the road etc.

By calculating risk in this way we are ensuring that our investment is targeted where it will have the most impact for our customers. We don't set a fixed benefit criteria - this means we can be flexible with the solution we provide in order to deliver the best value for all customers. For example we may be able to provide a 20 year level of protection to a property through some relatively low cost local up-sizing of sewers. Providing a 50 year level of protection may involve some expensive trunk sewer work that makes the project not cost beneficial.

Strategic sewer flooding projects
There are 2 strategic sewer flooding projects within our plan covering the towns of Ilkeston and Stroud where there are currently widespread issues with sewer flooding and the causes are linked to a lack of capacity in the trunk sewer system.

Both of these projects have gone through extensive optioneering and feasibility in AMP6 to identify the most cost beneficial solution. For Ilkeston the first option considered was a duplication of the trunk sewer. However further investigation demonstrated that the same level of protection could be given by separating out surface water from the sewerage system and draining away via SuDS alongside a much reduced scope of upsizing.

Customers support us working in partnership with others
Customers support working in partnership with other organisations to address wider flood risks to communities - but they want us to do so in a way which means everyone is doing their fair share.

This has helped us shape our Collaborative Flood Resilience Performance Commitment.

Alongside our investment options we have considered how we account for and incentivise the wider opportunities that our sewer flooding investment can bring. We are therefore proposing to continue to co-create and co-deliver schemes in partnership with the Environment Agency and Lead Local Flood Authorities and have evolved our AMP6 Partnership Working PC into a more targeted and outcome driven PC that we have called Collaborative Flood Resilience. This PC has been worked up with key members of our CCG to ensure that it aligns as closely as possible with their activities.

Where possible we will seek to deliver wider benefits
We have also considered the wider natural and social capital benefits that some of our choices of solutions could provide. For example constructing a green space area for the purposes of storage and sustainable drainage of surface water will also have benefits for health, water quality, air quality and amenity. We are therefore proposing to use a recognised industry tool (known as B£ST, the Benefits of SuDS Tool) to value these natural and social capital benefits and incentivise delivery of them through our sewer flooding enhancement programme. We have called this our Green Communities PC and it has been developed with input from our CCG representative from Natural England.

Prioritising solutions for those customers most vulnerable to flood risk
The pace at which we move away from traditional solutions to alternative approaches depends in part on how we value wider societal benefits including creation of amenity spaces and improved habitats. In addition to developing a robust valuation approach for 2020-25, we will also look at how to prioritise improvements towards helping those customers who are most vulnerable to flood risk. Our customers were supportive of us prioritising less advantaged areas.
The three factors that determine vulnerability to flood risk are:

- personal factors (for example age, health);
- social factors (for example income, tenure, mobility, social isolation, access to information and insurance); and
- environmental factors (for example housing and neighbourhood characteristics)

By taking into account customers' ability to recover from flooding it is hoped that additional funding would allow our engineers to develop more resilient solutions and incentivise the construction of green infrastructure solutions which can cost more than traditional sewer solutions. The thought being that retrofitting green street rain garden type solutions would provide wider health and amenity benefits compared with just traditional underground sewerage solutions and hence make a positive difference to the lives of customer is deprived postcodes as well as alleviating the flood risk.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for sewer flooding we have followed the company wide approach. Costs for mitigation are historic unit cost based. Costs for Ilkeston and Stroud Strategic Schemes are bottom up project estimates built following feasibility and optioneering.

How are customers protected?

Regulatory Mechanisms
The Water Industry Act s94 ensure that companies have a general duty to maintain and extend the wastewater network and to make provision for the emptying of those sewers. In the event the duty is not met, the Secretary of State can use its enforcement powers to issue sanctions and fines.

Our Code of Practice ensure that, in the event a customer experiences sewer flooding within inside or outside of their property, they will receive compensation through our Guaranteed Service Standards.

Performance Commitments

- F01 – Internal Sewer Flooding – underperformance penalties apply
- F04 – Risk of Flooding in a 1 in 50 year Storm
- F05 – External Sewer Flooding – underperformance penalties apply
- F07 – Public Sewer Flooding – underperformance penalties apply
- F08 – Green Communities – underperformance penalties apply
- F09 – Collaborative Flood Resilience – underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.12. Sewage treatment growth business case

Business case	Sewage Treatment growth
AMP7 enhancement Capex	£80m
AMP7 enhancement Opex (operating solutions)	£0.3
Price control	Wastewater Network +
Ofwat enhancement cost drivers	Table WWS2, Line 26: Growth at sewage treatment works (excluding sludge treatment)
Sensitive performance commitment	N/A – Statutory requirement (Water Industry Act 1991)

What is driving the need for this enhancement investment?

This enhancement investment is driven by the need to upgrade sewage treatment works to cater for future increases in domestic population served and trade effluent received.

The need to provide additional capacity to cater for growth is to meet a statutory requirement as laid down in Section 94 (clauses 1a and 1b) of the Water Industry Act 1991. This key duty states that the sewerage undertaker must make provision for the emptying of sewers and effectually dealing with, by means of sewage disposal works or otherwise, the contents of those sewers. This investment is designed to allow ongoing adherence to our statutory requirements.

Whilst there are no specific performance commitments relating to this business case, without this investment we would risk facing regulatory enforcement due to failures against our Water Act duties. We would also see a deterioration in environmental performance which in turn would be reflected in our Environmental Permit Compliance ODI.

The size of our wastewater treatment supply/demand programme is linked to the size of our quality enhancement programme. The new assets being provided to deliver our WINEP3 obligations are sized to cater for predicted demand increases. As such, a marginal cost for these new assets is proportionally allocated to supply/demand based upon the percentage increase in population to be served. Our AMP7 WINEP programme is significantly larger than it was in AMP 5 and 6, which has resulted in an increased provision for supply/demand expenditure.

All of our supply/demand expenditure is associated with our wastewater quality enhancement programme. When agreeing the WINEP3 enhancement measures with the Environment Agency, we deliberately sought to promote sites where we were aware of significant supply/demand pressures. This is a continuation of the approach that we adopted in AMP6 which enables us to deliver holistic solutions to meet demand pressures and environmental needs at lowest cost to our customers. For AMP7, we have successfully avoided the need to include any ‘stand-alone’ supply demand projects in our plan. We have long been concerned that catering for increased demand in isolation runs the risk of delivering new assets that are incompatible with future environmental requirements, notably the Water Framework Directive. The catchment solution approach that we have developed for WFD enables us to factor growth into our environmental solutions, eliminating the risk of inefficiencies arising from a piecemeal approach to supply/demand and quality enhancements.

In selecting our interventions, we have given careful consideration to a range of technical options including technologies to increase the treatment capacity of existing assets. E.g. the deployment of IFAS (Integrated Fixed film Activated Sludge) treatment to boost the capacity of existing Activated Sludge Plants. We have only made provision for new capacity to cater for predicated demand increases where we are certain that existing assets have insufficient capacity.

As all of our supply/demand investment is tied to our WINEP3 quality obligations, the cost of this part of the programme has de facto been subject to the same level of scrutiny as the cost claim business case. A full description of the costing methodology is provided in the WINEP3 cost adjustment business case.

How have we made sure that we are delivering the best option for customers?

As this business case is to address a regulatory requirement it has not been the subject of customer engagement.

When evaluating the upgrades required in the waste quality programme we have combined drivers and evaluated the optimal solution to address all needs. Through following this process we have reduced costs by having a single intervention (rather than installing potentially incompatible upgrades in successive AMPs). This allows us to choose the best option for customers, for inclusion in our business plan, across the different drivers.

Future demand has been quantified with reference to councils' local development plans which generally adopt a either 2033 or 2035 development horizon. We have therefore opted to size our new assets to match these development forecasts. The assets that we will be providing in AMP7 will not be amenable to marginal upsizing part way through the local development plan period. Adopting a shorter term design horizon therefore risks having to install an additional process unit in AMP8 in parallel with the AMP7 upgrade, resulting in an overall capacity increase in excess of foreseeable demand. It would also be inefficient from a procurement perspective to repeatedly revisit sites to deliver small capacity increases. Our strategy for both Quality and Growth enhancements is to invest at the right time to deliver long term solutions.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for sewage treatment growth we have followed the company wide approach. Expenditure in this business case has been derived from the audited cost estimates generated for the WINEP3 quality programme. The estimate of growth expenditure is £80m, derived from proportional allocations6 to growth from our quality programme.

Of this £28.3m will be invested at 6 significant growth point sites with a combined growth forecast of over 100,000 people (a 24% increase on current population served). These investments will deliver all the capacity required to meet demand forecasts 2035. Assessment of existing treatment process capacity has determined that this will be exceeded within AMP7, so now is the right time to invest.

Site name	Current PE	Forecast PE	Increase	% growth
Ashbourne	45,198	53,550	8,352	18.5%
Bromsgrove	47,500	65,000	17,500	36.8%
Kirkby in Ashfield	27,474	31,516	4,042	14.7%
Oswestry Mile Oak	23,103	27,032	3,929	17.0%
Scunthorpe	141,783	192,161	50,378	35.5%
Worcester	144,303	163,766	19,463	13.5%
Total			103,664	

- £24.4m will be invested at 21 sites where we are increasing both biological and phosphate removal treatment capacity to deliver WINEP3 obligations. These capacity increases are naturally sized to cater for forecast population increases. These sites represent a capacity enhancement of 140,000 people total (a 17% increase on current population served) and will ensure that all these sites are sized to cater for local development plan forecasts.
- £27.3 will be invested at 117 sites to ensure that phosphate removal assets provided to deliver WINEP3 obligations are sized to cater for forecast demand increases. For these sites, we have determined that other process units have sufficient capacity to cater for forecast growth to 2025 and it would therefore be premature to invest in new biological or hydraulic treatment capacity in AMP7.

[6] For assets are delivered to address quality drivers then the proportional allocation of cost to growth is based on the percentage increase in forecast population to be served.
For quality projects where a subset of new assets are purely to address population increase, costs will be allocated purely to growth (except where existing assets are being replaced - costs would then further be apportioned to Capital Maintenance, in line with regulatory guidelines on 'advanced maintenance'.)

How are customers protected?

Regulatory Mechanisms
The Water Industry Act s94 ensure that companies have a general duty to maintain and extend the wastewater network and to make provision for the emptying of those sewers. In the event the duty is not met, the Secretary of State can use its enforcement powers to issue sanctions and fines.

Performance Commitments
There are no direct performance commitments that relate to sewage treatment growth. However, customers are protected from the potential service failings in the event that we do not increase our treatment work process capacity.
For example, overloading of the sewage treatment works does not affect the permit compliance limits in place and, as such, any failure to meet the permit limits could lead to sanctions from the Environment Agency. Ofwat has also adopted this commitment as part of the suite of measures for the industry to select from – we have selected this commitment with associated underperformance penalties.

We did give consideration to a bespoke growth performance commitment linked to the population equivalent of new assets provided. We opted not to do this as we consider that the protections outlined above are sufficient. We also felt that there was the potential for the PC to have a perverse incentive to provide new capacity where the justification was marginal to avoid an ODI penalty.

8.4.13. Wastewater Network Plus Legacy business cases – Reservoirs Act and EU Landfill Directive

Business case	Wastewater Network + Legacy (landfill and sludge lagoons)
AMP7 enhancement Capex	£47.7 m
AMP7 enhancement Opex	£0m
Price control	Wastewater Network +
Ofwat enhancement cost drivers	• Table WWS2, Line 32: Additional company defined line

What is driving the need for this enhancement investment?

We have identified two separate legislative drivers that will lead to material additional expenditure in AMP7 at legacy wastewater sites for which we remain responsible. When setting up the separate Bioresources price control, Ofwat guidance was that 'legacy' assets would not be transferred to this new price control. These are non-operational assets of a type that new entrants to the bioresources market would not be expected to construct.

Within our asset base we have identified two types of legacy asset that new entrants to the market are unlikely to install.

- Sludge lagoons – constructed for long term storage of sludge unfit for beneficial recycling as a bioresource (e.g. due to high levels of heavy metal contamination)
- Hazardous waste landfill site – constructed to receive sludge incinerator ash, derived from incineration of sludge unfit for agricultural recycling

Each of these asset types are also now subject to new legislative requirements under the Reservoirs Act (1975) and the EU Landfill Directive (1999).

Reservoir Act – Legacy sludge lagoons

As part of the Reservoir Act 1975, we have a duty to appoint reservoir panel engineers for all our reservoirs and undertake maintenance as identified via their inspections. The Environment Agency (EA) are the regulatory authority responsible for the act in England.

Amendments to the Act following enactment of the Flood and Water Management Act 2010 has brought wastewater assets whose construction is similar to a reservoir under the Act. Severn Trent are accountable for a series of sludge holding lagoons associated with our major sewage treatment sites. These are simple impounding structures that were filled with sewage sludge from the 1940's in accordance with sludge disposal practices at the time.

In May 2017, The Environment Agency (EA) confirmed that some of Severn Trent's legacy sludge lagoons, namely [four locations REDACTED], are required to be registered under the Reservoirs Act 1975. A breach of the impounding structure would likely cause major environmental damage rather than the flood inundation impacts of a raw water reservoir. Any such incident would result in major environmental damage and consequential enforcement action though existing environmental legislation.

The Act places a number of requirements on owners dependent on the size of the reservoir and whether or not the EA has designated the reservoir as high risk. Typically, appointed engineers must supervise reservoirs making an annual statement on their condition followed by more detailed inspections every ten years. Panel engineers have the power to instruct that work is carried out to ensure the ongoing safety of the reservoir. Complying with these instructions is enforceable through the Act.

Since the registration of our sludge lagoons and to comply with the Act, it is necessary for us to adopt a more onerous regime of inspection and surveillance, which in turn requires ground maintenance at the sludge lagoons to be undertaken at a standard equal to that which we carry out at our large raised reservoir sites. Detailed inspections have now been carried out by panel engineers. In October 2017 the inspections at [two locations REDACTED] identified material capital investment that is required to ensure the lagoons comply with the Reservoirs Act.

The enactment of the Floods and Water Management act, and the subsequent regulatory interpretation of its implication on legacy sludge lagoon structures, will lead to material operating and capital expenditure not previously required. This is the catalyst for this additional enhancement expenditure that we have incorporated in our plan. A failure to act risks legal enforcement through the reservoir act and retain the current unmitigated risk of a catastrophic environmental impact.

Landfill regulations – Legacy sludge incinerator landfill obligations.

We are required to manage the environmental impact of landfill sites through our duties under the EU Landfill Directive 1999 and associated Environmental Permitting Regulations (EPR) 2010.

Minworth sewage treatment works includes a landfill facility that is licensed to receive hazardous waste (incinerator ash). The landfill has not been operated since 2008, when operation of our sludge incinerator at Coleshill ceased.

The sludge incinerator at Coleshill, and the ash receiving landfill at Minworth, remain part of our foot and mouth contingency plan. The last outbreak of foot and mouth in 2001 severely curtailed our primary disposal route of sludge to land. The incinerator, which could cater for c.25% of our total sludge, was mothballed to ensure a contingency plan was in place should another outbreak occur. However, a recent review of our strategy has concluded that recommissioning the incinerator to deal with the effects of a foot and mouth outbreak is no longer a viable proposition. As such we can no longer justify retaining the Minworth landfill facility. It isn't acceptable to the EA to retain a hazardous waste landfill site in perpetuity when there is no realistic prospect of landfilling activities recommencing.

EA national guidance under EPR requires that landfill facilities that are not operating, and are not likely to re-start accepting waste, should be capped off, enabling the long term closure of the facility. This is to prevent the ingress of rain water and therefore minimising the production of leachate in the long term, which has the potential to pollute the wider environment. Following our decision to decommission the incinerator facility at Coleshill, and as such no longer require the landfilling capabilities at Minworth, we are required to cap off the landfill which will require significant capital investment.

Additionally, our ongoing monitoring of the Minworth landfill facility has highlighted an issue of leachate and ground gas exceedances outside of the perimeter cut off wall that are above Environment Agency permit values. Resolution of these issues is being attempted through improved leachate management as well as review of the performance of monitoring boreholes.

We have fully engaged with the EA through liaison meetings on the issues faced. They have confirmed that a substantive solution is now required to ensure compliance with the EU Landfill Directive.

How have we made sure that we are delivering the best option for customers?

We have worked hard to identify how to most effectively comply with increased Reservoir Act and EU Landfill Regulations.

Reservoir Act – Legacy sludge lagoons (£18.7m)
For the sludge lagoons at [two locations REDACTED], an independent Inspecting Engineer has identified capital works and on-going maintenance activities that we must implement.

Feasibility investigations into our legacy sludge lagoons undertaken during AMP5 and AMP6 have considered numerous options for reducing the risks associated with the lagoons. Potential interventions investigated include strengthening of embankments, improved monitoring and surveillance, and complete removal of the sludge. We consider that the potential environmental impact of failure of a sludge lagoons and likely legislative enforcement means ongoing acceptance of the existing risk (i.e. do nothing) is intolerable.

Our analysis shows that a combination of embankment strengthening and protection from fluvial flooding combined with enhanced monitoring and surveillance provide the most cost effective solution balancing cost and risk. Through our supply chain partners, we have identified the most cost effective means of delivering these improvements at [REDACTED]. To determine investment needs across all the impacted sites, the [REDACTED] solution has then been applied to [two locations REDACTED]. . . Investigations at [REDACTED] have determined that no investment is required to maintain the structural integrity of these lagoons.

Landfill regulations – Legacy sludge incinerator landfill obligations (£29m)
The updated landfill regulations require the complete closure of Minworth Landfill through the construction of an impermeable cap to prevent infiltration of rainwater, thus minimising the generation of leachate. The cap

will be in accordance with Landfill Regulations, including Construction Quality Assurance to the satisfaction of the EA.
Feasibility investigations into identifying the technical aspects of capping Minworth Landfill are on-going. We will be incurring £1m in AMP6 on technical feasibility investigations. Based on the current status of our feasibility work, our consultants Stantec have provided a high level cost estimate.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for the sludge lagoons and landfill we have followed the company wide approach.

Lagoon costs are based on current piling works being carried out at the [Location REDACTED] sludge lagoons by Costain. This include disposal costs of hazardous material for floodplain compensation, provision of an access track enabling works and an array of vibration monitoring, as well as the actual piling works. We have few reference points for lagoon restoration work and are therefore reliant upon the cost of ongoing AMP6 work in developing our AMP7 estimate.

The landfill cost estimate was developed by Stantec (MWH) using industry standard estimating guidance and based on the known area of the landfill. We are not aware of another similar landfill comprising significant quantities of liquid sludge that has been capped/planning to be capped in the UK, so we are reliant upon third party expertise for this cost. We have used a leading international renowned consultant organisation with experts in the field to develop their best estimate.

How are customers protected?

Regulatory Mechanisms
Under the Reservoirs Act the Secretary of State can appoint independent assessors and instruct remedial activities in terms of both scope and timescales should they consider that we have failed to comply with the Act requirements.
Under the Environmental Permitting Regulations the Environment Agency may, where they consider we have contravened the regulations, issue enforcement and suspension notices against us. Where applicable, summary convictions and penalty fines can also be levied through prosecutions.

Performance Commitments
There are no performance commitments directly relating to these obligations. We consider the regulatory mechanisms provide appropriate protection for customers in the event of non-delivery.

8.4.14 Bio-resources Quality and Growth business case

Business case	Bio-resources Quality & Growth
AMP7 enhancement Capex	£23.9m
AMP7 enhancement Opex	£5.4m
Price control	Bioresources
Ofwat enhancement cost driver(s)	Table WWS2, Line 2: Sludge enhancement (quality) Table WWS2, Line 2: Sludge enhancement (growth)
Sensitive performance commitment	Satisfactory sludge disposal

What is driving the need for this enhancement investment?

We have a fundamental duty as set out in section 94 of the water industry act to empty and effectually deal with the contents of public sewers. In addition, the way in which we then treat and dispose of sewage sludge is heavily controlled by a wide range of regulations. Consequently, any changes to the amount of raw sewage received, as well as the regulatory expectations for the discharge of treated effluent and disposal of treated sludge, will directly drive a need for sludge enhancement expenditure.

Throughout AMP7, tightening environmental discharge consents will increase the amount of sludge we need to process. In particular, the additional chemical dosing we will undertake to remove meet ever tighter phosphorus limits will lead to an increase in sludge volume to be treated and disposed of. Additionally the anticipated population growth will also add to the volume of sludge we need to treat. This in turn creates a need to develop new capacity, methods or commercial agreements to cope with additional volumes beyond our current baseline.
We have used the Office of National Statistics (ONS) projections of population growth in our geographic area. From this we have calculated that an additional 4 TTDS will be received as a result of population growth. Similarly, we have calculated a further increase of 4 TTDS from the future tightening of environmental standards. To do this, we have identified the sewage works that will likely face tightening consents from the required National Environment Programme within AMP7. We have the calculated the additional volumes that will be produced when moving to a chemical sludge process at each affected sewage works.

To manage our current risks, we operate and plan to; deliver against our performance commitment of 100% satisfactory sludge disposal, and fully comply with the Biosolids Assurance Scheme (BAS). The BAS quality standard requires us to maintain retention times and processing rates in all of our sludge digestion plant. Our enhancement processes for the bioresources price control focus on the additional sludge quality required through enhanced treatment processes in order to maintain compliance. The additional requirements for growth are somewhat limited through our use of the bioresources market as discussed later.

How have we made sure that this is beneficial for our Customers?

We have sought to ensure that this identified sludge enhancement programme is optimal for customers. Our customers expect us to drive best value for our services and to do so we must find the most economic means to treat an increasing amount of sludge to increasingly higher standards.
To do this, we have sought to focus on three areas.

- Delivering a treated product that ensures access to the most efficient disposal routes.
- Actively exploring how to make effective use of the new Bio-resources market.
- Maximising throughput at existing assets by removing process bottlenecks, then delivering increases in capacity where the regional need and risk are clear.

Delivering a treated product that ensures access to the most efficient disposal routes
Making sure that the quality of our treated product is maintained minimises the risk of losing the most cost effective disposal routes and makes it more likely to compare favourably with other organic and inorganic alternatives. This is most clearly delivered through ongoing compliance with the BAS standards. These improve the likelihood of retaining access to a greater number of farms closer to our sites where we can dispose to land and recycle the nutrients back to the soil.

We have identified interventions that will improve our retention times, reduce our pathogen content and generally improve the performance and quality of our Biosolids. We are confident that this would deliver less transportation of digestate to land and a better rate per tonne to treat overall relative to a lower quality product.

Actively exploring how to make effective use of the new Bio-resources market
We believe that we can deliver a substantial efficiency through effective use of the new bio-resources market relative to an entirely internal set of capital interventions. Where sludge from our Sewage works can be transported less distance to a neighbouring wastewater company's site, we will take advantage of this efficiency. This means that we invest less in capital asset and we reduce our overall cost to treat by improving our transportation.

We have identified 17 of our sludge producing sites (an additional 2.8 TTDS across AMP7) that could be traded to other companies. This will be able to free up some existing treatment capacity at sites were we face growth pressures and therefore, negating the need for additional capacity to be installed. These anticipated capex savings have been built into this business case.
We have already secured active trades into our business and have terms ready to export sludge. This has allowed us to market test opportunities that would allow us greater resilience without the need for asset investment. These trades can and will be expanded around all of our boundaries in readiness for AMP7.

Maximising throughput at existing assets, then delivering increases in capacity where the regional need and risk are clear
After consideration of the potential for managing enhancement requirements through quality of the treated product and the use of the bio-resources market, we have identified the need for additional capacity at existing sites to ensure we have the capability to deliver. This is most acute where we are geographically constrained. At identified locations we have investigated how to maximise throughput in our existing assets by removing process bottlenecks and ensuring we are 100% compliant all of the time. We have identified increases in capacity only where the regional need and risk are clear and through use of the Bioresources market limited these increases to less than 3 TTDS.

Overall, as a result of the analysis we have undertaken, we are confident that this sludge enhancement programme is balanced in a way that is beneficial to customers. It will allow us to maintain a high quality biological product that can be disposed to land. We need to ensure we are processing the material in a way that keeps us competitive with materials from other organic and inorganic markets. However, the additional volume of incoming material will require us to upgrade some of our processes and facilities to sustain our service delivery at a high standard. Our ability to effectively dispose of the additional material from the treatment process is key to providing the customers with the service they expect. Given the interventions identified the capital programme within this business cases is lower than the AMP6 target spend.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for sludge treatment growth we have followed the company wide approach.

How are customers protected?

Regulatory Mechanisms
The Sludge (Use in Agriculture) Regulations 1989 govern the treatment standards and application methods we must adhere to for spreading of sludge to farmland. The Safe Sludge Matrix, produced by WaterUK, interprets

these requirements for water companies. In the event we are found to contravene the regulations we can be liable to conviction and a fine.

The Environmental Performance Assessment governed by the Environment Agency monitors satisfactory sludge disposal. In the event of non-compliance they are the relevant enforcement authority.

Performance Commitments

- C05 – Satisfactory sludge use and disposal – underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.4.15. First time sewerage business case

Business case	First Time Sewerage (S101a)
AMP7 enhancement Capex	£16.9m
AMP7 enhancement Opex	£0.5m
Price control	Wastewater Network +
Ofwat enhancement cost drivers	Table WWS2, Line 1: First time sewerage (s101A)

What is driving the need for this enhancement investment?

We have a duty to provide first time sewerage to properties where existing private drainage systems cause or have the potential to cause environmental / amenity damage. This duty is set out in section 101a of the Water Industry Act 1991.

Where customers make an application for a sewerage connection to existing properties, and the criteria as set out in the duty is satisfied, we are obliged to deliver a capital scheme to connect the properties involved to the public sewerage network. Unlike costs incurred due to new development, expenditure for first time sewerage of existing properties is fully recovered from the wider customer base rather than those specifically benefiting. If we did not deliver this work we would be in breach our statutory obligation.

Customers will benefit from a reduction in the risk associated with managing and maintaining private drainage networks. Concurrently, the investment will deliver a local reduction the environmental or amenity damage being caused be the current drainage arrangements.

How have we made sure that we are delivering the best option for customers?

We protect the interests of our wider customer base by undertaking an in depth survey of each first time sewerage application. This comprehensively evaluates the current drainage arrangements in the area, including their historic environmental impact (on groundwater supply and also in terms of pollutions to water courses).The survey provides confidence that the intervention is required as per the duty.

Each survey also explores the potential for the benefit of the intervention to be extended to other properties in the locality (over and above those that have made the application). This involves further survey of their drainage arrangements with the aim of ensuring that required interventions are designed in such a way that the maximum benefit is accrued. Wider buy in is encouraged through a connection offer that incentivises customers to connect from the outset.

The design and extent of each first time sewerage intervention will depend on the specific circumstances of each location. However, we take appropriate steps to ensure that we are delivering the best option that will provide the greatest benefit. We also develop solutions that take into account potential future household and trade developments in the surrounding area which may impact the appropriateness of specific solutions. Customers are actively engaged during solution development because they provide information on their existing drainage arrangements including tank size, tankering costs and regularity, and environmental impact.

During each first time sewerage survey, multiple notional solutions are developed. These include: 1) private solutions whereby the existing cesspool/septic tank is upgraded/refurbished or small package treatment solutions; and 2) public solutions whereby means of connecting to the public sewer are evaluated in terms of their cost, their appropriateness considering any planned growth in the area, and the impact of the scheme on customers. The solution whose whole-life performance is considered most cost effective is then included in programme development. During the design and delivery, further optioneering and design is considered to make sure that the most effective variant of the chosen solution is delivered. Where applicable we also look for innovative solutions for pumping and treating low volume flows.

How have we demonstrated that the costs are robust and efficient?

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency. In order to determine robust and efficient cost estimates for first time rural sewerage we have followed the company wide approach.

How are customers protected?

Regulatory Mechanisms

We have a legal duty under the Water Industry Act s101A to provide first time rural sewerage where a duty is identified. Where a duty is accepted, or the Environment Agency has determined that the duty exists in the case of a dispute, enforcement action will be undertaken in the event that the connection is not made within time frame agreed.

Performance Commitments

We do not have a performance commitment relating to first time rural sewerage. Whilst we did have a commitment at PR14 this was in response to a challenge for us to demonstrate we were meeting all statutory obligations and legal duties. We do not think that a performance commitment is necessary as there are other regulatory mechanisms in place to ensure we comply with our obligations.

8.4.16. Developer service business case

Business case	Developer Services and Network Reinforcement (Waste Network+)
AMP7 enhancement Capex	Net -£2m (Gross £70m)
AMP7 enhancement Opex	£0
Price control	Waste Network +
Ofwat enhancement cost assessment drivers	Table WWS2, Line 25: New development and growth

What is driving the need for this enhancement investment?

We have a duty under the Water Industry Act 1991 (s94) and our licence to ensure that our sewerage and waste water treatment systems can ‘effectually drain’ a catchment. As part of discharging our duties under the Water Industry Act we must ensure that we provide a new public sewer if requested (a sewer requisition under s98), that we adopt suitably constructed sewers (s104), that we allow connections to our sewers (s106) and that we provide sufficient capacity in our sewers and at our treatment works such that performance does not deteriorate.

The investment that we make in doing this is broadly split into 2 areas:

- The on-site work of laying new sewers and providing a connection to the existing network (that may involve the requisition of a new sewer) as well as any cost incurred in adopting new mains that have been built.
- The off-site work to reinforce the existing network to ensure there is sufficient capacity to drain and treat the additional flows.

This is an enhancement investment because it is creating new assets, or assets with additional capacity that leads to us being able to serve additional customers. We have a statutory duty to invest in the on-site works to allow the connection of a new development to our existing network.
There is some degree of optionality around how and when we reinforce our network to ensure new customers can be connected without detriment to existing asset performance. However not investing in network reinforcement would result in deterioration of our performance on sewer flooding metrics, pollution and permit compliance. Sewer Flooding and pollution are both important issues for our customers and stakeholders with preferences for improvement. Any deterioration would be unacceptable to them. Compliance with our Environmental Permits is a legal requirement and non-compliance could result in enforcement or prosecution.

The level of infrastructure network reinforcement cost could vary significantly between companies depending on local planning policy and the level of engagement between companies and developers in each region, and the other network activity being undertaken in the relevant areas as explained in the next section.

In addition, the changes to the charging rules for English companies which are being brought in over the next two years add to the complexity of this enhancement spend as historic data trends may not be directly comparable to future trends. As the changes to the charging rules are implemented companies will be working on projects and collecting income under both the old and the new charging regimes for most of AMP7. We also note that these changes do not currently apply in Wales creating further differences across the industry and making any cost modelling more difficult.

We set out below how the costs and income from the relevant data tables (App28 and WWS2)

Firstly we look at the costs included in the plan

WWS2			20/21	21/22	22/23	23/24	24/25	AMP7
25	New development and growth	£m	16.9	14.3	11.5	10.6	17.0	70.4

The total capital costs forecast in our plan as shown above are £70m in AMP7.

By using the data on App28, and our plan data, the 'new developments' line above can be split between onsite costs (Requisitions and adoptions) and infrastructure network reinforcement (offsite costs).

	20/21	21/22	22/23	23/24	24/25	AMP7

23 (App28)	*Total infrastructure network reinforcement expenditure for new water connections*	*£m*	*14.3*	*11.5*	*8.5*	*7.5*	*13.9*	***55.7***
	Requisitions costs (including lateral drains on adoption inspection costs	*£m*	*1.5*	*1.6*	*1.7*	*1.7*	*1.8*	***8.4***
	On site adoptions (inspections)	*£m*	*1.2*	*1.2*	*1.3*	*1.3*	*1.4*	***6.4***
	Total (as per WS2)	***£m***	***16.9***	***14.3***	***11.5***	***10.6***	***17.0***	***70.4***

The adoptions costs are costs incurred by us to inspect assets prior to adoption, and do not relate to payments to developers for assets.

Secondly we look at the income streams shown on App28

The total grants and contributions include three developer services income streams (in bold below) which relate to the enhancement spend above. None of the other income shown on App28 relates to the developer services enhancement capex included on WWS2.

The diversions income and "other contributions" offset against IRE (infrastructure renewals expenditure), and MNI (maintenance non infrastructure) spending and are not related to developer services enhancement capex costs.

	Grants and contributions		20/21	21/22	22/23	23/24	24/25	AMP7
24a	*Infrastructure charge receipts gross*	*£m*	*9.5*	*9.0*	*10.4*	*10.2*	*11.5*	*50.6*
24b	*Less income offset*	*£m*	*-0.7*	*-0.8*	*-0.8*	*-0.8*	*-0.9*	*-4.0*
24	**Infrastructure charge receipts (s146)** *[Net]*	**£m**	**8.8**	**8.2**	**9.6**	**9.4**	**10.6**	**46.6**
25	**Requisitioned sewers (s100)**	**£m**	**1.5**	**1.6**	**1.7**	**1.7**	**1.8**	**8.4**
26	**Other contributions (price control)** [inspections]	**£m**	**3.1**	**3.3**	**3.5**	**2.6**	**2.6**	**17.1**
27	Diversions (s185)	£m	15.6	3.9	2.5	2.6	2.6	27.2
28	Other contributions (non-price control)	£m	0	0	0	0	0	0
13	Total grants and contributions ~ wholesale water service	£m	29.1	17.1	17.3	17.2	18.7	99.3

The total net developer services income is therefore £72.1m, being the sum of lines 24-26 shown above. This results in a net income of £1.7m in our plan, which is explained in the table below.

	Cost	**Income**	**Difference**	**Reason**
Requisitions	£8.4m	£8.4m	-	100% recovered from developers
Infrastructure network reinforcement	£55.7m	£50.6m	£5.1m	Timing difference (before income offset)
Income offset		(£4.0m)	£4.0m	
Lateral drains and sewer adoption inspections	£6.4m	£17.1m	(£10.7m)	Income calculated at 2.5% of the value of assets adopted based on the "sewers for adoption" guidelines.
Total	**£70.4m**	**£72.1m**	**(£1.7m)**	

Therefore there is no net cost in totex.

How have we made sure that we are delivering the best option for customers?

The need for the investment is statutory but we do have options around how, where and when we provide connections and additional capacity. There are a number of ways in which we do this to ensure that we provide the most cost effective or cost beneficial option:

- We engage with developers at an early stage in the planning process to discuss site layout and possible connection points such that the impact on our existing network is minimised where possible.
- We consider whether there are any linkages to other capital maintenance or enhancement needs within the area. For example we may be able to deal with existing sewer flooding problems at the same time as providing capacity for growth.
- We will evaluate wider system options as well as local options. For example there may be an option to transfer an area into an alternative catchment rather than upsizing all the sewers.
- Where there are multiple development sites in an area we will consider them holistically and look at whether a strategic level capacity solution may be more cost effective than accommodating development piecemeal.
- We will always look to optimise our existing network before considering solutions that require additional capacity. This could be interventions such as altering flow controls or separating surface water from combined systems and installing sustainable drainage (SuDS).

We have worked with developers and local councils to understand their local plans and obtain the best available information. However there is still an element of uncertainty in this as development is frequently driven by macro-economic factors and Government policy. The forecasts used for our new development and network reinforcement investment are consistent with those used in our long term Drainage and Wastewater Management Plans (DWMPs) and use the same base data as our Water Resource Management Plans (WRMPs).

We note that the costs anticipated this AMP are significantly higher than in AMP6. This is due to the requirement for key schemes in AMP7, and we anticipate that the requirements in AMP8 will return to levels similar to previous AMPs.

How have we demonstrated that the costs are robust and efficient?

We have benchmarked our costs and this has shown that we are one of the best in the industry in this area. Whilst costs have risen in recent years, our ongoing contract negotiations with suppliers is anticipated to bring these costs down, and this is reflected in our plan. However, we note that we are facing pressures (as outlined in the Arcadis report) due to the high demand for skilled workers.

Our approach to cost efficiency is described in chapter 20 – Securing Cost Efficiency.

How are customers protected?

Regulatory Mechanisms
As described above, we have statutory duties under the Water Industry Act to allow connections to our network and to ensure our sewerage system is able to accommodate new developments. In the event of non-compliance enforcement action via the Secretary of State will be triggered.

For the non-contestable work (of which the infrastructure renewals is the major part), we can demonstrate that our costs are efficient, and as set out above, we proactively work with developers and local authorities to try and ensure these costs are minimised.

Performance Commitments

- D-Mex – underperformance penalties apply

Read more: More information can be found in A3 – Designing performance commitments and A4 – Designing outcome delivery incentives

8.5 COST CLAIM PROFORMAS

This section includes the completed Ofwat proformas for our cost claims.

Name of claim	Wastewater quality
Name identifier of related claim submitted in May 2018	01 WWQae Wastewater quality
Business plan table lines where the totex value of this claim is reported	**WWS1** A1 (£3.4m), A7 (£5.2m) A8 (£6.2m) B14 (£72.4m)and B15(£311.4m) **WWS2** A7 (£3.8m), A8 (£0.4m), A9 (£13.0m), A10 (£3.2m), A11(£30.5m), A16 (£5.8m), A18 (£102.5m), A19 (£83.8m), A20 (£32.9m), A22 (£107.8m), Block B (opex) – various NEP lines (£14.8m)
Total value of claim for AMP7	£398.6m (Note – WWS2 contains flow through of £27.6m opex costs relating to AMP6 WFD schemes coming online in 2019/20)
Total opex for AMP7	£14.8m
Total capex for AMP7	£383.8m
Depreciation on capex in AMP7 (retail only)	N/a
Remaining capex required after AMP7 to complete construction	N/a
Whole life totex of claim	£943m (over 60 years)
Company estimated claim value covered by cost baseline	£123.6m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	16% of wastewater network plus totex (WWS2 line B21)
Does the claim feature as a Direct Procurement for Customers (DPC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment/ expenditure	Two main statutory drivers underpin the need for the wastewater quality enhancement investment: the Water Framework Directive and the Urban Waste Water Treatment Directive. The specific enhancement requirements we are obliged to deliver are set out in the Water Industry National Environment Plan 3 (WINEP3), issued by the Environment Agency in March 2018.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 16: A thriving environment
Need for the adjustment (if relevant)	We believe the wastewater quality enhancement programme we have proposed is materially different in size and characteristic to that seen in previous AMP periods. Consequently modelling based on the geographical distribution of past expenditure is not likely to be representative.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 16: A thriving environment
Outside of management control (if relevant)	As noted above, these are statutory requirements. However, we have and continue to invest over multiple AMP periods to smooth bill impacts and deliver only those schemes which are necessary each AMP to enable us to ultimately comply with the 2027 full completion deadline.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 16: A thriving environment
Best option for customers (if relevant)	The work that we've done to investigate the need, define innovative solutions and align with other drivers to lever in additional benefits gives us confidence that the activities planned for AMP7 efficiently deliver for the environment in accordance with customers' wishes and our statutory requirements. We have also worked very closely with the EA, utilising our systematic 'source to estuary' catchment approach, to ensure that solutions will be delivered at the optimal time.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 16: A thriving environment Chapter 20: securing cost efficiency

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Robustness and efficiency of costs	Whilst our wastewater quality programme is driven by statutory requirements, we've not taken the view that costs are outside of management control. We've challenged ourselves, and our approach has allowed us to make successive reductions in the proposed programme costs. To achieve further savings for our customers, we've worked collaboratively with the EA to try and ensure only necessary work is undertaken.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 20: securing cost efficiency
Customer protection (if relevant)	Despite our close and ongoing engagement on the development of WINEP3, we recognise that there is uncertainty over full scope of investment required until the WFD improvement schemes are approved by the Secretary of State in 2021. To mitigate this risk for customers, we have only made provision for enhancements in the business plan are currently graded by the EA as Green, or Amber projects that deliver multiple benefits. For the remaining less certain projects, we have developed the real options mechanism that will be triggered when the programme is finally confirmed. This is to protect customers from funding components of the latest version of WINEP that may prove to be unnecessary.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Appendices A3 and A4: Designing Performance Commitments and Designing outcome delivery incentives
Affordability (if relevant)	See above and further detail in the relevant chapter of our plan	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 7: Addressing affordability and vulnerability
Board assurance (if relevant)	The Board have been integral to the development of the cost claim.	Chapter 2: Our Board's confidence in this plan and Chapter 23: Securing trust, confidence and assurance

Name of claim	Water supply demand balance
Name identifier of related claim submitted in May 2018	02 SDBae Water supply and demand
Business plan table lines where the totex value of this claim is reported	**WS1** A7 (£19.9m) B14 (£31.4m) and B15(£251.2m) **WS2** A8 (£116.6m) A10 (£30.4m) A18 (£40.9m) A19 (£12.9m) A20 (£15.2m) A21 (£28.3m) A22 (38.4m) B49 (£4.6m) B57 (£15.3m) **WR2** A4 (£13.0m)
Total value of claim for AMP7	£302.4m
Total opex for AMP7	£19.9m
Total capex for AMP7	£282.5m
Depreciation on capex in AMP7 (retail only)	N/a
Remaining capex required after AMP7 to complete construction	N/a
Whole life totex of claim	£915m (over 60 years)
Company estimated claim value covered by cost baseline	£162.1m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	10% of water services totex (from WS1 B21)
Does the claim feature as a Direct Procurement for Customers (DPC) scheme?	Part of this claim relates to a DPC scheme for further details see Section 8.8 of this appendix and Chapter 21: Markets and innovation

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment/ expenditure	Our draft Water Resources Management Plan (dWRMP) showed a deficit of 164Ml/d at the end of AMP7 increasing to 320 Ml/d by the end of AMP8. This shortfall reflects two key drivers: 1. Reductions in our abstraction licences relating to WINEP3, a legal requirement. 2. The impact of climate change.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there
Need for the adjustment (if relevant)	We modelled a large number of alternative supply / demand scenarios. Our analysis shows that there is a high level of certainty that three supply schemes will need to start in AMP7 in order to solve spatially distinct deficits driven by WINEP3 abstraction reductions.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there
Outside of management control (if relevant)	While there are statutory drivers for this investment, we have challenged the need case and worked with the Environment Agency to manage down the requirements where possible.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there
Best option for customers (if relevant)	We have worked with our Water Forum (customer challenge group) for over two years and have been actively debating and developing our proposals over that time. We have worked closely with the Environment Agency (EA) to deliver the environmental objectives of the WFD in the most affordable way for our customers without putting security of supply at risk.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there Chapter 20: securing cost efficiency

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Robustness and efficiency of costs	The assessment of the overall cost estimate is based on Ofwat's PR14 approach. Our analysis used unit cost data from the Water Resources market information published by all companies in 2018, but removed disproportionately costly solutions included in this dataset.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 20: securing cost efficiency
Customer protection (if relevant)	We are proposing to invest in three schemes, and deliver them in AMP7. If additional supply schemes are required, our proposed uncertainty mechanism and associated ODI will be used to fund them.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Appendices A3 and A4: Designing Performance Commitments and Designing outcome delivery incentives
Affordability (if relevant)	We have worked with the EA to move from an initial scenario requiring more investment in AMP7, to a risk based environment programme that meets our WFD objectives over a 10 year period. The benefit of this approach is that it is more affordable as the cost is spread over a longer period and only incurred when absolutely necessary.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 7: Addressing affordability and vulnerability
Board assurance (if relevant)	The Board have been integral to the development of the cost claim, the draft WRMP and progression to the final WRMP.	Chapter 2: Our Board's confidence in this plan and Chapter 23: Securing trust, confidence and assurance

Name of claim	Resilience
Name identifier of related claim submitted in May 2018	03 RESae Resilient water service
Business plan table lines where the totex value of this claim is reported	**WS1** B14 (£57.4m) & B15(£77.9m) **WS2** A14 (£135.4m)
Total value of claim for AMP7	£135.4m
Total opex for AMP7	N/a
Total capex for AMP7	£135.4m
Depreciation on capex in AMP7 (retail only)	N/a
Remaining capex required after AMP7 to complete construction	N/a
Whole life totex of claim	£179m (over 60 years)
Company estimated claim value covered by cost baseline	£61.4m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	5% of water network plus totex.
Does the claim feature as a Direct Procurement for Customers (DPC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment/ expenditure	Assets, systems and networks, by their very nature, will deteriorate with time, be subjected to external shocks and stresses and could eventually fail. To mitigate the customer impact of asset failure, interventions can be undertaken that will ensure that this risk is kept at an appropriate level. This can be either through investing to reduce the likelihood of failures occurring or minimising their impact on customers when they do.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there
Need for the adjustment (if relevant)	Resilience enhancement interventions are required where the current level of risk is assessed to be too great and needs to be systematically and permanently lowered. The need to make resilience enhancement interventions across several different types of strategic assets has been developed where current levels of risk are out of step with customer expectations.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there
Outside of management control (if relevant)	We have carried out an extensive risk analysis across a range of asset types. This, alongside our recent experiences, suggests that expectations are higher than those assumed when investment decisions were made in earlier AMP periods. Where any systems and assets have been designed (or modified) to provide resilience but currently do not, they have been excluded from this claim.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there
Best option for customers (if relevant)	Following identification high priority assets and systems that require intervention to satisfy customer resilience expectations, we have sought to ensure that the method on increasing resilience is both optimal and cost beneficial. We have also re-engaged with customers and the water forum to ensure that the proposed programme is appropriate	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 12: Water always there 20: securing cost efficiency
Robustness and efficiency of costs	The extent of our work in formulating this business case includes many thousands of hours of engineering and customer research time. For each asset type our ‘optioneering’ has been extensive. We have scoped, designed and costed over 60 different schemes to ensure only the most optimal are included.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 20: securing cost efficiency

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Customer protection (if relevant)	We are proposing a performance commitment to protect customers, which focuses on delivering a service level that they expect – percentage of customers whose service to the tap can be restored within 24 hours of a single failure event in their normal supply route.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Appendices A3 and A4: Designing Performance Commitments and Designing outcome delivery incentives
Affordability (if relevant)	Our customers, through research, have told us they are willing to pay for the improvement to resilience.	Severn Trent Cost adjustment claims [May 2018 submission] Sections 8.3, 8.4 and 8.7 of this appendix Chapter 7: Addressing affordability and vulnerability
Board assurance (if relevant)	The Board have been integral to the development of this cost claim.	Chapter 2: Our Board's confidence in this plan and Chapter 23: Securing trust, confidence and assurance

Name of claim	[claim REDACTED]
Name identifier of related claim submitted in May 2018	
Business plan table lines where the totex value of this claim is reported	
Total value of claim for AMP7	
Total opex for AMP7	
Total capex for AMP7	
Depreciation on capex in AMP7 (retail only)	
Remaining capex required after AMP7 to complete construction	
Whole life totex of claim	
Company estimated claim value covered by cost baseline	
Materiality of claim for AMP7 as a % of the totex of the relevant controls	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme?	

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Outside of management control (if relevant)		
Best option for customers (if relevant)		
Robustness and efficiency of costs		
Customer protection (if relevant)		
Affordability (if relevant)		
Board assurance (if relevant)		

Name of claim	Water treatment works economies of scale
Name identifier of related claim submitted in May 2018	05-WES-mc
Business plan table lines where the totex value of this claim is reported	WN6 – Section D WS1 – line 9, Line 13
Total value of claim for AMP7	£41m AMP7 Totex
Total opex for AMP7	
Total capex for AMP7	
Depreciation on capex in 2020-2025 (retail controls only)	N/a
Remaining capex required after 31 March 2025 to complete construction	N/a
Whole life totex of claim	N/a
Materiality of claim for AMP7 as a % of the totex of the relevant controls	2.0%
Does the claim feature as a Direct Procurement for Customers (PDC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment/ expenditure	This claim relates to routine expenditure to deliver core service to customers which are subject to wider customer protection measures. The claim is based on the assertion that Ofwat's econometric models will not adequately account for primary cost drivers (in this case treatment economies of scale), rather than the case for optimal expenditure outside of the modelling data set and beyond management control.	See Severn Trent Cost modelling consultation response (4 May 2018), specifically 'Economies of scale' chapter.
Need for the adjustment	Economies of scale are a primary driver of water treatment, network plus and wholesale expenditure: larger treatment works can allow for significantly lower treatment costs per unit. However, half of Ofwat's network plus and wholesale water models (and 6 of its 10 water treatment models) do not seek to capture opportunities for economies of scale in water treatment. The other models may capture opportunities for economies of scale to some extent, but only partially: through reliance on one of two density variables. Population density is clearly relevant to opportunities for economies of scale, and urban populations may allow for larger plants to be efficiently developed and operated. But there are 3 key factors that undermine the adequacy of relying on the density variables the initial model has used to capture opportunities for economies of scale: i) The size, location and condition of available water resources: the proximity of available water resources to demand centres matters, as does whether those sources are surface or groundwater. ii) The extent to which densely populated groups of customers are in practice dispersed. iii) The 'sunk' nature of historical decisions concerning the location and scale of long-lived treatment assets. The second point is particularly relevant for Severn Trent Water. While we serve a large number of customers that are located in densely populated urban areas, we also serve a large number of	Discussion on basis for the primary driver of economies of scale in both treatment and network is described in detail in the 'Economies of Scale' chapter of the Severn Trent Cost modelling consultation response (4 May 2018) Discussion of current model coverage, opportunities of treatment economies of scale and the specific circumstance of Severn Trent set out in **"Severn Trent and Hafren Dyfrdwy supporting report (Arup)"** submitted with the consultation response (4 May 2018).

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
	geographically dispersed urban areas. This has a material bearing on opportunities for economies of scale, and is not captured in the density measures used. That is, there is a significant difference – in terms of costs - between serving a population of a given density level, when that population resides in a small number of larger cities, as compared with when they reside in a larger number of smaller cities. We have reviewed the distribution of WTWs across all companies and see that there is no clear relationship with density. This is because of the above factors and proves that models which rely on density alone to proxy for economies of scale will not adequately account for the costs that companies actually face.	
Robustness and efficiency of costs	To ensure appropriate model coverage, we recommend that treatment economies of scale should be considered directly through an asset size metric (with appropriate care taken to account for the systemic differences between SW and GW treatment assets). In May, we have considered two potential solutions and tested them using the Ofwat treatment econometric models. When averaged, this suggested a modelled detrimental impact of £41m on AMP7 predicted totex for Severn Trent if not taking account of treatment economies of scale. We have now tested the modelling impact of including the number of WTWs and the GW:SW ratio across all triangulated modelling streams – which we consider to be more robust. This also gives a detrimental impact of £41m. The exact position in the range will depend on the final specification and coverage of the Ofwat models used for PR19. The need for a material adjustment in all of our modelling tests supports our view that treatment economies of scale is a primary cost driver. A model adjustment would be needed if Ofwat's chosen models do not take appropriate account of economies of scale.	Methodology and impact of including WTW economies of scale on WTWs set out in **"Severn Trent and Hafren Dyfrdwy supporting report (Arup)"** submitted with the consultation response (4 May 2018). Further model testing also set out in 'Economies of scale' chapter of the Severn Trent Cost modelling consultation response (4 May 2018)

We do not consider the remaining categories from the pro-forma are specifically relevant to this claim. However, further detail can be found in relation to our approach to customer protection, cost efficiency, affordability and assurance in the relevant chapters of our narrative.

Name of claim	Sewage treatment works economies of scale
Name identifier of related claim submitted in May 2018	06-SES-mc
Business plan table lines where the totex value of this claim is reported	WWn8 – Section B WWS1 – line 9, line 13
Total value of claim for AMP7	£72m AMP7 Totex
Total opex for AMP7	
Total capex for AMP7	
Depreciation on capex in AMP7 (retail only)	N/a
Remaining capex required after AMP7 to complete construction	N/a
Whole life totex of claim	N/a
Company estimated claim value covered by cost baseline	£0m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	2.7%
Does the claim feature as a Direct Procurement for Customers (PDC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment	The claim relates to routine expenditure to deliver core service to customers which are subject to wider customer protection measures. The claim is based on the assumption that Ofwat's econometric models will not adequately account of treatment economies of scale.	Severn Trent Cost modelling consultation response (4 May 2018), specifically 'Economies of scale' chapter.

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for cost adjustment	Economies of scale are a primary driver of wastewater treatment, network plus and wholesale expenditure: larger treatment works can allow for significantly lower treatment costs per unit. Ofwat recognises the materiality of this issue, by including an explicit economies of scale based variable in all 6 of its wastewater treatment models, and all 8 of its wholesale wastewater models. We think this principle should be extended to the network plus models (which sit between its treatment and wholesale models). The current models assume that economies of scale can be adequately captured by including a variable for the proportion of load treated at band 1-3. We agree that load treated in these bands will have a much higher unit cost. However, our analysis shows that unit costs reduce on average as scale increases across all bands. Given that only a tiny fraction (4% on average) of load is treated at these small works, differences in costs at these works are not likely to drive material differences in efficiency across companies. Therefore, it is much more important to focus attention on the whole of the asset base, acknowledging the significant differences in unit costs even across the very largest STW's. While Severn Trent have some extremely large STW's (such as Minworth which serves Birmingham) that yield very low unit costs, we also have one of the highest number of small STWs (limiting opportunities for economies of scale) in the industry due to some of the very rural areas that we serve. This is shown by the fact that the capacity of the firm's bands 1-3 works is substantially lower than the industry average (12% lower). Over the whole of the asset base, SVT has an average capacity that is 20% lower than the industry average. We realise that these industry average capacity figures are skewed by the presence of one large outlier firm (Thames Water) with works capacity that dwarves all others. Given the impact of this outlier firm on estimates of efficiency, and given the poor engineering logic underlying the "bands 1-3" cost driver, we believe that Ofwat's proposed models are unfairly biased against Severn Trent.	Section 8.6.3 of this appendix. The basis for the primary driver of economies of scale in wastewater treatment is described in further detail in the our response to the Cost modelling consultation response (4 May 2018) Review of the current model coverage, opportunities for treatment economies of scale and the specific circumstance of Severn Trent are set out in **"Severn Trent and Hafren Dyfrdwy supporting report (Arup)"** submitted with the consultation response (4 May 2018).

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Robustness and efficiency of costs	We have considered how to best account for treatment economies of scale in econometric models in two ways. The first adds the total number of sewage treatment works as model variable. The second adds the average utilised capacity (total load treated / number of STWs) as a model variable. We have observed little difference in model performance between the two approaches. However, we have chosen average utilised capacity on theoretical grounds. This is because average utilised capacity will make better allowance for the known variance of trade effluent across the industry. The amount of trade effluent treated will also impact on the opportunity for economies of scale. Any claim will depend on the final specification and coverage of the Ofwat models used for PR19. A modelling adjustment would be needed if Ofwat's chosen models do not take appropriate account of wastewater treatment economies of scale. It should be noted that in developing our cost claim, we used a load variable that we have composed ourselves based on the population equivalent value for each company. For most companies this was identical to the load figures in Ofwat's master file but for some it was different and did impact on various company results.	Methodology and impact of including STW economies of scale set out in **"Severn Trent and Hafren Dyfrdwy supporting report (Arup)"** submitted with the consultation response (4 May 2018). Further model testing also set out in the Severn Trent Cost modelling consultation response (4 May 2018)

We do not consider the remaining categories from the pro-forma are specifically relevant to this claim. However, further detail can be found in relation to our approach to customer protection, cost efficiency, affordability and assurance in the relevant chapters of our narrative.

Name of claim	Sewage treatment works complexity
Name identifier of related claim submitted in May 2018	07-STC-mc
Business plan table lines where the totex value of this claim is reported	WWn8 – Section C WWS1 – line 9, line 13
Total value of claim for AMP7	£55m AMP7 Totex
Total opex for AMP7	
Total capex for AMP7	
Depreciation on capex in AMP7 (retail only)	N/a
Remaining capex required after AMP7 to complete construction	N/a
Whole life totex of claim	N/a
Company estimated claim value covered by cost baseline	£0m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	2.1%
Does the claim feature as a Direct Procurement for Customers (PDC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment	This claim relates to routine expenditure to deliver core service to customers which are subject to wider customer protection measures. The claim is based on the assertion that Ofwat's econometric models will not adequately account for primary cost drivers (in this case treatment complexity), rather than the case for optimal expenditure outside of the modelling data set and beyond management control.	Severn Trent Cost modelling consultation response (4 May 2018), specifically 'treatment complexity' chapter.
Need for cost adjustment	Treatment complexity is a primary driver of wastewater expenditure. Treatment costs are driven by the load received and the level of treatment required, which is itself a function of the underlying volume and quality of the receiving water: the more stringent the quality requirements, the more complex and energy intensive the treatment process, the higher the cost. Ofwat has not sought to capture treatment complexity at all in 2 of its 6 treatment models, and 8 of its 10 network plus models. None of Ofwat's wholesale water models appear to seek to capture this primary cost driver. In the models where Ofwat has sought to capture treatment complexity, it has used a single explanatory variable that is highly limited in terms of the extent to which it can expected to pick up treatment processes that drive costs. Specifically, the 1mg/l ammonia consent measure. In practice, Ofwat's measure does very little to distinguish between the differing treatment requirements that companies have. Only two companies (with less than 15% of their load) are captured. All other load is assumed to have no complexity price pressure. This is not representative of the variance in complexity across the country. We have reviewed the distribution of tight consents across the sector. Severn Trent will be materially adversely affected relative to the wider	Section 8.6.4 of this appendix Discussion on basis for treatment complexity is described in the Severn Trent Cost modelling consultation response (4 May 2018) A review of current model coverage, the impact of complexity and the specific circumstances of Severn Trent is set out in **"Severn Trent and Hafren Dyfrdwy supporting report (Arup)"** submitted with the consultation response (4 May 2018).

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
	sector in the absence, or poor specification of a treatment complexity cost driver. This is influenced by the fact that we have no coastal discharges and our large STWs discharge into relatively small (in-land) receiving waters (i.e. we are constrained due to geography).	The engineering and economic basis for treatment costs based on complexity is set out in Jacobs wastewater cost driver report: https://www.ofwat.gov.uk/wp-content/uploads/2018/03/SVT_Jacobs-Wastewater-cost-drivers-report-Final.pdf
Robustness and efficiency of costs	We have tested the impact of changing the treatment complexity variable to the proportion of works that have a tertiary treatment stage, thereby taking account of a wide range of more complicated treatment consents. We also included in these models the variable measuring the average capacity of STW's. This is important because in order to obtain an accurate estimate of the impact of treatment complexity, we must ensure that differences in economies of scale at sewage treatment works are appropriately accounted for in the models. We derive the claim amount as the difference in the allowance between models with and without the treatment variable. Once again, we only used models of network costs that included a density term as this is such a structurally important variable. This improved both the theoretical and econometric specification of the models, resulted in an improvement in relative efficiency for Severn Trent and led to a rise in our allowance of £55m. Any claim will depend on the final specification and coverage of the Ofwat models used for PR19. The need for a material adjustment in all of our modelling tests supports our hypothesis that treatment complexity is a primary cost driver. A model adjustment would be needed if Ofwat's chosen models do not take appropriate account of this complexity.	Methodology and impact of including STW complexity is set out in **"Severn Trent and Hafren Dyfrdwy supporting report (Arup)"** submitted with the consultation response (4 May 2018). Further model testing set out in the Severn Trent Cost modelling consultation response (4 May 2018) specifically 'treatment complexity' chapter.

We do not consider the remaining categories from the pro-forma are specifically relevant to this claim. However, further detail can be found in relation to our approach to customer protection, cost efficiency, affordability and assurance in the relevant chapters of our narrative

Name of claim	Developer services costs
Name identifier of related claim submitted in May 2018	08-DEV-mc
Business plan table lines where the totex value of this claim is reported	WN6 – Section E WS1 – Line 14, 15, 16 WS2 – Line 11, 12
Total value of claim for AMP7	£179m
Total opex for AMP7	£0m
Total capex for AMP7	£179m
Depreciation on capex in AMP7 (retail only)	n/a
Remaining capex required after AMP7 to complete construction	n/a
Whole life totex of claim	n/a
Company estimated claim value covered by cost baseline	£79m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	6.5%
Is the claim likely to feature as a Direct Procurement for Customers (DPC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment	We have assumed our costs remain stable in this area. Given we are competing with large construction firms for some of this work, the prices, and therefore costs need to be efficient. We have based our growth forecast on published government data regarding housebuilding volumes. We believe are charges are in line with others in the industry based on published data.	Section 8.4.9 of this appendix **"Severn Trent 08 modelling claim supporting document"** section B. (Summary of published data for comparison to modelled costs with links to published documents). [May 2018 submission]
Need for cost adjustment	Developer services costs comprise of 3 main elements: (i) new mains laying (requisitions); (ii) connections from properties to a main (new connections); and (iii) network reinforcement (off site upgrades to existing water company assets). We expect to incur £170m of costs associated with developer related activities in AMP6 (or £220m including network reinforcement). This is driven by the volume of new builds and the Charging Rules. These rules limit what we can recover from developers and require us to hold the balance stable between what customers, and what developers pay for this new infrastructure. Government forecasts show that home building will increase in the West Midlands, resulting in an estimated 15% additional volume compared to AMP6. Using this growth data and holding costs flat this suggests costs of c.£188m. (£258m including network reinforcement). The need for the cost adjustment arises because the model outputs do not reflect actual costs. We think this is because not all companies are reporting the three costs in the model input.	Section 8.4.9 of this appendix **"Severn Trent 08 modelling claim supporting document"**, section A (summary of types of cost and comparison to data used in Ofwat models). [May 2018 submission] **"Severn Trent 08 modelling claim supporting document"**, section B. (Summary of published data for comparison to modelled costs with links to published documents). [May 2018 submission]

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
	This results in an unreliable model output, when compared to actual costs. Using the Government growth projections, the Ofwat cost models only allow for £79m, a potential shortfall approaching 70% of totex. As our volumes of new connections are the highest in the industry, the model error has a more significant effect on our company, compounding the issue.	
Management control	New development (requisitions) costs are contestable. Therefore we believe our costs are efficient, as we compete for work in the market. Asset value payments (which also form part of this capital spend) are based on these same, market tested, costs. The contestable spend represents c. 50% of our total cost. Ofwat's guidance, set out in the new charging framework for developer services, is clear that the existing balance of costs paid by developers' vs. customers should be maintained in future. This results in approximately 10% of new development costs ("on site" costs excluding new connections) being paid by the developer with the remaining 90% funded by customers (as previously calculated by the value of 12 years billed revenue from the newly connected properties). This means the shortfall falls on STW and not developers. All non-contestable elements, where efficiently incurred, are 100% recoverable from developers. Therefore, these should not impact totex allowances and should not be part of the modelled costs. However we note the difficulty faced by Ofwat in splitting costs consistently and therefore an 'all in' method may be the only suitable approach. Although we note that depending on the location and type of new development the required costs could still have significant variation between companies who were equally efficient. Volumes of activity are outside of management control as are determined by the level of housebuilding in the region.	Section 8.4.9 of this appendix **"Severn Trent 08 modelling claim supporting document"**, section B. (Summary of published data for comparison to modelled costs with links to published documents). [May 2018 submission] **"Severn Trent 08 modelling claim support – ONS table 406"** excel file. This is an ONS data set on forecast household volumes, This data is used as the basis for our forecast growth projections which will form part of our plan, in conjunction with correspondence from the relevant local authority planning teams to ensure local plans are reflected in our forecasts. The historical period on which the model is based was a period of low growth, and therefore it is important these future projections are taken into account. [May 2018 submission]
Affordability	100% of new connections and 'off site' reinforcements is paid by developers. That is developers pay c. 55% of our total costs (ignoring any discount schemes). The driver of cost increases from AMP6 in our forecast is purely volume related. We are forecasting to be able to hold costs at current levels (plus CPIH).	Ofwat's consultation and decisions on charging rules for developer services.

Name of claim	Energy price increases
Name identifier of related claim submitted in May 2018	09-EGY-mc
Business plan table lines where the totex value of this claim is reported	Wr8 – Section B Wn6 – Section F WWn8 – Section D WS1 – Line 1 WWS1 – Line 1
Total value of claim for AMP7	£20m (Water resources) £85m (Water N+) – AMP7 Totex £80m (Waste N+) – AMP7 Totex
Total opex for AMP7	£20m (Water resources) £85m (Water N+) – AMP7 Totex £80m (Waste N+) – AMP7 Totex
Total capex for AMP7	£0
Depreciation on capex in AMP7 (retail only)	N/a
Remaining capex required after AMP7 to complete construction	N/a
Whole life totex of claim	N/a
Company estimated claim value covered by cost baseline	£0m
Materiality of claim for AMP7 as a % of the totex of the relevant controls	5.3% (Water resources) 3.1% (Water N+) 3.1% (Waste N+)
Does the claim feature as a Direct Procurement for Customers (PDC) scheme?	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for investment	Electricity price is primarily a product of wholesale market rates and a number of 'pass-through' costs which relate to recovery of network charges, capacity incentives and Government policies. In recent years, wholesale rates have been maintained at relatively stable levels in real terms whilst 'pass-through costs' (also known as non-commodity costs) have continued to rise year-on-year. Of the expected rise in costs over 80% relates to the pass through element. In 2017-18 we saw a 13% rise in our total electricity unit price compared to 2016-17 and we expect rises beyond inflation throughout the remainder of AMP6 and AMP7. In addition to the known price factors, there are a number of ongoing reviews into the energy market which will also affect our prices. These include Ofgem's Distribution Charging Methodology Review, the Charging Futures workstream, and the Target Charging Review Significant Code Review.	We commissioned Cornwall Insights to provide electricity price forecasts for the 'pass-through components' based on our demand portfolio ("**Severn Trent 09 modelling claim support – Cornwall report"**). This forecast anticipates a 106% rise in costs between 16/17 and 24/25. [May 2018 submission] 2 charging changes came into effect in 2017 which have increased our net electricity costs. The review of electricity transmission charging arrangements for Embedded Generators reduced our regulated income from exported electricity during triad periods (c£0.5m per year) and the DCP288 change to distribution charging decreases the impact of our current efficient load shifting activity (c£2m per year from 2018-19).

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers
Need for cost adjustment	There is significant evidence from the energy industry and indeed from the Government's own data, that energy prices will increase at a much faster rate than in the past. This means that past trends evident in the historical data set will no longer be a valid basis for future costs, and therefore any cost models based on historical data will need adjustment to take account of this change. The claim values above relate solely to the price variation, although we also expect usage volumes to increase (despite our mitigation measures).	Independent October 2017 'Cost of Energy' Review. https://www.gov.uk/government/publications/cost-of-energy-independent-review. Government (BEIS) 2017 forecasts indicate a continuous rise in wholesale electricity prices. https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2017 Annex M: Growth assumptions and prices (see reference scenario which shows a 28% real terms increase in industrial electricity wholesale prices 2017 to 2025). [May 2018 submission]
Management control	Our energy volume use is stable and has remained generally flat over AMP5 and AMP6. This reflects a balance of upward and downward factors. Increasing demand for water, improvements in treatment and water quality and moving more water around our network to deliver resilient services has required ever-greater energy use. Following the Birmingham resilience scheme which has enabled it, we will require periods of additional energy use when the EVA is offline for maintenance. However, reductions in leakage and our work to encourage lower usage, including more metering help of offset some of this. In addition, we continue to deliver cost-beneficial gains in the energy efficiency of our most energy-intensive assets (motors, pumps and air blowers) using and trialling the best technologies available. We have developed and deployed world-leading technology to improve efficiency on these assets.	Examples of energy savings implemented via new technology: The Lontra blade compressor and real-time pump system optimisation control which won project of the year 2016 from the Pump Centre. https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/ See section 2 covering non-domestic costs figure 2.11. Also note figure 2.10 which illustrates that most product efficiency improvements have occurred in computing and lighting – which account for less than 4% of our total electricity usage. Motor and pump efficiency, which accounts for most of our electricity cost, has not seen significant product improvement or volume efficiency in any industry over recent years.
Customer protection	We propose that an uncertainty mechanism be used to protect customers. For example we could measure actual versus a forecast price, and reduce bills to compensate where prices are materially lower than the forecast.	

8.6 ECONOMETRIC MODELLING CLAIMS

Our PR19 business plan sets out the totex that we require to deliver resilient services to our customers. In assessing the efficiency of our totex submission, we recognise that Ofwat will utilise a range of econometric models. Given that the design and specification of these models will be unknown at the time of submission, it impossible to assess whether they will robustly capture appropriate cost drivers to Severn Trent.

For this reason our PR19 submission includes the modelling claims that we submitted in response to the April consultation models. We recognise that it's highly likely that these April models will have been updated. This means our modelling claims, which identify ways to improve the robustness of the April econometric models, may not be needed.

Nevertheless, in the interests of completeness, we have included these claims and policy items against the April models. The claims we presented in May are summarised in the table below.

Modelling claim	Claim identifier	Price control	Claim (May submission)	Final claim (Business plan)
Water treatment works (WTWs) economies of scale	05-WES-mc	Water N+	£30m - £75m	£41m
Sewage treatment works (STWs) economies of scale	06-SES-mc	Wastewater N+	£40m - £120m	£72m
Waste water treatment complexity	07-STC-mc	Wastewater N+	£65m - £130m	£55m
Developer services costs	08-DEV-mc	Water N+	£140m - £180m	£179m
Energy price increases (policy item)	09-EGY-mc	Wastewater N+ Water N+ Water resources	£80m £85m £20m	£80m £85m £20m

The claims identified required expenditure that may be considered as inefficiency in Ofwat's independent benchmarks due to the way in which econometric models are developed and used. They have been developed on the basis of models shared as part of the 2018 cost assessment consultation. We stated that the claims will need to be considered alongside the approach that Ofwat finally select for independently identifying required expenditure. Therefore, we accept that the size and/or the need for claims may materially change.

Since May, we have we have developed our evidence base for several of the claims. This extra information is set out in this chapter. In other aspects, the pro-formas and supporting information provided in May should be considered as evidence for the claims in this plan. The basis of each claim is summarised below. We include our updated May pro-formas and accompanying evidence for completeness.

8.6.1 Summary of the econometric modelling and policy claims

Claim	Claim identifier	Value of claim	Basis of claim
Water treatment works (WTWs) economies of scale	05-WES-mc	£41m - As per May document but considers only modifications to Ofwat's treatment models	Economies of scale at treatment works exist across the full range of asset sizes. Ofwat's consultation models do not allow for treatment economies of scale. Failure to explicitly include could result in bias in several other coefficients and inaccuracies in modelled allowance.
Sewage treatment works (STWs) economies of scale	06-SES-mc	£72m - Updated since May following additional analysis	Economies of scale at treatment works exist across the full range of asset sizes. Ofwat's consultation models only consider economies of scale at very small assets. This excludes 96% of the load treated by the industry. Despite Severn Trent having one of the highest number of small STWs in the industry, the proportion of load treated at these works is less than the industry average. When considering all STWs, our average utilised capacity is 18% lower than the industry average.
Wastewater treatment complexity	07-STC-mc	£55m - Updated since May following additional analysis	Severn Trent STWs collectively have some of the tightest discharge consents in the sector. This reflects the absence of a coastline and the need to discharge into relatively small receiving waters. Only a small number of Ofwat's consultation models take account of sewage treatment complexity. Where they do, it is defined too narrowly meaning that the majority of our costs due to complex treatment are not taken account of.
Developer services costs	08-DEV-mc	£179m - Updated since May following additional analysis	Indicative new development and new connection models appear to poorly reflect required future expenditure. This is likely to be driven by the way in which related expenditure has been historically accounted for by different companies – particularly in relation to infrastructure reinforcement costs.
Energy price increases	09-EGY-mc (WWNP) 09-EGY-mc (WNP) 09-EGY-mc (WR)	£80m £85m £20m	There is significant evidence that energy prices will increase at a much faster rate than in the past. Consequently, benchmarking of historic costs are not likely to accurately reflect future efficient expenditure. We recognise this is more akin to a policy item as considered at PR14.

8.6.2 Updated analysis completed since the May submission

Since May, we have we have developed our evidence base for three of the claims:

- Developer services costs (see section 8.4.9)
- Sewage treatment works (STWs) economies of scale (see 8.6.3)
- Wastewater treatment complexity (see 8.6.4)

We have undertaken additional analysis highlighting the potential need for a claim. The need is based on identifying material costs that we incur which may not be adequately accounted for in modelled expenditure predictions. Following additional analysis and model testing, we have also made some changes to the way in which the identified issues are best corrected in models. Finally, we have now been able consider the identified impact across the full suite of triangulated models. This has allowed us to identify a more focused claim size rather than showing a range of impacts across individual models.

For developer services costs, we have continued to articulate the various expenditure components that contribute to developer services costs. This is documented elsewhere in this appendix in our enhancement business case for developer services. It includes consideration of recent changes to charging rules and the interaction with the different revenues that we receive. We have run and triangulated Ofwat's consultation models for new developments and new connections. This has been considered alongside our business plan enhancement expenditure to review the size of the claim.

Updated analysis for the two wastewater claims are considered in turn below.

8.6.3 Sewage treatment works (STWs) economies of scale

Summary of additional analysis undertaken	Improved quantification of totex impact
The average size of our small (band 1-3) STWs is 12% smaller than the rest of the industry. If bands 1-3 are used in a model, all small works are counterintuitively presumed to have consistent cost characteristics. Economies of scale at large (band 6) STWs vary by around 50% across the category. This will not be accounted for if scale effects are only considered at small STWs. Average STW size is strongly skewed by TMS. If specific consideration is not made to asset size, necessary costs driven by regional geography will not be considered.	We have undertaken further analysis of how best to correct Ofwat's consultation models for economies of scale effects. We have now used a variable for utilised capacity across all STWs rather than the number of STWs as presented in May. This is theoretically preferable and helps model fit. Not allowing for population density in network models will bias any economies of scale variable (omitted variable bias). Therefore, we have made sure that models appropriately account of population density. We have now considered the impact on all four levels of model disaggregation and then triangulated to arrive at a potential impact across a full suite of models.

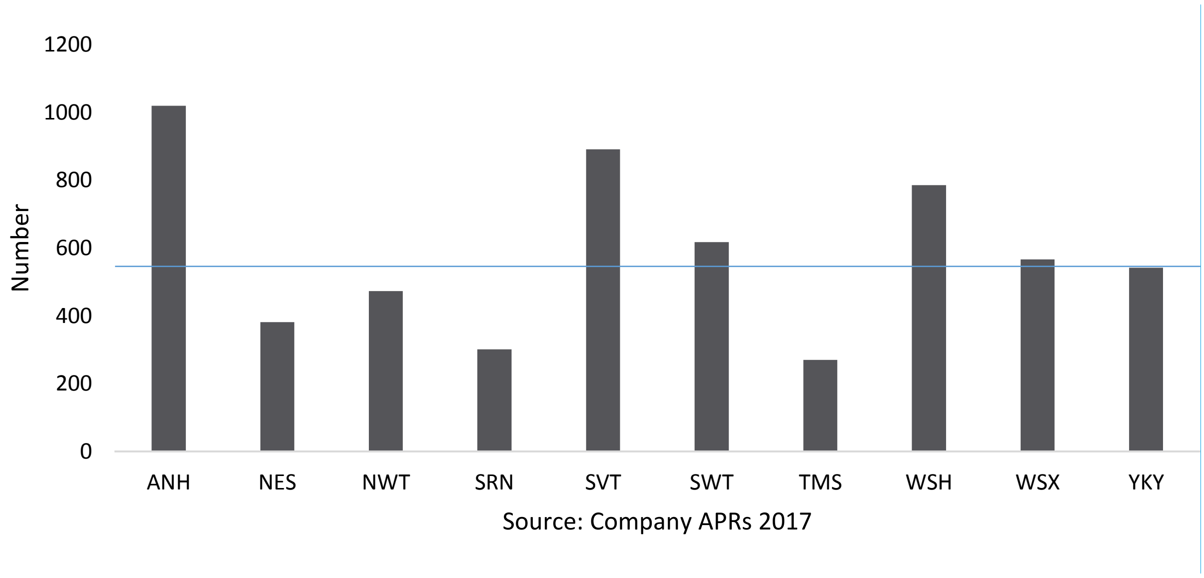
Economies-of-scale play a significant role in determining costs

At the highest level, the complexities of moving sewage long distances means that the size of sewage works will be driven by the size of the direct conurbations that they serve. Building, operating and maintaining large works creates opportunities of economies of scale per unit. For example, construction scale efficiencies, greater opportunities of optimising processes and the benefits of centralised resourcing.

Regional geography is such that we serve one of the highest number of discrete urban populations in the UK and some of the most sparsely populated areas of the country: we serve around one quarter the most rural decile of local authority districts in England and Wales. Consequently, we have a sewage treatment asset base that varies considerably. We have some very large Sewage Treatment Works as well as a great number of small works. With the exception of Anglian Water, we have the highest number of Sewage Treatment Works in size bands 1-4[7], as can be seen in the graph below:

[7] Under Ofwat's classification system, large works are as those with an average daily loading >1,500kg BOD5/day, and small works are those with an average loading <=1,500kg BOD5/day. Large works are Band 6, while small works are in bands 1-5 as follows:
• size band 1 <= 15kg BOD5/day (population equivalent: 0 - 250);
• size band 2 >15 but <= 30kg BOD5/day (population equivalent: 250 - 500);
• size band 3 >30 but <= 120kg BOD5/day (population equivalent: 500 – 2,000);

Number of Band 1-4 Sewage Treatment Works



As was the case at PR14, the models that Ofwat presented in its 2018 cost assessment consultation measure economies-of-scale using the proportion of load treated in Bands 1-3 works. This infers that companies that treat more of the load they receive at small works will incur more cost due to an inability to access the opportunities for economies of scale at larger works. While works in these categories undoubtedly have higher unit costs than larger works, our investigations have found that Ofwat's variable misses important attributes that materially drive costs – namely:

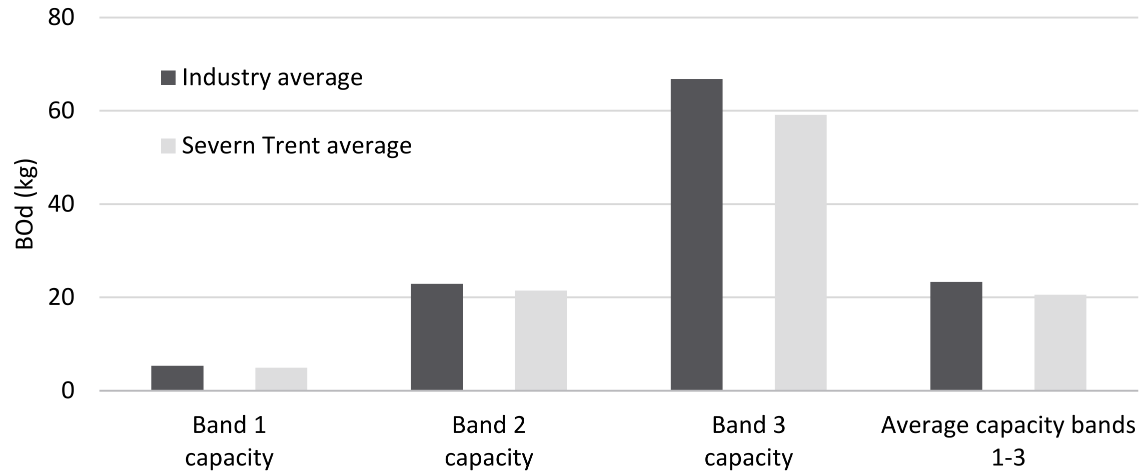
- the size distribution within Band 1-3 works; and
- the omission of the largest works.

Economies of scale at small works

While we have a smaller proportion of our overall load treated in Band 1-3 works relative to the industry, the average size of our Band 1-3 works is around 12% smaller than the industry equivalent (see graph below) . This is the result of us having proportionally fewer Band 3 works than the rest of the industry. The overall effect is that our band 1-3 average unit cost of treatment is justifiably higher than the industry average. However, this will not be accounted for by any model that considers economies of scale at a defined threshold.

• size band 4 >120 but <= 600kg BOD5/day (population equivalent: 2,000 –10,000); and
• size band 5 >600 but <= 1,500kg BOD5/day (population equivalent: 10,000 – 25,000)

STW capacity in small works

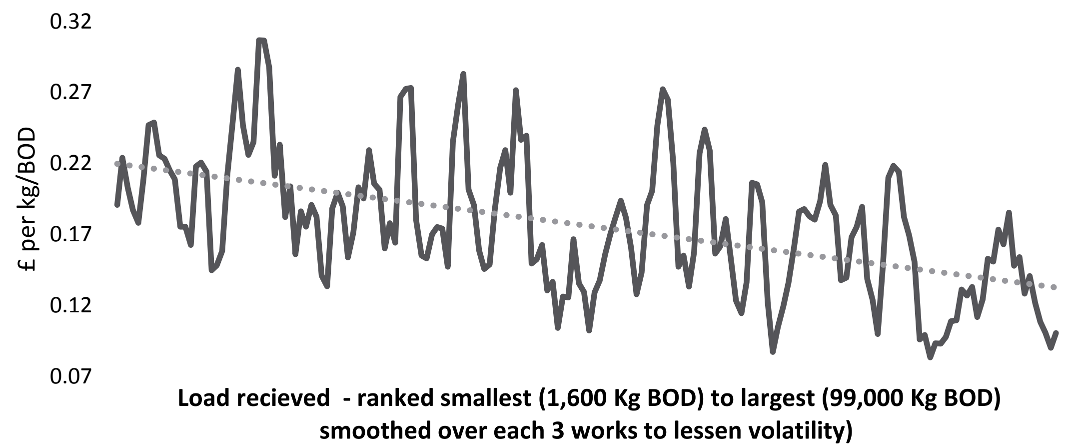


Economies of scale at large works

If the size of all works are not taken account of, this disregards any opportunities of economies of scale at treatment works serving more than a small village. In practice that accounts for 96% of industry load. Jacobs, our independent consultants, found that there was a case for excluding the Band 1-3 variable or at least not using it alone.

Jacobs found that substantial economies-of-scale materialise as works-size increases within Band 6 – the category for the largest works (see below). Given that the overwhelming majority of load will be treated away from small works, and a similarly large proportion at band 6 works, the presence of scale economies mean that such works will exercise significant influence on a company's overall relative efficiency.

Economies-of-scale at large works with ammonia consents ≤5mg/l (all companies, 16/17 direct costs)



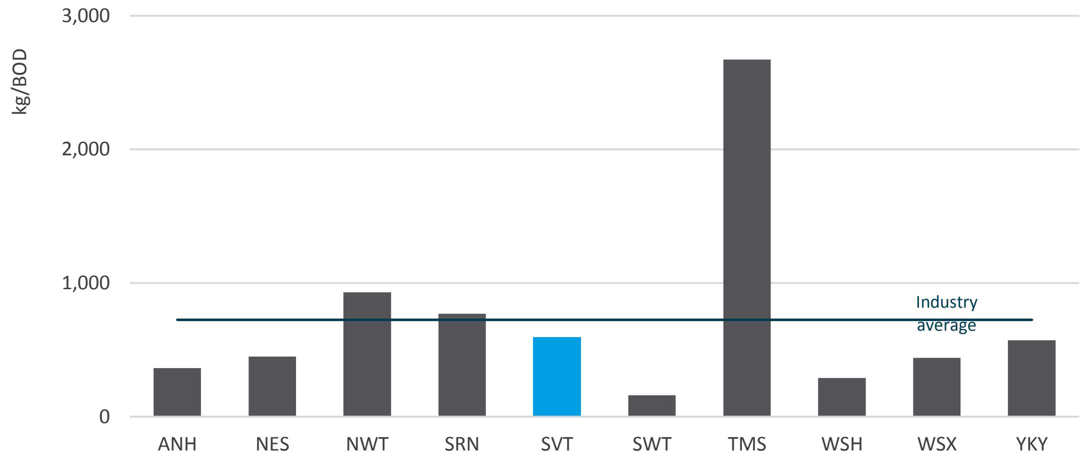
Interpretation of the above graph

- The graph uses a non-linear scale on the x-axis
- Economies of scale vary at works wihtin the band 6 category
- The average company treats about 80% of load at band 6 works
- The analysis compares works with ammonia standard of 1-5mg/l and therefore differences shown are not likely to be due to complexity

- Variations around the trend line are driven by other site specific factors such as process type and other consents also present
- Unit costs for the largest works are around 50% of those at the smaller works

When considering the overall average size of the works (and therefore taking account of all treatment works), we are around 18% below the industry average. At the most extreme, Thames Water is almost 270% above average – see graph below

Total average works capacity



In the event that Ofwat do not consider the opportunities for economies of scale across all treatment works, costs that we necessarily incur due to regional geography will not be reflected. Conversely, Thames Water will appear disproportionately efficient. This is because, without the inclusion of a relevant variable, models will inherently assume that companies have the same average works size. Were Thames Water excluded as an outlier, the industry average would reduce and place Severn Trent much closer to the average.

Economies-of-scale is outside management control

The size of different Sewage Treatment Works is driven by a mix of the geography, topography and population density within the catchment area, along with the legacy decisions made decades ago about asset size. In our case, the extreme rurality of some parts of our catchment necessitate extremely small works that pull-down our average capacity, despite the presence of very large works (such as Minworth), servicing the big cities. Overall, it is clear that the resultant effects on economies-of-scale are outside of management control.

A robust and efficient solution

We have successfully corrected for the undue economies-of-scale effects from Ofwat's modelling approach. We accomplished this by taking account of cost differences across all sizes of works, by creating a variable for the average utilised[8] capacity across works of all size bands. This captures both the higher costs faced by companies with a large proportion of small works and the substantially lower costs for companies with large capacity Sewage Treatment Works. This also avoids the problem of relying on arbitrary bandings – such as those used in Ofwat's models – that are unable to represent the most important cost differentials.

[8] By utilised we mean the average quantity of load treated at an STW: Jacobs inform us that if a large works is only used to, say, half of its capacity this works will not experience the lower unit costs that a full capacity works of the same size will experience

Specifically, we replaced Ofwat's chosen economies-of-scale metric that represented the proportion of load treated in bands 1-3 size works. In its place, we use a variable that measures the average utilised capacity across all Sewage Treatment Works. Overall, we found this change consistently improves the accuracy of both our efficiency standing and, materially, our cost allowance. When we made substitution across Ofwat's models, the cost allowance, triangulated across the four modelling streams (wholesale, network plus & sludge, bioresources plus & network, fully disaggregated), improved by £36m with upper quartile efficiency applied.

Econometric logic for our findings

Having analysed the average-size of the scale-coefficient across Ofwat's models, we have found that this implies significant company-level economies-of-scale. Yet, given the scale of WaSCs, we would not expect to see such economies-of-scale at this level. It appears highly likely that the coefficients in Ofwat's models are reflecting something else entirely – simply that larger firms tend to have large urban conurbations that are served with large treatment works. This leads to the conclusion that omitting a correct economies-of-scale variable biases the scale coefficient downwards. By contrast, our economies-of-scale variable corrects for this, such that the coefficient on the main scale-variable moves closer to 1, which is much more in line with logical expectations.

Given that population density is such an important driver of network costs, any model of network costs that excludes this variable will be unable to produce robust results. If population density is excluded from a model, then the coefficient on the economies-of-scale variable will be biased, because the correlation between these two variables will create an omitted variable bias. Clearly, there is a robust logic that our economies-of-scale analysis should focus only on those Ofwat models with network cost that include population density. Under this more focussed approach, our cost allowance improves by £72m (at UQ efficiency).

We also examined the outlier effect from Thames Water, by re-estimating Ofwat's models on a reduced sample that excluded Thames Water. This consistently improved our relative efficiency standing and resulted in an increase in cost allowance of around £60m. We note though, that excluding a company from the econometric modelling would not provide the most representative view of the sector. Our view is that it is important for the modelling to include all companies.

8.6.4 Wastewater treatment complexity

Further analysis undertaken	Improved quantification of totex impact
The proportion of load we treat with BOD consents <10mg/l is 75% greater than the industry average. Consents of this level drive a step change in treatment costs. 98% of ammonia is removed at a 1mg/l consent (as used in some Ofwat models). However, this number remains at 94% and 90% for 3mg/l and 5mg/l consents respectively. Engineering analysis shows that it is only at consent levels lower than 5mg/l that costs will materially change at large works – where treatment processes that are cheaper to operate and maintain can then be used.	We have undertaken further analysis of how best to correct Ofwat's consultation models for treatment complexity. We have now used a variable for the proportion of STWs with tertiary treatment rather than choosing a lower consent limit. This is preferable on a range of standard model comparison metrics. Not allowing for population density in network models will bias any treatment complexity variable (omitted variable bias). Therefore, we have made sure that models appropriately account of population density. We have now considered the impact on all four levels of model disaggregation and then triangulated to arrive at a potential impact across a full suite of models.

Treatment complexity is an important driver of costs

Our BOD consents for treatment works are one of the most stringent in the industry. This is evidenced by the fact that, for us, the proportion of load subject to a tight consent is over 75% greater than the industry average as shown below. This is based on consents below 10mg/l being regarded as tight, given this is the threshold where there is a significant step-change in the power, processes and costs involved in treatment.

Proportion of load with tight BOD consent (10mg/l maximum)

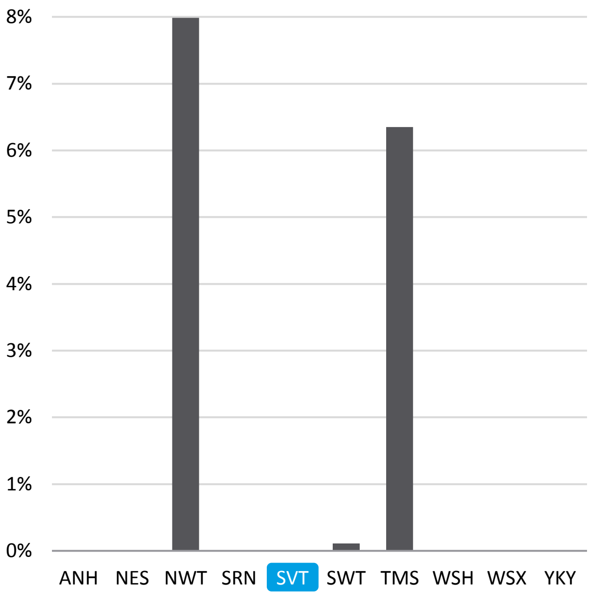
In Ofwat's suite of econometric models, treatment complexity is taken account of in just two of the ten network plus model and four out of six sewage treatment models. Given that costs between treatments works vary dramatically according to the strictness of the treatment consents and that sewage treatment is the single biggest component of wastewater expenditure, this is a significant omission. Accordingly, it is clear that Ofwat's models cannot provide a sufficiently accurate view of wastewater expenditure.

Where Ofwat's modelling does consider treatment complexity, this is done so by reference to the Environment Agency's ammonia standard that requires maximum concentrations 1mg/l. To some extent, this is logical because the requirement does drive differences in costs between Sewerage Treatment Works. However, it only provides a partial picture and our independent consultants, Jacobs, have informed us that for different ammonia treatment standards of:

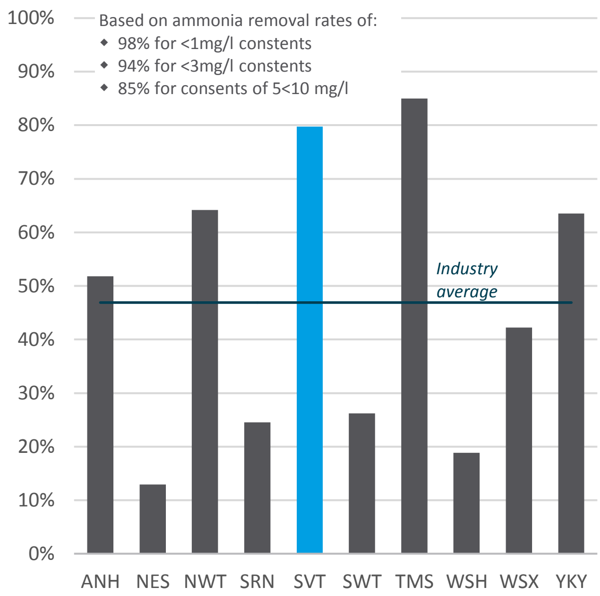
- 1mg/l maximum – 98% of ammonia is removed;
- 3mg/l maximum – treatment is marginally less energy-intensive and 94% of the ammonia is still removed. There is minimal difference in cost between this and the tighter <1mg/l standard; and
- 5mg/l maximum – 90% of ammonia will be removed. If the standard is any looser, costs will change notably as different treatment processes, which are cheaper to operate and maintain, can then be used.

As can be seen in the left hand graph below, none of our load is subject to the 1mg/l ammonia standard, which means Ofwat's modelling will assume that treatment complexity has no effect on our costs. By contrast, despite the absence of load with the 1mg/l ammonia consent, our sewage treatment works over the last five years have removed almost one-and-three-quarters more ammonia, proportionately, than the industry average. As can be seen in the right hand graph below, our removal rate is the second highest in the sector and exceeds that of NWT – the company with the largest proportion of load with the 1mg/l ammonia consent.

Load in work with ammonia consent <1mg/l



Percentage of ammonia removed



As shown above, the rate at which we are required to remove ammonia is one of the toughest in the sector. In turn, this requires us to incur many additional costs from both operating and capital maintenance expenditure. But, because of the approach taken in Ofwat's modelling, these costs are not captured in the models.

The treatment consents and the required standards are determined and imposed directly by the Environment Agency according to relevant criteria such as geographic characteristics. Given the Environment Agency is an independent regulator, the ability to control both the consents and their levels are completely outside of management control.

We have assessed the impact that a theoretically-correct treatment variable would have on our allowance and efficiency ranking. We investigated several theoretically justifiable variables and given the statistical constraints we identified a suitable variable. Our research found that the proportion of works with a tertiary-treatment variable was generally highly-significant and appropriately signed. This is also a variable that takes account of a range of different treatment requirements that all require substantial extra expenditure.

Accordingly, in making our cost assessment we added this variable to each of Ofwat's models for wholesale, network plus and sewage treatment. Also, in the case of the wholesale and network plus models, which include a network cost element, we only added the new variable to the subset of models that also contain a population-density variable – a fundamental component of any such model.

Aside from the theoretical importance of population-density as a driver of costs in wastewater networks, it is also important to include this driver from a purely econometric perspective given the correlation between population-density and treatment complexity. This correlation arises because receiving water in more populated areas is generally more polluted and will therefore be subject to tighter treatment consents, all else equal, than more rural waters. Furthermore, if the population-density variable were excluded, this would create the risk of omitted variable bias and result in a biased and inaccurate coefficient on the treatment variable – as well as other coefficients because of the potential for smearing.

The addition of a theoretically correct consent level in Ofwat's models inevitably leads to an improvement in our efficiency standing and materially increases our cost allowance. Specifically, altering each of Ofwat's models – to include a variable measuring the proportion of works with a tertiary treatment stage (and excluding Ofwat's 1mg/l variable where necessary) – increases our allowance by £55m at upper quartile efficiency.
When the econometric models have the treatment variable revised, we see that in most models the tertiary works variable is preferred based on standard model comparison metrics (the Bayes Information Criteria shown in figure A1.8). Overall, the weight of theoretical and econometric evidence advocates this more encompassing measure of treatment complexity.

Model	Bayes Information Criteria delta (absolute value)	Preferred model
OWW3	9	Ammonia below 1mg/l
OWW4	10	Tertiary works
OWW5	10	Tertiary works
OWW6	16	Ammonia below 1mg/l
OWW7	5	Tertiary works
OWW8	4	Ammonia below 1mg/l
ONPW1	7	Tertiary works
ONPW2	4	Tertiary works
ONPW4	7	Tertiary works

It is therefore clear that Ofwat's chosen treatment consent variable creates particular bias against Severn Trent, as we will only be allocated costs for an industry average treatment complexity standard. This is despite the fact that we remove a higher proportion of ammonia and substantially more BOD than most other firms.

8.7 FULL BUSINESS CASES FOR THE COST CLAIMS

This section includes the full evidence base of the cost claims, excluding modelling claims covered in Section 8.6 above, building on the information provided to Ofwat in May 2018. For a summary of each claim, including refrences to relevant performance commitments and ODIs can be found in section 8.4 as shown below:

8.4.1 Supply demand balance (from page 41)
8.4.2 Security (from page 47)
8.4.3 Resilience (from page 53)
8.4.10 Wastewater environmental programme (from page 87)

Pro-forma relating to each claim are included in section 8.5, pages 114 to 121.

8.7.1 Cost adjustment claim: wastewater environmental programme

Changes since May 2018 Submission

We submitted our case to Ofwat in May 2018 to outline the key need for the cost adjustment; the key changes to the case are outlined below.

1. Incorporated detailed information on the customer engagement we have undertaken relating to the environment and this case specifically
2. Undertaken cost benchmarking of representative schemes and incorporating this in to this case
3. Continued to review the scope of the base case based on discussions with the Environment Agency
4. Further developed the PR14 customer protection mechanism (ODI) to ensure that changes in the scope of the final WINEP3 can be delivered without delay

8.7.1.1 Need for investment

The need for investment is driven by both statute and customer support. Over the last two decades we have established a strong track record of efficiently delivering improvements to meet our environmental obligations. Our proposed programme of £515 million for environmental enhancements for AMP 7 will ensure further progress. We have aligned our environmental drivers with our maintenance and growth needs to ensure design and cost synergy across the programme but have only included environmental expenditure in this claim.

This overall need for the cost adjustment is driven by Water Industry National Environment Programme 3 (WINEP3) which was issued by the Environment Agency (EA) in March 2018 and sets out the actions required to ensure we comply with statutory environmental obligations. The WINEP3 requirements are of a scale and complexity not reflected in historic data and as such, we are uncertain how they will be dealt with in Ofwat's cost modelling. We recognise that Ofwat could negate the need for a cost adjustment by developing a bespoke model for WINEP3 but, given the uncertainty, we have chosen to provide transparency on the drivers for this investment, costs and customer protection. As such, this section sets out almost all of our wastewater environmental enhancement programme under WINEP3 (a small element is being delivered as part of our base plan activity). In *Section 2: need for a cost adjustment* we explain the element for which we are proposing a cost adjustment, and our rationale for doing so.

Our investment is driven by legislation

In its document 'A Green Future: Our 25 Year Plan to Improve the Environment'[9], the government has set ambitious objectives for the environment. Cleaner water in our cities and rural landscapes is an essential element of the plan and the aim is to improve at least three quarters of our waters to as close to their natural state as soon as is practicable.

Our proposed environmental programme contributes towards this objective. It is underpinned by two statutory drivers; the Water Framework Directive (WFD) and the Urban Waste Water Treatment Directive (UWWTD). While meeting the requirements of both Directives is mandatory, the improvements required by the WFD allow for some discretion about timing (until 2027) and must be cost-beneficial.

Legislative drivers for wastewater enhancement

Statute	Area	Requirements	Timing
WFD	No deterioration	Mandatory	Mandatory - AMP7
	Improvement - good ecological status	Mandatory (if cost-beneficial)	Mandatory - 2027
	Community legislation: Habitats directive and CRoW Act improvements	Mandatory	Mandatory -AMP7
UWWTD	CSO investigations	Mandatory	Mandatory - AMP7
	Improvement and monitoring	Mandatory	Mandatory - AMP7

The EA is the authority responsible for implementation of both the UWWTD and WFD. It sets out the actions that companies will need to complete to meet their obligations using the WINEP. In line with EA requirements, we have included costs for all 'green and amber' measures (i.e. those with a very high level of certainty) in our programme. All investment needs included are new (first time) and do not duplicate outcomes included in our AMP6 programme.

We have recently been advised that the Secretary of State has instructed that the WINEP3 should be delivered in full by 2025 and that neither phasing of the WFD enhancements, nor the wastewater flow programme would be supported.

As explained in *section 3: management control*, this investment secures compliance but - through our collaboration with the Environment Agency - represents a significant reduction in scope (and therefore cost to customers) from earlier versions of the WINEP. We discuss the key statutory drivers below.

The Water Framework Directive

The WFD came into effect in 2009 with the objective of improving all rivers, lakes and ground-waters to Good Ecological Status (GES) by 2015, subject to this being technically achievable and cost beneficial. Application of

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

‘disproportionate cost’ criteria allows for the deferral of cost beneficial improvements to a backstop date of 2027.

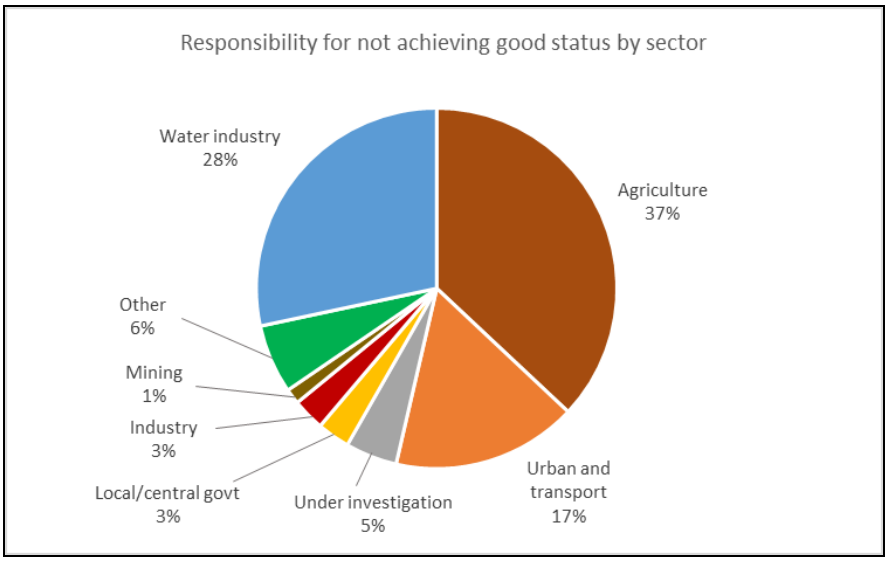
The WFD is delivered using River Basin Management Plans (RBMPs) which are refreshed on a 6 yearly cycle. RBMPs set out how stakeholders and regulators with vested interests within catchments, such as water companies, local authorities and others, can cooperate to improve the water environment.

The WFD drives our investment in three ways.

First, the WFD includes a mandatory, ‘no deterioration’ objective – effectively prohibiting any deterioration in the water environment in the future. This could come about in circumstances where existing discharge permits (when fully utilised) allow sufficient loads to be discharged to deteriorate the downstream river e.g. as a consequence of population increase. The EA are reducing the maximum load we are permitted to discharge at some sites (either by tightening quality standards or reducing dry weather flow limits), where they have confirmed a deterioration risk. This objective is not subject to cost benefit criteria.

Second, the WFD includes improvement targets for all waters to achieve good ecological status (or good ecological potential) by 2027. This requirement is subject to the necessary improvements satisfying both cost benefit and technical feasibility criteria. Where improvements to achieve good ecological status are not technically feasible (e.g. due to natural background conditions), alternative objectives can be set.

The EA produce a database of ‘reasons for not achieving good status’ against the WFD. This dataset attributes, by sector and activity, the underlying causes for WFD non-compliance and is at waterbody level, in line with the classification data. Figure 2 indicates the proportional contribution of different sectors for not achieving good status. It shows that the water industry and agriculture have the most significant impact. Of the 2695 individual reasons for not achieving good status[10] identified in our area, 764 (28%) are attributable to our activities. Phosphate levels are the biggest reason for not achieving good status, representing 57%. We use this information to target where we can have the biggest benefit on the overall status.



Reasons for not achieving good status by sector in our region

[10] Based on our analysis of the RNAG data published by the Environment Agency in 2013

Finally, the WFD also refers to existing community legislation. The Countryside and Rights of Way Act (2000) (CRoW Act) is concerned with protecting Sites of Special Scientific Interest (SSSI). The Habitats Directive (1992) relates to the conservation of a range of rare, threatened or endemic animal and plant species through sites designated as Special Areas of Conservation (SAC). We need to deliver our fair share contribution to the delivery of conservation objectives in these protected areas. Unlike WFD good status improvements, delivery of Habitats Directive objectives are not subject to cost benefit criteria.

For all improvements under the WFD, following their implementation, the 'no deterioration' objective means that these improvements will endure indefinitely.

WFD driven interventions

Area	Needs
No deterioration	8 standalone schemes
Improvement – good ecological status	Treatment works: 154 site upgrades CSOs: 55 schemes
Community legislation	Habitats Directive improvement: 2 site upgrades CRoW Act improvement: 7 site upgrades WINEP3 investigations: Chemical investigations programme 3 and SSSI and SAC investigations

The Urban Waste Water Treatment Directive

The UWWTD aims to protect the environment from potentially detrimental wastewater discharges from cities and certain industrial sectors. While the UK water industry has already made significant investment towards the UWWTD, in 2012 the European Commission raised infraction proceedings against the UK government for failure to appropriately implement the Directive. The proceedings focussed on the interpretation of a statement in the Directive specifying that all flows should be treated except in 'unusually heavy rainfall'.

In response, the UK Secretary of State for the Environment sent a letter to all water companies and Ofwat requiring that the 'vast majority' of overflows be monitored and reported for spill frequency by 2020. We are undertaking our spill monitoring programme in AMP6.

On the basis of this reinterpretation of the UWWTD (it should be noted we were already recognised as compliant), the EA has prescribed new WINEP3 drivers to:

- support an increase in flow to full treatment (FFT) and storm tank storage capacity at treatment works as well as more accurately monitor our compliance with FFT; and
- understand the environmental impact of all high frequency spilling combined sewage overflows (CSOs) on our wider network (using investigations in line with 21st Century Drainage Group's Storm Overflow Assessment Framework), to identify where improvements may be required.

On the latter point, WINEP3 includes 105 investigations on *known* high frequency spills (based on the coverage of our monitoring midway through our AMP6 roll out programme). However, the EA also expect that companies will conduct investigations on all high frequency CSOs in AMP7 - once confirmed by spill monitor data collected during the remainder of AMP6. In the light of the EA's expectations, and given customer and stakeholder support for environmental improvements, we have included scope for additional investigations based on extrapolated data.

Our programme also includes nutrient removal schemes where the EA are proposing to designate new nutrient sensitive areas under the Directive. These are included in WINEP3 at amber status as the new designations are awaiting a final ministerial approval.

UWWTD driven interventions

Area	Revised needs
CSO investigations (on our network)	351 investigations (stages 1-4 of 21st Century Drainage Group guidance)
Improvement (storm overflows at treatment works)	13 flow to full treatment increases
	26 storm tank capacity increases
Improvement (nutrient removal)	14 site upgrades (of which 7 overlap with WFD improvements)
Flow to full treatment monitoring	60 new flow monitors
	211 flow investigations
	179 new event duration monitors

Our investment will deliver enhancements for customers and the environment

As a consequence of our proposed investment, customers and the environment will benefit from the following:

- There will be no deterioration in our region's waterbodies resulting from serving our customers.
- We will further protect our rivers and make our service more resilient with reduced intermittent discharges during storm events.
- Building on the 1500km achieved in AMP6, we'll improve the condition of around 2100km of rivers in our region
- Where sustainable urban drainage solution (SuDS) can be implemented, multiple societal and economic benefits will also be delivered.

Summary of proposed benefits

Benefit measure	Number of
Kilometres of waterbodies improved*	c2100
Kilometres of waterbodies protected from no deterioration	c530
Treatment works effluent improvement (exc FFT &Stormtank improvements)	166
CSO improvement schemes	44
Sites treating increased flow	13
Sites with additional storm storage capacity	26
CSO investigations	351

**measure refers to total water body length improved*

Our customers support further improvements

Although our programme of work is driven by statute, we were really pleased that our extensive research demonstrated very clearly the outcomes it will deliver are consistent with our customers' preferences and priorities. We know that our customers both value improvements in, and have an emotional attachment to, the rivers in our region.

We carried out extensive stakeholder and customer engagement on the environment for PR14. This revealed a strong desire from both customers and stakeholders for Severn Trent to invest in river water quality improvements.

For PR19, we've made further improvements to *how* we engage with customers on these issues. These changes represent a step change in the depth, and quality of our research from PR14.

These improvements have given us more nuanced and, we believe meaningful insight. But the overall sentiment of customers remains unchanged from PR14. This consistency gives us further confidence that our proposals are supported by customers.

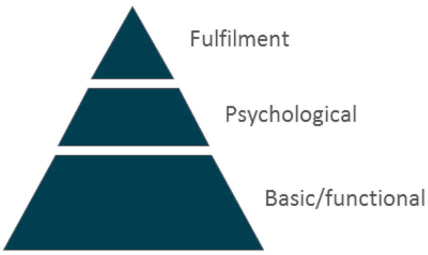
The environment in the context of our customers' needs

Our strategic approach to customer insight is founded on an understanding that not all customer needs are equal. There is a hierarchy of needs and the tools which we use to understand these will be different as each level. Our categorisation of customer needs draws on Maslow's three levels – delivering basic needs, meeting psychological needs and creating opportunities for self-fulfilment.

Our research consistently shows that customers value the natural environment, whether that is through the appreciation of their personal interactions with local green spaces or concern for the wider global environment. Local green spaces allow escapism and relaxation, enhance health and wellbeing, and are sites for quality time with friends and family. Some customers are highly engaged with their local rivers and care deeply about their local natural habitat and that Severn Trent does not adversely affect it in any way.

The environment runs through all levels of the hierarchy, reflecting the fact that some of our activities deliver a basic need (such as complying with statutory no deterioration obligations) and other activities can satisfy wider needs, such as enhancing biodiversity which creates opportunities for wider fulfilment. Our plans look for opportunities for solutions which deliver value at each level, for example, by delivering wider benefits.

The environment relates to our customers' needs on a number of levels



How we've approached understanding our customers' needs is important

Despite valuing the local environment, the environmental impact of our activities can be far from the conscious understanding of customers. While climate change, environmental damage and pollution are front-of-mind issues that customers discuss, few spontaneously associate our activities with the environment. This necessitates a different approach to research.

In the light of this, our Water Forum has challenged us to be more strategic in our research design, taking into account:

- where the topic sits within the hierarchy;
- the extent to which the topic is conscious in customers' mind vs unconscious; and
- whether the topic/issue occurs today or could in the future.

This implication of this framework is that, for unfamiliar issues including some environmental improvements, the research needs to involve active participation in order to build awareness to get valid opinions. We therefore chose to use deliberative research to understand customer views.

We have triangulated this with insight from our willingness to pay valuation research, our quarterly customer tracker and observed how customers discuss the environment when unprompted, using social media scraping.

Annex 1 sets out a line of sight showing how we have triangulated a range of sources to inform both the extent and pace of improvements we make, and the approach we take to doing so.

Support for improvements

Our willingness to pay research found that customers value river water quality improvements – we've used these monetised benefits compared to the totex costs in order to determine a cost beneficial programme.

In three separate forms of stated preference research (which is more akin to techniques used at PR14), customers typically considered improving river water quality as a medium priority.

However, within the deliberative research – which our Water Forum challenged us to include as the most appropriate form of research for issues of this nature - as customers became more aware of how central the environment is to our activities, they showed even stronger support for us prioritising the environment and ensuring it is protected. Customers felt that Severn Trent should be seeking to do as much as possible to protect and improve the environment. They were not concerned about the distinction between legal requirements and *additional* action, which they felt was largely artificial. This view is supported by our willingness to pay results from the deliberative workshops (customers self- completed the survey during the workshop) which shows much higher valuations for environmental improvements once they have a deeper understanding of the reason for them. However we did not use it for our cost benefit assessment (on the basis of sample size).

The Water Forum has challenged, and accepted the need

We have worked with our Water Forum (customer challenge group) for over two years and have been explaining our proposals over that time. As time has progressed and our thinking evolved we have been able to share more detail.

The Water Forum organised itself into a number of sub-groups to focus on key issues associated with PR19. These sub-groups bring together a diverse range of expert skill sets. The Water Forum's investment sub-group (ISG), which is relevant to the cost adjustment claims, comprises members from: the Environment Agency; Natural England Consumer Council for Water (two members; one Chair of CCWater's Central and Eastern Region); Confederation of British Industry; the West Midlands Combined Authority; and two from industry leading engineering consultancies (one of which started his role on the Water Forum as Head of Scientific Consultancy at the Met Office).

The ISG has been in operation for over 12 months and had a terms of reference to review all our cost adjustment claims. In total almost 100 challenges have been raised by the ISG and responded to. We have also demonstrated the coherence and customer focus of our cost adjustment claims within the context of our wider plan to the Water Forum's customer research sub-group, and the performance commitments sub-group.

A key challenge from the WF was in design of our research approach and deployment of the various techniques. Furthermore the WF attended our deliberative research and witness for themselves the engagement levels and interest in the room. The WF wanted to understand; the challenge we are facing, the options we have considered, the benefits we are seeking to deliver, the preferences of our customers and how we are accommodating them and the areas of support we had for our proposed plan.

We explained the two levels of optioneering we have done to respond to the challenge, namely; optimising the programme and optimising solution choice given the extent of project development. The WF tested how we had arrived at the size of proposed programme within WINEP. We explained how we had worked collaboratively with the EA from their 'long list' of required improvements and how we applied 'filters' based on evidence to ensure only genuine needs would be included. Our filters included, amongst other things; insufficient technical evidence, sub-optimal time to invest, cost beneficial, opportunities for catchment approach and non-capital solutions. We estimate the impact of these filters have removed c£450M CAPEX.

The ISG also wanted to see evidence of the optioneering we have applied at a project level. We used a number of examples (at Blackminster and at Milnhay) to show how we are optioneering at a project level to secure the best value option for our customers. One area the WF pushed particularly hard at was in making sure we articulated the line of sight from Customer research to investment proposal.

This has resulted in a Line-of-Sight (Annex 1) document which not only links customer views gathered through research to proposal, but also references the research data sets and weights the strength of feedback. We were also encouraged to think how we can continue to refine our 'best value' options as we move forward - recognising that we are at a point in time. This has resulted in our commitment to continually reference our live research information (obtained principally through our on- line community panel 'Tap Chat') which we will collect beyond September 2018 to check if any additional benefits (e.g. those over and above our primary benefits identified in WINEP3) we may be able to deliver, do in fact have customer support.

The WF also encouraged us to explore how to deploy natural capital solutions where possible. With this in mind we engaged two external experts to work collaboratively ('eftec' and 'ESI') to help us understand how natural capital opportunities can be appraised. We undertook a catchment study on the Erewash River (see Annex 2A) and this helped us quantify the benefits associated with the wider environment but did not bring any new natural solution options to the challenge we are facing there. Indeed the specific advice from the external experts is that natural solutions to the wastewater challenges we are facing under WFD are likely to be quite rare given that they will be predicated on, contributory causes, local geographic conditions, willing partners and the inherent risk the solutions will bring when compared to more traditional solutions. However we are committed to continuing to explore these as we progress detailed feasibility.

The WF have also encouraged us to be more holistic in our planning so that we approach needs at a catchment level and not just individual project level. We believe we have started to do this by already filtering out needs that may be addressed through other interventions e.g. sub-optimal time to invest [because AMP6 projects currently underway may deliver benefit negating the need for AMP7 investment]. As we progress our detailed feasibility we will look for synergies across our CSO programme, our Water WFD programme and flooding drivers - but we will need granular project information to be reasonably certain of this that will be available. We are currently trailing 'Cash for Catchments' with potential partners to understand if objectives from others (e.g. NGOs) can also contribute to the delivery of benefits within our programme. The success of this trial will not be dependent solely on this outcome but we are anticipating synergies exist. Our partnership working has been successful in AMP6 and we will continue to push this forward in AMP7.

While the Water Forum has yet to complete its final report, the ISG has reported to the full Forum that it believes the need for investment is supported by customers and well-evidenced to that effect.

8.7.1.2 Need for a cost adjustment

Defining the scope

We’ve worked collaboratively with the EA throughout the WINEP process. This includes iterative reviews of the EA’s evidence of need, a combined approach to river quality modelling and subsequent review of our proposed interventions.

Successive reductions in scope

Driver	Area	Initial needs assessment (from mid-2015)	Revised needs (March 2018)
WFD	No deterioration	62 standalone schemes	8 standalone scheme
	Improvement – good ecological status (treatment works)	247 site upgrades	154 site upgrades
	Improvement – good ecological status (CSOs)	421 schemes	55 schemes
	Community legislation - Habitats Directive and CRoW Act	N/A	9 site upgrades
UWWTD	Improvement (storm overflows at treatment works)	258 flow to full treatment increases |	13 flow to full treatment increases
		82 storm tank capacity increases	26 storm tank capacity increases
	FFT monitoring	545 new flow monitors	60 new flow monitors
			211 flow investigations
		545-1090 new event duration monitors	179 new event duration monitors
	Improvement (nutrient removal)	N/A	14 site upgrades (2 no cost implementations)
	CSO investigations (on our network)	351 Storm Overflow Assessment Framework investigations (stages 1-3)	351 Storm Overflow Assessment Framework investigations (stages 1-4)

This approach helps to ensure that we are addressing issues to get the best possible value for our customers, but without compromising on the outcomes that will be delivered. Our optioneering has achieved significant reductions in cost for customers, while allowing the same outcomes to be achieved. As a consequence, our capital expenditure is approximately 50% lower than it would otherwise have been.

Defining the costs

WINEP3 requirements are of a scale and complexity not reflected in historic data and as such, we are uncertain how they will be dealt with in Ofwat's cost modelling. We recognise that Ofwat could negate the need for a cost adjustment by developing a bespoke model for WINEP3.

At PR14, Ofwat's cost adjustment for NEP5 reflected its scope over and above previous NEPs (with costs for these effectively being included in the underlying unit cost models and un-modelled allowance). The precise calculation was complicated by the application of an overall totex cap for Wholesale Wastewater costs. Despite this complication, the principles are clear; we should not expect the cost models to reflect activity beyond the historic levels. This cost adjustment therefore focusses on £399m of the overall environmental programme, with our estimate for the implicit allowance being based on historic levels of activity and efficient cost.

The calculation of indicative implicit allowances is complicated by the interaction of the real options mechanism and the change on scope of required expenditure relative to historic AMPs. We have assumed that:

- Ofwat’s PR14 unit cost models remain appropriate when updated for increased AMP7 forecast volumes.
- The expenditure assumed within our real options mechanism would still be largely accounted for in the outputs of Ofwat’s unit cost models.
- Ofwat will make an allowance for enhancement opex (associated with operation of AMP7 capital interventions) – previously not modelled in PR14 unit cost models.

Components of our overall environmental programme

WINEP3 environmental programme **Central estimate: £399m (excludes £27m opex relating to AMP6 schemes)**		
Water Framework Directive (WFD) Central estimate: £357m		UWWTD Central estimate: £42m
WFD Cost Adjustment Central estimate: £275m	WFD Implicit Allowance Central estimate: £82m	UWWTD Implicit allowance Central estimate: £42m

Our analysis shows that our WINEP3 obligations require us to deliver more improvements than in previous AMPs (driven largely by the need to meet the Water Framework Directive 2027 deadline for getting to good status alongside action to avoid deterioration in status) with an increased complexity as standards tighten beyond the historic precedent. We understand we have the second largest programme in the sector.

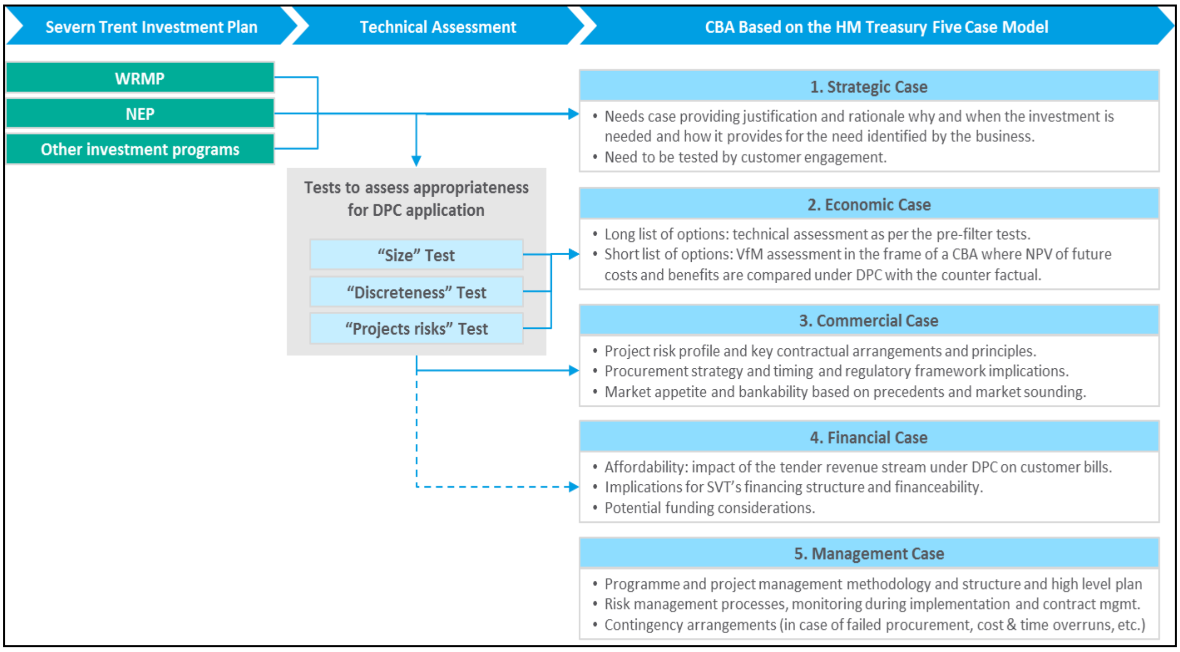
We have worked constructively and collaboratively with the EA to develop the scope of WINEP3. We have challenged aspects where we were not the primary cause of the environmental issues or where cost beneficial solutions could not be developed. We have challenged ourselves to develop more innovative and efficient solutions, building on our recent track record of delivery and extensive research and development investment. Overall this process has halved the total programme when compared to the original WINEP.

We have considered the potential for Direct Procurement for Customers

We are supportive of DPC and recognise that, used in the right way, it can deliver benefits to customers.

For PR19 we sought specialist advice on understanding the concept and how to apply DPC consistent with Ofwat guidelines, transparency and repeatability. This was to ensure that any scheme progressing via this route would provide genuine value for customers.

We have worked with KPMG to develop a DPC assessment framework and for assessing potential discrete, large-scale enhancement projects expected to cost over £100 million whole-life totex.



Assessment process flow diagram for DPC

We have applied this process to all projects and programmes with a totex of greater than c.£80 million.

The conclusions of our work confirm that DPC does not apply to this programme. This is because the projects did not pass the technical assessment tests for:

- size - the totex was less than £100 million; or
- discreteness - the activity was either disaggregated across many sites or highly integrated within existing processes.

A detailed description of our methodology, criteria and assumptions used is available in a separate report on request.

8.7.1.3 Management control

We understand the need to balance the value our customers attach to environmental improvements (and support for them) with the affordability constraints they face. While there are statutory drivers for this investment we have not been complacent about the need case, nor taken the view that scope or costs are outside our control.

We have exploited synergies across our programme

From both across our environmental investment programme, and other areas of our wider investment programme we have looked for synergies we can make. For example:

- Of the 55 CSO sites listed for WFD improvements, 12 also have an UWWTD drivers. To ensure that we capitalise on synergies between the two, our proposed solutions will meet the requirements of both.
- Two CSOs in Ilkeston were excluded on the basis that they will be improved through other growth and flooding related surface water separation and sewerage upgrades planned in the area.

Example 1: Combining multiple needs to maximise benefit for minimum cost

At Haxey – Graizelound sewage treatment works the Environment Agency identified a need to apply a 'no deterioration' consent which would necessitate an ammonia effluent limit reduction from its current level of 15mg/l down to 4.9mg/l. However, we proposed an additional reduction to 1mg/l which would also improve the associated waterbody to good status. We are proposing to meet both drivers ('no deterioration' and 'improvement') in AMP7. If these investments were undertaken in successive AMPs the existing works could be expanded to meet the no deterioration driver in AMP7; the ammonia limit is within the typical range of values which can be met with the process currently on site, biological filtration. If the improvement was then implemented in AMP8 we would completely replace the biological filters to meet the low 1mg/l ammonia limit. In this case the investment in AMP7 would have been inefficient and potentially wasted, as any new assets would only have been used for an AMP. As the improvement to 1mg/l is cost beneficial, the optimum whole life cost approach is to deliver the full upgrade in AMP7.

Our plan contains many proposals where we have combined multiple drivers together, allowing us to choose the optimal solution on site to meet the current and future needs of the treatment works.

We've used the option to 'do nothing'

While working with the EA on WFD improvements at our treatment works we have been able to narrow down the list of improvements generated through the use of a shared river quality modelling tool (SAGIS – Source Apportionment in GIS) to construct catchment level improvement strategies. This has allowed us to exclude certain sites from proposed improvements by focusing upgrades where it is more cost effective to do so and maximising opportunities to deliver improvement by way of optimisation of existing assets.

At any given point on a river, water quality is the product of all the upstream sewage treatment works (plus diffuse inputs and third party discharges). This usually means that there are multiple options to deliver our fair share of the desired improvement. We use the SAGIS models in combination with our expert process knowledge to determine which sites offer the greatest scope for load removal and which sites have existing treatment processes that are most amenable to upgrade. By taking both factors into consideration we can propose the most cost-effective catchment level interventions.

Example 2: choosing the most cost effective option

When evaluating the improvements required to remove our fair share of phosphorus in the Weir Brook we evaluated the two sites upstream: West Felton treatment works; and Knockin treatment works. The site details are as follows:

Site	Population equivalent treated	Dry Weather Flow rate (m3/d)
West Felton	1,027	160
Knockin	151	25-30

Our joint modelling exercise with the EA generated two new effluent permit limit combinations:
Option 1 West Felton – 2mg/l Total Phosphorus (TP) and Knockin – 2mg/l TP
Option 2 West Felton – 1mg/l TP and Knockin – no limit for TP

Without doing any site investigation, process option sizing and costing, we already know that option 2 is most likely to be optimal because:
Option 1 Two separate upgrades and two new limits means we would cost two sets of chemical dosing units to remove phosphorus and two tertiary solids removal processes to polish the effluent.

Option 2 One single upgrade with one chemical dosing unit and one tertiary solids removal process.

Our experience, honed over several AMPs, is that the assets required to meet phosphorus limits of 1mg and 2mg/l TP are essentially the same, meaning option two is optimal because the cost of TP removal at West Felton is essentially the same under both options. We have sought to optimise investment in this way before WINEP3 so that customers are the sole beneficiary from this optimisation.

Option 2 is clearly the optimal option as it excludes all the upgrades required at Knockin and there is no change in the asset sizes required at West Felton – allowing Option 1 to be eliminated and Knockin does not require any further consideration for upgrade. Therefore only Option 2 appears in WINEP3 for delivery in AMP7.

This approach has allowed us to find the optimal set of sites proposed for upgrade reducing the number of magnitude of investments.

We've used the capabilities of our current assets

Wherever we have proposed river quality improvement work at our treatment works, we have given careful consideration to the capacity and capabilities of our existing assets and where these assets are located, both within the river catchment and relative to our wider asset base. This has enabled us to propose alternative solutions to the Environment Agency, such as asset base rationalisation and effluent discharge relocations instead of 'end of pipe' treatment options.

Example 3: making the most of the assets we have and optimising our discharge locations

At Scunthorpe wastewater treatment works we reviewed the new permit limits needed to meet good status for ammonia and phosphorus in the Bottesford Beck. The result was a 0.2mg/l TP limit and a 1.5mg/l ammonia limit. Both new limits constitute challenging upgrades for a works which is also facing a population increase of 30% up to 2035. Our alternative, for which the Environment Agency have provided likely permit limits, was to transfer the effluent directly to the tidal River Trent, a significantly larger waterbody offering far higher dilution.

The summary of the options is as follows:

Current limits and options	Ammonia limit (mg/l)	Total phosphorus limit (mg/l)
Existing limits	3	No limit
Option 1 - Current discharge point	1.5	0.2
Option 2 - Transfer effluent to the River Trent	3	1

Option 1 would require the following upgrades.

An expansion of the Activated Sludge Plant (ASP) to meet the lower ammonia limit and further expansion to mitigate against the population increase

Chemical dosing for phosphorus removal

Tertiary solids removal for phosphorus removal

Option 2 would require the following upgrades.

A potential (smaller) expansion of the ASP to mitigate against the population increase

Chemical dosing for phosphorus removal

A 3.5km pipeline to transfer the discharge

We costed both options and found Option 2 to be significantly less costly, and therefore this would be our notional solution and cost for inclusion in this programme. Option 2 also delivers a greater degree of improvement to the local watercourse so our customers receive additional benefits and at lower cost

We have undertaken reviews of our asset base before choosing notional solutions for inclusion in this business case. We assessed sites in the context of the wider catchment area in which it is situated. This ensures that we have the right assets in the right place, discharging at the most appropriate location.

We're exploiting the potential of innovation

We've invested more than £4 million in trials of new technologies over and above our contribution to the national water industry trials (being carried out as part of our current NEP obligations) to target lower phosphorous permit limits. Our innovation trials conducted at our research facility at Packington sewage treatment works, supported by additional trials at Bucknell and Warwick Longbridge works, has enabled us to deploy innovative new technologies to deliver our AMP6 programme and to incorporate these solutions into our AMP7 plan.

Through this innovation work, we are at the frontier of what is considered technically achievable. Following the outcomes of the industry-wide phosphorus trials the EA have revised their Technically Achievable Limit (TAL) for phosphorus down to 0.25mg/l (from 0.5mg/l in AMP6). In contrast we have already committed to limits down to 0.2mg/l in AMP6 based on our own assessment of TAL. This gives us both greater flexibility about how and where we adopt solutions (to optimise across a catchment) and to ensure we have greater resilience against future tightening of limits. Some examples from the trail are as follows:

Magnetite ballasted coagulation process (CoMag)

This process combines a coagulant, a magnetite ballast and a polymer to produce a weighted precipitate that settles very quickly and effectively. The trial was successful and showed the potential for delivering very low phosphorus levels. As a result we are already installing the process at Finham sewage treatments works in Coventry, one of our largest sewage works to achieve a very tight phosphorus limit of 0.22mg/l. Installing a CoMag solution, over a conventional method resulted in and estimated totex saving of £8.7 million and ROI of 218% on one scheme alone.

Pile cloth media filters (Mecana)

This technology uses a similar method for phosphorus removal as traditional sand filters, however, this innovative cloth filter is very fine and can change weave, making it a more effective alternative, as well as using less energy. We are installing or proposing to install pile cloth filters at twenty seven sites in AMP6. These filters provide a very effective solids removal process and are including in our design manual as a low totex solution for tight phosphorus limits on small to medium sized works. For example installing these filters at Redmile sewage treatment works, a small works serving a population of 826 with a new Phosphorus permit of 0.5 mg/l delivers an AMP6 totex efficiency of £209,000 over the conventional solution.

Learnings from these trials are being worked into our company design standards

We have also reviewed best practice sustainable urban drainage approaches to remedy the impact of CSOs river water quality. As part of our wider wastewater programme, we are proposing a performance commitment that will encourage greater uptake of sustainable solutions – creating greater natural and social capital value.

8.7.1.4 Best option for customers

Our proposals have been built iteratively – allowing for successive rounds of challenge and engagement. As well as challenging ourselves to deliver successive cost and scope reductions, we have listened to our customers and sought to exploit the potential to deliver multiple environmental and societal benefits from our investment.

Our programme is underpinned by customer value - we are only putting forward improvements that are cost beneficial (where this test applies) and are included in WINEP3. Where we have discretion about pace and phasing, we have sought to use it to securing the best value for customers by avoiding any potential spikes in bills in the first three years of AMP8 (to meet the 2027 WFD deadline).

The extent of our work in formulating this business case includes many thousands of hours of engineering and customer research time. Our optioneering has been extensive. A summary of the scale of activity is shown in Annex 3 which includes a high level review of optioneering (excerpt only as the data is extensive and cannot be captured so that it is legible on one sheet), and a simplified process to explain key stages and activities.

Our programme has been shaped by our customers

Views that customers have formed as a result of the deliberative workshops are that;

(i) we should design our programme to go as fast as we can, without compromising the outcome but be mindful of bill impact (affordability),
(ii) we should pursue partnership working (where the problem is complex i.e. multiple sources of pollution) but recognise others (e.g. farmers) have a role to play,
(iii) they favour solving problems [e.g. pollution] at source [i.e. simplify the approach to solutions] rather than dealing with it later (when it could be more difficult and costly),
(iv) working in partnership brings risks and they have encouraged us to test our approach to ensure partnerships do work and,
(v) we should tackle the worst rivers first and those where most people would benefit.

Given these explicit findings we have responded by;

a) confirming a delivery programme which sets out to deliver a significant number of WFD 'improvements' (as opposed to just the minimum mandated 'no-deterioration') in AMP7 and thus reduces risk the defaulting on the Government's ultimate delivery timescale of Dec 2027. We have tested all our WFD 'improvement' investments and are including only those that are cost beneficial,
b) continuing to work in partnership with farmers and Non-Government Organisations (NGOs) to deliver water quality improvements (nitrate and metaldahyde reduction) and environmental improvements through river restoration projects. We will look to expand this approach into our wastewater WFD environment programme where we identify practicable opportunities (e.g. 'fair share' contribution, amount of chemical removal required to deliver improvement, willing partner[s], where the technical challenges). Notwithstanding the need for these conditions to exist, we will also need to engage in regulatory changes (e.g. changing our solutions set out in WINEP3),
c) exploiting opportunities to reduce the complexity of our solutions where we can,

d) we will review our partnership approach on our waste programme once we have evidence to understand the success (or otherwise) and,

e) confirming of delivery programme that sets out to address river reaches with more tighter effluent consents (than in AMP6) and lower down the catchment (compared to AMP6) where more urban populations exist.

We've used the expertise of our stakeholders

We have drawn on the expertise of our regional stakeholders to develop our proposals. In addition to our ongoing collaboration with the Environment Agency, in March 2016 we held a programme of workshops with our stakeholders to discuss how we can best address the future challenges we face.

In our 'Shaping our Future' workshops stakeholders including the Environment Agency, Natural England, Natural Resources Wales, Severn Rivers Trust, Severn Trent Water Forum, Wildfowl and Wetlands Trust and Coventry University discussed. Their feedback has helped to shape our approach.

Responding to stakeholder views

What our stakeholders told us	How we have responded
Delivering WFD objectives by 2027 should remain a priority	Our plan is focussed on achieving our WFD objectives by 2027
We will need to work towards Environment Agency guidance on reducing spills from our CSOs	Our UWWTD investigations in this proposal are part of a longer term strategy to reduce spills from our CSOs (and the overflows at our works)
We should prioritise schemes using a range of benefits	We will seek to prioritise deployment of our programme by a number of factors (local population, social deprivation and availability of active catchment partnerships)
We should demonstrate our environmental leadership	We have identified areas where we could reach our WFD objective by working with other parties, in-line with our catchment incentive activities this AMP

We've ensured all WFD improvement schemes are cost beneficial

Our proposed WFD improvement schemes have been subject to cost-benefit assessment. We have ensured our analysis is underpinned by customer value by using a willingness to pay value derived by our research.

In order to assess the cost-benefit of WFD related improvements at our treatment works, we have scoped, designed and costed over 300 different schemes. Each scheme typically had 1-3 solutions entailing different technology choices and process risk levels and multiple other schemes had the option of closing treatment works or moving the discharge.

The costs from these improvements are then grouped together around the catchment(s) improved as benefits to the river are co-dependent upon multiple schemes. This is then compared to the benefits associated with these improvements, namely the kilometres of waterbodies improved for the sub-catchment or batch, which aligns with the Environment Agency's methodology. The Environment Agency then performed cost benefit analysis, based on our costs, using their own methodology.

For additional rigour, we applied a cost benefit assessment based on customer willingness to pay values. We cross referenced our results with the Environment Agency's to exclude catchments and sub-catchment areas which were not cost beneficial by both measures. We have then only proposed improvements which were found to be cost beneficial.

For completeness, the mandatory improvements in our proposal are not subject to cost benefit criteria. However, as explained in *section 3: management control* we have sought to drive down scope and cost. In section 5: *Robustness and efficiency of costs* we explain how we have derived solution costs and are benchmarking them.

We've driven and will continue to drive multiple benefits (to maximise cost benefit)

We've responded to customer and stakeholder feedback that we should exploit the potential for multiple benefits for the communities we serve. We have recently trailed the use of natural capital appraisals and early results suggest we will embed this into our project delivery processes notwithstanding that we have a long track record of installing solutions that offer natural capital enhancements whilst delivering the traditional needs of our customers. In the current AMP (across our whole investment programme) we are;

- delivering improvements to SSSIs,
- undertaking hydro-morphology improvements through river restoration work,
- delivering aquifer improvement work,
- constructing reed beds to delivering our WFD obligations,
- installing Sustainable Urban Drainage Systems,
- working with farmers to reduce their impact on the environment and
- constructing wetlands.

However our traditional appraisal tools do not help us assess the full impact of these solutions. Generally in the past we have not sought to appraise the enhancement value associated with these type of investments, nor the wider natural benefits any of our investments may create over and above the principal benefits we are seeking to achieve (such as UWWTD compliance or WFD improvement). Natural capital appraisal tools should help us do this in future and thus help us make more balanced decisions and we have been using the services of a specialist independent supplier in this area to help us. We are in discussions with them to understand how we can upskill our engineers to undertake this work as a matter of routine.

To date we have looked at the following appraisal tools;

- The 'EA's natural capital tool' for assessing the appropriate costs and mitigations following pollution events.
- The 'Water Appraisal Tool' (which the EA use for WFD assessments) to augment our cost-benefit assessment of catchment management interventions.
- The 'UKWIR Tool' on a number of case studies (Sutton Park post pollution, Waterside Care etc). Phase 1 has been released – scope for Phase 2 being assessed.
- The B£ST Tool to set incentives for our bespoke sustainable drainage ODI for AMP7 to better value the natural capital of SUDS features in the community.

As a result we have been able to map out the extra benefits that would be delivered in addition to the core objective of river quality enhancement to ensure that we prioritise investments that deliver maximum benefit to both our customers and the environment. These additional benefits include:

- downstream Biodiversity Action Plan priority habitat areas;
- public amenity areas and visitor attractions through which benefitting rivers flow;
- downstream protected areas (SSSI, SAC etc) that would benefit from improved river quality; and
- proximity of improvements to areas of low social mobility.

We are now better able to communicate to customers the contribution these benefits make to the environment in their region. We have used this additional information to prioritise between projects that are marginal on cost benefit to ensure that we select those that deliver more of what our customers' value.

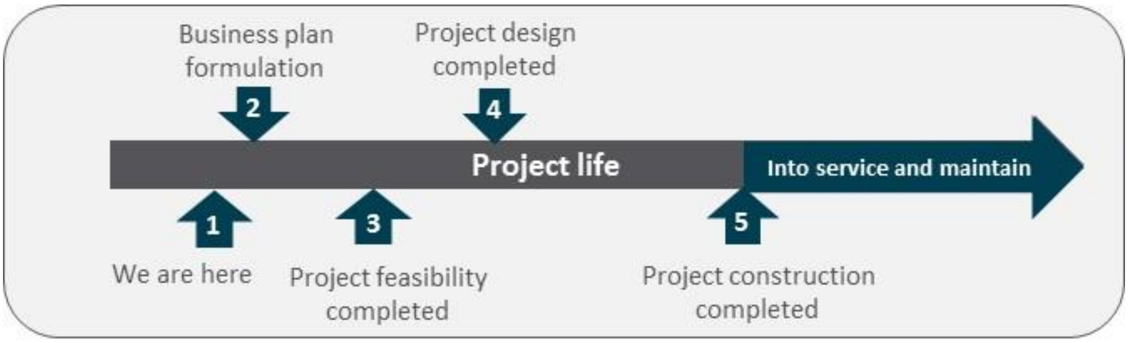
Our environmental enhancement investments have therefore been designed to deliver additional benefits including (but not exhaustively) water quality improvements:

- at three SSSI sites:- Clumber Lake, Thoresby Lake and the River Eye
- in the River Mease Special Area of Conservation (which is also a SSSI), measures to meet Natural England's conservation objective on naturalised river flow will also deliver river quality benefits;
- In the river Dove, our measures to meet WFD good status have been designed to also achieve water quality targets in Staunton Harold and Foremark reservoirs.

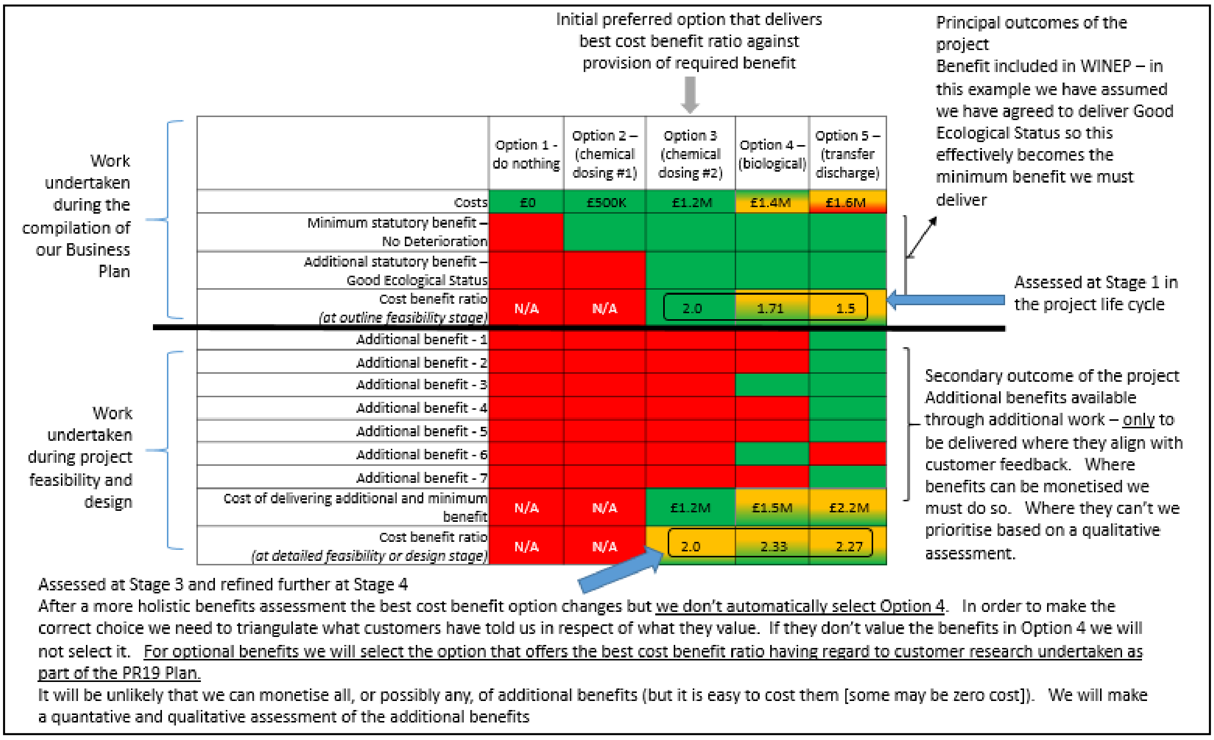
Annex 2A and 2B demonstrate how we have used catchment thinking and natural capital appraisals

Our process for exploiting more benefits in the future

There may be more optional benefits we can exploit as we progress further through the project lifecycle. We are currently at stage 1 of the project lifecycle, indicated in the figure below.



Our cost-benefit assessment reflects our current stage in the project lifecycle



We will have the opportunity to find further benefits as we progress through the project lifecycle

As we progress the detailed feasibility we may uncover other benefits for example those associated with the wider environment or wider societal benefits (natural and social capital). Throughout our work we have sought to integrate customers in shaping our proposals by listening to what they have told us and bringing those views into consideration. However we will have further opportunities for our customers to be involved in the delivery phase of the proposals themselves, particularly as we identify additional (secondary) benefits and confirm which our customers value. This work will represent a major step change in our approach to understanding and responding to customers in a much more dynamic and meaningful way. Where we can, we seek to monetise these and bring them into the financial option analysis. In the example above:

- Option 1 does not achieve the minimum statutory requirement so is rejected.
- Option 2 achieves the minimum statutory requirement but goes no further.
- Options 3 and 4 achieve minimum statutory requirements but go further as it is cost beneficial to deliver the WFD 'good ecological status'.
- Option 4 has the additional benefit of using less chemicals to achieve the standard.
- Option 5 achieves removal of hazardous chemicals from the receiving watercourse which is not required as part of the statutory driver but we need to work with the Environment Agency to agree the transfer option.

We therefore have options to pursue Option 3, 4 or 5. Given the value our customers place on the natural environment, we would seek to do more where we can - so we would pursue Option 5. However, we would only do this where the option continues to be cost beneficial.

The Water Forum has challenged our approach

The Water Forum and the ISG have challenged us to demonstrate that our proposed approach is the best option for customers – on the basis that it reflects customers' priorities and their views on approach. Our response to the challenges laid out by ISG are explained in Section 1.4

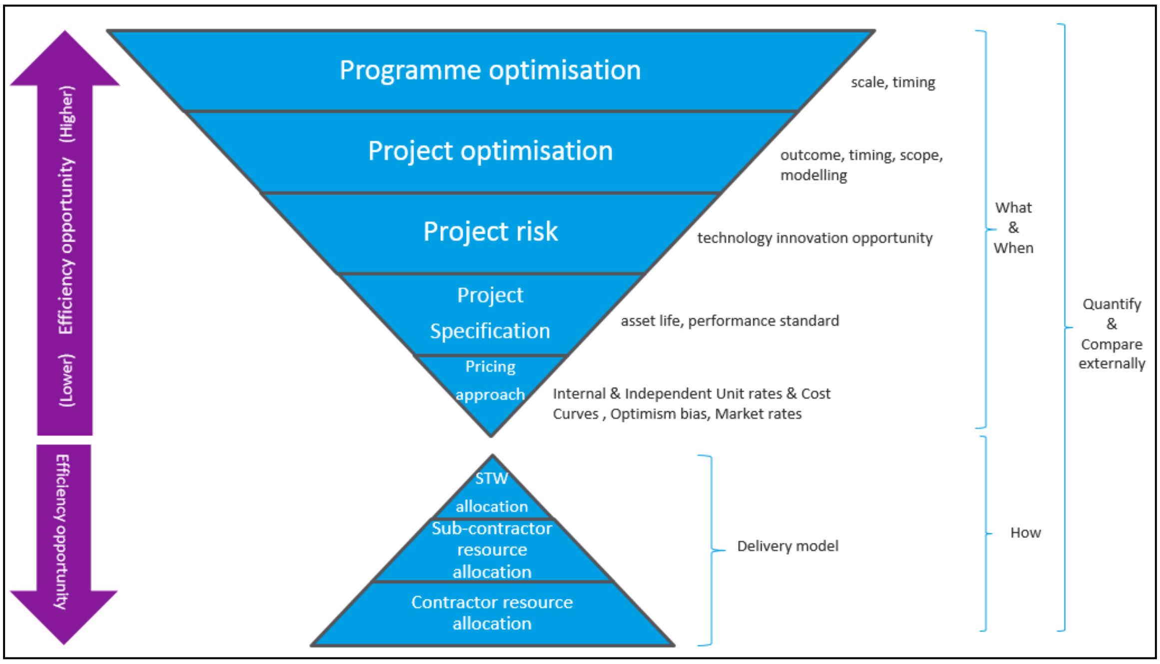
8.7.1.5 Robustness and efficiency of costs

Delivering cost efficiency in Severn Trent Water

For this business case we have adopted a proportionate approach to risk and cost having regard to our customers' needs. They have told us that they think of value [of investments] in terms of 'effectiveness and spreading the cost over time and not the lowest cost option', so it is clear they have sophisticated expectations in this area. The linking of solution effectiveness, time and low cost, suggests to us that our customers expect;

- our work to be phased in such a way to avoid large changes in bills (wherever we can)
- solutions that do not deliver short term cost savings at the expense of long term cost increases,
- our solutions need to be reliable over time,
- have an associated benefit stream that addresses the challenge sufficiently and,
- our cost efficiency strategy seeks to deliver on all these expectations.

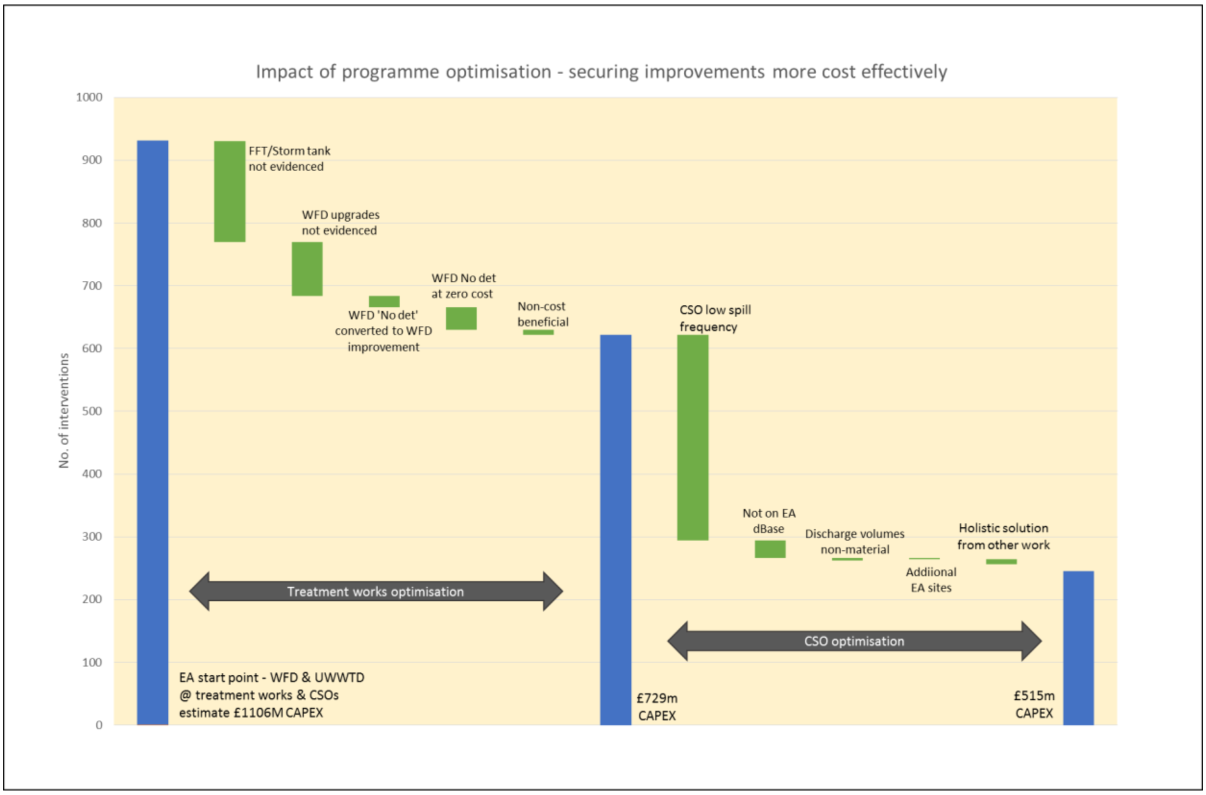
There are multiple strands to delivering cost efficiency as shown in Figure 7.



Our model for delivering cost efficiency

The most significant savings exist when looking at the proposal from a programme position; scaling the investment proposal offers the most significant level of savings to our customers. In order to establish the appropriate scale of investment we have worked with our regulators to understand if investment needs actually exist or not. We have also sought to understand the optimal time to deliver any investment that may be required.

We have challenged the need on numerous water bodies and have confirmed with the EA that we will only invest at those sites where we there is a reasonably strong body of evidence to suggest that our activities have a detrimental impact on the environment. Equally if we have work on-going in AMP6 and we are confident that this will make sufficient impact after commissioning we will delay committing to investment now and we will re-appraise needs in AMP7. This work has been extensive and taken c2yrs of collaborative working with the EA and resulted is a programme that delivers a higher cost benefit return for our customers with no diminution in real benefit delivery for the environment.



We have also looked at how we can optimise projects in terms of outcomes, timing and scope. For example we have sought to convert projects which start out as a lower standard now (i.e. No-Deterioration [of waterbody]) to the higher standard which is required by 2027 (i.e. Improvement [of waterbody]) where we can if the additional costs are minimal or it makes sense to convert the obligation to an 'improvement' rather than a 'no-deterioration' (i.e. logistics, early benefit etc). We are also delivering more efficient solutions by assessing needs at a broader, catchment level. By doing this we have removed the need to invest at many sites through implementing a slightly larger solution at one site which delivers the improvements required at both sites. Wilson STW and Branston STW are two such examples. We have also looked at optimising the number of sites we need to invest in by seeking to combine flows across multiple sites and reduce overall investment. This has been achieved at Lower Gornal STW and Hinckley STW

Project scope is selected according to the most optimal way of delivering the benefit in the particular project circumstances. Scope is determined by understanding the building blocks that will lead to delivering the benefits. We have then been able to select elements of work within projects and cost these using our cost tools. We have followed a structured approach to building cost estimates using standard cost curves, non-standard cost curves and unit rates. The scope also embeds the level of project risk we are undertaking, principally risk on technology process.

Technology innovation (Section 3.5), where appropriate, is included in the options review and we are using our experience from our test bed (at Packington) and AMP6 as-delivered schemes to embed this into our AMP7 plans. This comprises proposing new technology such as, Aerated Granular Activated Sludge, Cloth Media Filters and Ballasted Coagulation, but perhaps more importantly considering new technology options for a wide range of problems we need to solve (whether we adopt it or not as the preferred solution).

Finally we have sought to deliver multiple benefits where opportunities exist. This ensures that customers benefit from minimising scope whilst delivering maximum benefit across different programmes of work. A number of our sites fall into this category where we are improving both SSSIs and waterbody quality - Burton Lazars STW and Skegby STW are two such examples.

The costs of the projects which have been selected and included in our plan have been established through the use of the following estimating tools;

- STW cost curves established, updated and refined over the last 15yrs for similar activity,
- STW unit rates established, updated and refined over the last 15yrs,
- Cost data provided by an independent engineering consultant with specialist cost data sets

We have then tested the efficiency of these using an independent expert (Turner & Townsend) by;

- Benchmark testing a selection of representative projects,
- Benchmark testing a number of programme level costs e.g. feasibility fee, design fee, project support costs

Cost efficiency benchmarking is set against the background of having secured programme optimisation and project optimisation savings such that they accrue in their entirety to Customers.

The results of the benchmarking exercise are set out below;

The projects at Alvechurch STW and Kempley STW contain elements of work that are replicated across the whole proposed programme has been tested for cost efficiency by our independent third party specialist cost expert (Turner & Townsend [T&T]). Across both projects scope comprised; primary, secondary and tertiary treatment enhancements, sludge improvements and general site wide enabling work. The costs against which T&T tested our estimates came from projects that have been constructed or are under construction – this means their reference prices are comprised of suppliers who have been successful in securing work and therefore are de-facto the most competitive.

T&T priced the work according to our bill of quantities and compared them to a central estimate of their cost estimates. The representative schemes were considered competitive by T&T:

"The estimation which Severn Trent Water submitted for the [Alvechurch STW] scheme was £3.55M. This is lower than our estimate [P50 = £3.81M] therefore in our view Severn Trent Water's estimate is deemed competitive''.

''The estimation which Severn Trent Water submitted for the scheme [Kempley] was £666K. This is considerably lower than our estimate [P50 = £1.88M], however this may be driven by either a difference in technical

specifications in comparison to our benchmark data or Severn Trent Water can deliver schemes of this nature more efficiently than our benchmark."

We applied the same logic for our CSO intervention projects at Birchwood Lane and Sliverdale. The analysis was thus; t*he estimation which Severn Trent Water submitted for the [Birchwood Lane] scheme was £311K [P50 = £315K], therefore in our view Severn Trent Water's estimate is deemed competitive. The estimation which Severn Trent Water submitted for the [Silverdale] scheme was £1.333M [P50 = £1.348M], therefore in our view Severn Trent Water's estimate is deemed competitive.*

We also engaged T&T to consider how competitive our assumptions of programme overheads are. They assessed the cost efficiency of general recurring project costs such as upfront feasibility, investigative contracts and project management, design costs and Company overhead costs. Our proposals were benchmarked against other water companies and other sectors (rail, highways, environment, telecoms, aviation and power). The results of this analysis is shown below;

Summary of overhead cost benchmarking findings

Cost type	Range	Average	Severn Trent
Owner team	[REDACTED]	[REDACTED]	[REDACTED]
Design Costs	[REDACTED]	[REDACTED]	[REDACTED]
Capital Overheads	[REDACTED]	[REDACTED]	[REDACTED]

Whilst the assessment acknowledges that there is subjectivity in the analysis and requires further validation, we are confident that the findings of the initial review prove that Severn Trent's costs are competitive across all aspects of project overheads and design.

8.7.1.6 Customer protection

We have a good track record of delivering environmental improvements. Our current AMP6 programme will deliver improvements in at least 1500km of rivers in our region. We have achieved the Environment Agency's top 4* rating three times in last five years, and in the most recently published year (2016), our environmental compliance (at 99.6%) was industry leading.

Customers will be protected from the risk of under-delivery by either statutory enforcement action (where schemes are mandatory) or in the case of WFD improvements to which our cost adjustment claim principally relates, a performance commitment.

Customers are protected by a combination of statute and performance commitments

Statute	Area	Requirements	Timing	Customers protected by:
WFD	No deterioration	Mandatory	Mandatory - AMP7	Statutory enforcement action
	Improvement – good ecological status	Mandatory (if cost-beneficial)	Discretionary until 2027	WFD performance commitment
	Community legislation - Habitats directive and CRoW Act	Mandatory	Mandatory - AMP7	Statutory enforcement action
UWWTD	CSO investigations	Mandatory	Mandatory – AMP7	Investigations only proposed
	Improvement and monitoring	Mandatory	Mandatory - AMP7	Statutory enforcement action

We recognise that there is uncertainty over full scope of investment required until the WFD improvement schemes are approved as part of River Basin Management Plan 3 in 2021. To mitigate this risk for customers, we have only made provision for enhancements that are 'green' or 'amber' in the WINEP3. We have worked very closely with the EA to ensure that these projects are clearly supported by the available evidence and meet cost benefit criteria.

Our primary mechanism to protect customers will be to through an updated WFD performance commitment. We have successfully used a WFD performance commitment in AMP6 to accommodate changes in the EA's National Environment Programme 5 (NEP5). NEP5 was agreed twelve months after PR14, and due to additional bodies of evidence and improved river quality models being available, 15 of the original 89 schemes proposed were removed and substituted with 32 replacement projects. . As a result of these changes, which were agreed with the EA, customers will benefit from improvements in an additional 244km of river in 2015-20.

Our proposed performance commitment for PR19 will retain the ability for project substitutions to deliver the same overall outcome. Where suitable substitutions cannot be agreed with the EA, we will return unused resources to our customers via an ODI penalty. The full performance commitment definition is set out in Appendix 3.

Our Water Forum has reviewed, and not raised any concerns with, our proposed approach to customer protection.

8.7.1.7 Affordability

We'll review affordability again in the context of our overall plan

We have carefully considered the affordability implications of our environmental wastewater programme and sought to drive down scope and cost wherever possible.

However, the scale and complexity of required improvement results in a significant step-up in investment which, if all else were to stay the same, would increase customer bills. We will continue to develop the programme as we move towards business plan submission in September 2018, taking opportunities to reduce the scale and improve efficiency of our programme. WINEP3 will continue to be uncertain to some extent until 2021, and so we will consider an uncertainty mechanism to cover the less certain requirements in a way which will not hold up delivery of the overall programme. We believe the proposed WFD performance commitment is suitable for this purpose.

We've considered the implications for customers' bills

While compliance with the WFD is constrained by the 31 March 2027 completion date, the Directive gives us until that date to bring forward or defer delivery - allowing us to ensure we're investing at the right time and avoiding unnecessary investment. It has also allow us to spread the cost over AMP6, AMP7 and AMP8 to ensure the March 2027 date is met while at the same time as ensuring that we properly investigate investment requirements (to ensure we do not unnecessarily commit customers' money) and smoothing the bill impact wherever possible.

We have not submitted a request to the national EA/Defra for elements of WINEP3 to be phased across AMPs 7 and 8. Phasing delivery of WINEP3 is likely create affordability and delivery pressures in early AMP8, given the WFD backstop date of 2027. This is not to downplay the challenging programme contained in our WINEP3 list of obligations, but we recognise that phasing is unlikely to address any affordability risks in the long run.

A key reason for not asking for a phased approach to WINEP3 is that we are already anticipating a need for further Water Framework Directive investment in early AMP8. Through our discussions with the Environment Agency we have agreed to reserve potential schemes for AMP8 where we believe the need could change in the future and therefore be achieved at lower cost for customers. There are three principal circumstances in which we have done this.

Building on benefits in AMP 6

Some quality improvement projects in our current programme go beyond the Environment Agency's AMP6 'technically acceptable limit' for phosphate of 0.5mg/l. This has enabled us to tackle some large catchment areas in the upper reaches of several major river systems. As these improvements will deliver benefits to the lower reaches of these rivers, we have agreed with the Environment Agency that it would be appropriate to assess these benefits before finalising additional measures.

Omitting sites where WFD 'good status' is currently technically unachievable

Our joint models have identified some river reaches where delivery of WFD good status standards is currently technically unachievable. Where achieving a lesser WFD standard in AMP7 is likely to be very expensive, we have agreed that it would be appropriate to wait for the Environment Agency to confirm an alternative river quality objective as part of RBMP3 in 2021.

Investigating alternative approaches

We have jointly identified three catchment areas where significant phosphate removal has already been delivered, but some further improvement is needed. This further improvement would be relatively high cost if tackled through traditional 'end of pipe' approaches. Investigations in AMP7 to assess alternative approaches, such as offsetting, as we believe that this could deliver more benefits to customers and the environment at lower whole life cost.

8.7.1.8 Board assurance

Working with Pricewaterhouse Coopers, we designed a bespoke assurance framework to support the development of our plan to the highest quality. This Board-led framework builds upon our well-established and robust annual assurance processes. Each 'building block' within our plan was assessed for 'bottom up' risk to include the individual components (e.g. data/source, methodology, judgements and assumptions) against our likelihood factors (level of change, complexity, roles and responsibilities and subjectivity) and our impact factors (financial value, customer impact, competition, statutory/regulatory requirement).

The level of risk determined the type and level of assurance required with significant or high risk building blocks allocated to an independent third line assurance provider depending on the particular expertise required (technical/regulatory, financial, specialist model expertise etc.). This framework was applied to our cost adjustment claims which were assessed as high risk and therefore were assured through all three lines of assurance. Assurance was undertaken in stages and took account of costs, the need for the claim and testing of solutions. For more information on how we developed and applied our framework to our cost adjustment claims and the findings of the assurance, please read our 'securing trust, assurance and confidence' chapter and supporting appendix.

Annex 1: Line of sight between customer insight and our approach

Strategic investment area		Consolidated theme emerging from research	Details underpinning the theme	Sources	Further details of the sources	Score	How our plan reflects customer research findings
Wastewater	Customer priorities & investment support	Customers value the natural environment	Customers think that we should do as much as possible to protect and improve the environment	Environment deliberative research (page 33)	Whilst this emerged as a theme in the deliberative research there are conflicting sources of insight - Choices research qual participants didn't see the need for faster progress compared to legal obligations relating to river water quality		We have worked with the EA on defining the WINEP programme Where appropriate (and cost beneficial) we are seeking to do more (e.g. by bringing forward WFD improvement obligations rather than just doing the no deterioration component in this AMP) We have an employee volunteering programme which works in collaboration with river charities and delivers "softer" environmental improvements (e.g. litter picking)
			Customers see the aspiration of going above and beyond legal obligations as very positive in principle, but there are some concerns about bill impact	Environment deliberative research (page 28)			
			Some customers are happy in principle with delivering WFD improvements faster but are concerned about bill impacts and "rushing it", in other research customers did not see the need for faster progress	Environment deliberative research (page 46)			
			Customers value the environment (despite not always explicitly linking our activities to an environmental impact)	Multiple - see next column	We are saying this because: 1. PR19 deliberative research shows customers care about their local environment, and are concerned about wider issues 2. In the 2016 customer priorities research this emerges as a key theme 3. Customers are WTP for environmental improvements (both PR14 and PR19) (pollution, river quality, biodiversity) 4. Reducing pollution emerges as a high (prompted) priority for customers 5. Improving river water quality emerges as a medium (prompted) priority for customers		
			They are not concerned whether this [biodiversity improvement] is on sites that we don't own or where customers don't have access	Environment deliberative research	This was in the context of biodiversity improvements on operational sites, once customers had spent the entire day immersed in environmental aspects of our work		See biodiversity strategy and performance commitment - we are seeking to identify potential improvements on sites that are not owned by ST and/or accessible by the general public
	Solutions	Customers show some preferences about which rivers we should prioritise	We should tackle the worst rivers first We should also prioritise areas which will benefit the greatest number of customers - for some this meant focusing on urban over rural areas There should be a fair balance of investment over the region	Environment deliberative research (page 47)	Our PR14 research found customers wanted a roughly equal split of investment on river water quality and preventing pollution between urban, rural and "beauty spot" areas, with a slight preference for investment in urban areas		Our prioritised investment programme is in line with customer expectations: We have analysed where the worst rivers are located, using water industry tools - these are included in the WINEP The majority of proposed improvement is located in urban areas Our investment is spread across our region to ensure a spread and balance but the investment is driven by water body need.
		Customers think we should raise awareness and educate customers on the environmental impact of their activities, as well as provide reassurance and communicate how customers' money will be invested	A strong theme emerging from the research is that customers want to know more (about what we are doing) however they don't want to be bombarded with blanket comms	Customer needs research Environment deliberative research (page 54)			We are planning an increased education programme in AMP7 which will better engage current and future customers. We should also review our engagement strategy on capital projects as this could increase engagement on positive messages such as environmental improvements.
		Customers are supportive of partnership solutions. However they also feel an all options approach is preferable	When talking to customers we generally find that they are risk adverse. For example they tend to favour all options approaches such as treatment and catchment solutions, without fully appreciating the bill impact of doing both and the controls that would be put in place to ensure success of a catchment solution. We also find they are trusting of Severn Trent to have the technical expertise (e.g. to decide on the most appropriate solution)	Environment deliberative research (page 44) and flooding deliberative research (page 30)			We are investigating the possibility of using catchment incentives where this reduces the cost of end of pipe solutions. We are conscious that any partnership solution is effective and whilst we have a good model from our water programme it is not directly transferrable to our waste programme as the long term implications from 3rd parties are more complex. We will continue to work on developing acceptable proposals,
			Working in partnership is seen as a practical solution for complex issues that affect multiple organisations, with the potential to reduce costs and environmental impacts. However customers are also concerned about the effectiveness of partnership solutions, for example where other parties have different priorities				
		Customers think that we should seek to tackle problem upstream as opposed to solving issues after they happen		Environment deliberative research (page 13)	This is one of the environmental principles from the deliberative research, and as such not necessarily generalisable to all customers		We are looking at the balance of upstream vs downstream improvements

Scoring	Rationale
	Multiple sources of evidence converge on the same finding (repeat themes) Including both quantitative and qualitative evidence
	Some consistency in themes across multiple sources but also some contradictory views
	Qualitative evidence from a single study that we should be wary of generalising Single source of evidence or multiple contradictory evidence from different sources Evidence from a old research project or on a slightly different topic

Annex 2A - Catchment thinking in action

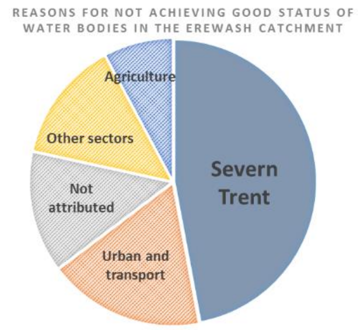
1. The River Erewash catchment

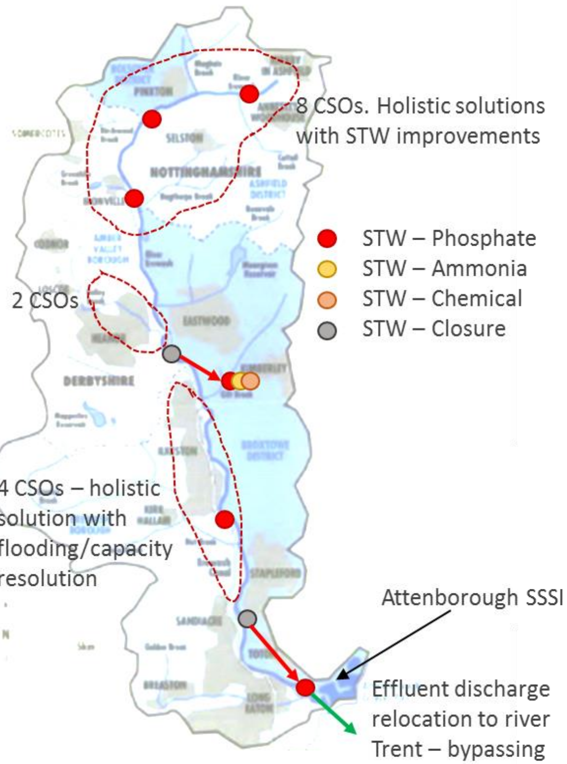
270,000 customers live in the River Erewash catchment, a small, predominantly urban area west of Nottingham. The catchment is characterised by low social mobility (amongst the lowest in our region). The 78km river and its tributaries flow south from Kirkby in Ashfield through several large urbanised conurbations prior to entering Attenborough Nature Reserve (SSSI). The lakes at the nature reserve then overflow to the River Trent. Eight of our sewage treatment works discharge into the Erewash catchment.

2. Working collaboratively to protect the environment

None of the waterbodies in the catchment achieve WFD good ecological status with the predominant cause of failure being water industry wastewater activities mainly in relation to phosphate and ammonia. The EA identifies both sewage treatment works and Combined Sewer Overflows (CSOs) as the causes of WFD failure.

In partnership with the EA we have reviewed environmental compliance data which shows 83% of the phosphate in the catchment comes from sewage effluent. Our analysis indicates a 75% load reduction is required for us to deliver our fair and proportionate share. Data from the chemical investigations programme similarly confirms the ammonia and chemical requirements in WINEP3 are also fair and proportionate.





The River Erewash catchment

3. A catchment solution delivers the outcome efficiently

Traditional solution: Upgrade all eight works to meet stringent permit limits between 0.2 and 0.3mg/l phosphorus, implement enhanced ammonia removal at two works, with action required at one works to prevent chemical deterioration. Action also required at 14 CSOs to reduce spill frequency and volume.

Proposed solution: We've reviewed the condition, location and capabilities of our existing asset base together with future demand and asset maintenance needs to design a catchment solution that delivers long term, sustainable benefits whilst driving down the marginal cost of enhancement.

4. Our approach delivers a wide range of benefits

- **Rationalised, more efficient, asset base (from 8 to 6 works);**
- **More environmentally effective solution implemented (30% of the load reduction achieved by redirecting effluent from 100,000pe directly to the river Trent instead of installing enhanced treatment, with no net detriment to the Trent).**
- **Significant synergies between our CSO improvement programme and work to reduce the risk of sewer flooding in Ilkeston. A programme of surface water separation to improve performance and capacity of the combined sewers will have knock on benefits in terms of spill frequency and volume from CSOs in the network, reducing the level of end of pipe intervention required.**
- **Also able to assess options for improving storm overflow performance at two works through increasing flow to full treatment in place of storage solutions.**

5. The benefits of the catchment solution exceed the costs

The catchment solution has a cost benefit ratio of 2, so we are confident that the improvements are beneficial and that now is the right time to invest.

Note: Our cost benefit assessment is done on a per parameter basis and also takes WFD classification improvement into consideration. We've used our customer willingness to pay values, with the assessment only applied to enhancement expenditure. As WFD no deterioration is not subject to a cost benefit test, we have excluded these marginal costs from our calculation.

6. We will also deliver wider societal and natural capital benefits

Our enhancements will improve:

- **The SSSI at the south of the catchment (it is made up of a series of ex-gravel extraction pits and is adversely affected by the high level of nutrients in the Erewash). We will investigate options for addressing the legacy issue of sewage effluent derived nutrient trapped within the nature reserve lakes;**
- **Riverside amenities, which we estimate deliver over £5m benefit to local communities (based on mapping public recreation and biodiversity features within 200m of a section of the river);**
- **Ten recreation areas and five biodiversity priority areas downstream of our enhancements will also benefit; and**
- **The general environment within which some of our most vulnerable customers live.**

Annex 2B – Natural Capital Appraisal – appraising benefits more holistically

TRADITIONAL BENEFITS

WWTW investments are currently assessed using a cost benefit analysis.

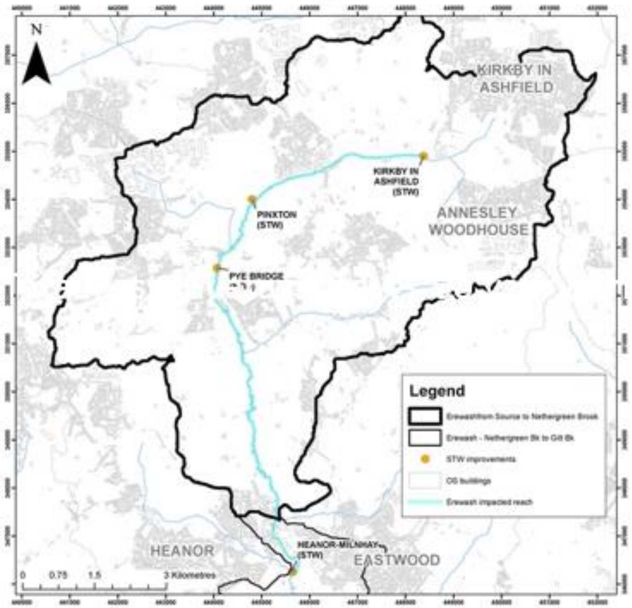
Upgrade costs for the three WWTW considered is £8.8m CAPEX.

As part of wider catchment improvements (including other WWTWs and CSOs) this yields a cost benefit ratio of 1.63:

£37.9m (NPV TOTEX) Cost

Benefit £61.7m (NPV Benefit)

Objective: What are the benefits of WWTW investment in P reduction?



Upper Erewash waterbody (Erewash from Source to Nethergreen Brook)

ADDITIVE BENEFITS

Using the UKWIR Natural and Social Capital Accounting Tool additional benefits we have appraised relate to:

- Wildlife
- Recreation
- Fishing
- Aesthetics
- Aquatic sports
- Health impacts

We have sought to monitise these benefits through an independent consultant. Estimated at:

+£15k/yr

In addition to identifying these additive benefits we have established a number of baseline benefits that were not previously visible to us. Based on our independent consultants' assessment of benefit associated with recreational value we estimate this to be c£1M/yr (source *Outdoor recreational value 2018 – University of Exeter*)

Annex 3: Scale of activity undertaken, option analysis (excerpts only as full list is too extensive) to develop this business case and simplified process and activities

	EA long list (WFD improvement only)				Options reviewed							Final costs and drivers (for inclusion)						
Site name	Insufficient evidence	Not necessary	AMP6	Potential AMP7	Biological filters	Innovation (installed AMP5/6)	Innovation (due for AMP6)	Biological P removal	Activated sludge	Effluent transfer	Closure	Habitats Directive	CRoW Act	UWWTD - P&N	WFD P	WFD NH3	WFD BOD	WFD Chem
HEANOR-MILNHAY (STW)																		
SCUNTHORPE-YADDLETHORPE (STW)																		
BURNTWOOD (STW)																		
NUNEATON-HARTSHILL (STW)																		
ROUNDHILL (STW)																		
WADWORTH (STW)																		
CALVERTON (STW)																		
REDDITCH - SPERNAL (STW)																		
SKEGBY (STW)																		
SNARROWS (STW)																		
CLOWNE (STW)																		
ARMTHORPE (STW)																		
BALDERTON (STW)																		
EAST BRIDGFORD (STW)																		
HAXEY - GRAIZELOUND (STW)																		
LANGHAM (STW)																		
LOGGERHEADS SANATORIUM (STW)																		
MINSTERLEY (STW)																		
NORTON GREEN (STW)																		
BURTON ON THE WOLDS (STW)																		
WYMONDHAM (STW)																		
ALCESTER (STW)																		
ASHWELL (STW)																		
BURTON LAZARS (STW)																		
HIXON (STW)																		
KIRTON-IN-LINDSEY (STW)																		
MARKET OVERTON (STW)																		
MERIDEN (STW)																		
BRAMPTON BRYAN (STW)																		
WHISSENDINE (STW)																		
PACKINGTON (STW)																		
ILKESTON - HALLAM FIELDS (STW)																		
ARLEY (STW)																		
ASHBOURNE (STW)																		

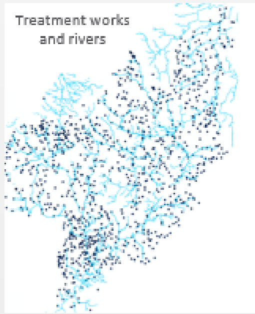
Sewage Works Name	EBPR	ASP + Chem dose + TSR	Biofilter + Chem dose + TSR	Innovative tech - tested	Innovative tech - untested	Effluent transfer	Closure
ABBOTS BROMLEY (STW)			Op1 Retain Works				
ABBEY LATHE - MALTBY (STW)			Op1 Retain Works		CoMag		
ADBASTON (STW)			Op1 Retain Works				
ALBRIGHTON (STW)		Op1 ASP	Op2 Retain Works				
ALCESTER (STW)			add dosing and TSR				
ALFRETON (STW)	EBPR plus top-up dosing		Retain works	IFAS	CoMag		
ALTON (STW)		Op1 Retain Works					
ALVECHURCH (STW)	EBPR plus top-up dosing	add dosing and TSR					
ARLEY (STW)		Option 1 Replace with dosed ASP	Option 2 add dosing and TSR				To Finham
ARMTHORPE (STW)		Chem dose			CoMag		
ASHBOURNE (STW)	1. EBPR + top-up dosing			2. Settled Hybacs	3. Settled Nereda		
ASHBY FOLVILLE (STW)			Retain works				
ASHORNE (STW)		Ext Works + chem dosing + refurb reed beds					
ASHWELL (STW)			1. Chem dose+TAR+TSR				
ASTWOOD BANK (STW)			Option 1 add dosing and TSR				
ATHERSTONE (STW)	Option 2 EBPR plus CoMag	Option 1 add dosing and CoMag			CoMag		To Nuneaton
BALDERTON (STW)					CoMag	1. Divert FE+Storm to Trent + Growth	
BARLESTONE (STW)		Oxidation ditch plus chemical dosing	Retain works and New Additional TSR				
BARROW & QUORN (STW)			Option 1 add dosing and TSR		CoMag		
BELBROUGHTON WORKS (STW)			Option 1 add dosing and TSR				
BILSTHORPE (STW)	2. Crude EBPR Ditch + chem	1. Crude Ditch + Chem	3. Retain + chem				
BISHAMPTON (STW)			Existing Works + TAR				
BISHOPS CASTLE (STW)		Option 1 Replace with dosed ASP	3. Retain + chem				
BLACKMINSTER (STW)	Option 2 - Extra Ditch capacity + EBPR + Top Up dosing & TSR	Option 1 - Extra Ditch capacity + add Dosing & TSR				Option 3 - New Outfall to river Avon	
BLYMHILL (STW)			2. Retain Works + Chem dose				
BOMERE HEATH (STW)						Effluent transfer	
BOTTESFORD (STW)	1. Oxy Ditch + Chem dose		2. Retain Works + Chem dose				
BRAMPTON BRYAN (STW)			Op1 Retain Works				
BREEDON (STW)			Retain Works				
BRIDGNORTH-SLADS (STW)			Retain works and possible TAR				
BROADWAY (STW)		Broadway Option 1 Replace with dosed ASP	Broadway Option 2 add dosing & TAR & TSR				
BROMSGROVE (STW)	Bromsgrove : Extend add EBPR plus top up dosing & CoMag	Bromsgrove : Extend add dosing & CoMag			CoMag		
BULKINGTON (STW)	EBPR+top up dosing +CoMag	Bulkington add CoMag			CoMag		
BURNTWOOD (STW)	Op2 EBPR ASP	Op1 ASP	Op3 Retain Works & TAR		CoMag		
BURTON ON THE WOLDS (STW)		Op1 ASP	Retain Works				
BURTON LAZARS (STW)			1. Chem dose+TAR+TSR				
BUTLERS MARSTON (STW)							To Kineton
BUTLERS MARSTON (STW)							Option 1 -Close Butlers + ASP + chem Dosing + TSR

1. UNDERSTANDING WHERE WE IMPACT WATERBODIES

Evidence review

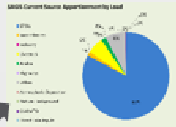
- Link waterbody failures to published river classification data
- Verify treatment works is reason for not achieving good status in EA published data
- Review weight of evidence (WoE) of eutrophication data to test if failed standards are resulting in ecological impact

Initial EA improvement list – 303 site improvements
- 58 sites removed as not supported by WoE or classification



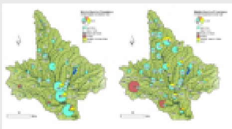
Timing and catchment approach

Improvements reviewed:
- Defer improvements benefiting from AMP6 investment
- Review achievability of effluent standards
- Check if we are a meaningful contributor



Source apportionment available at each monitoring point

SAGIS-SIMCAT calibration



EA develop catchment optimisers

Catchment approach:
- Identify works contributing to failure
- Review asset capacity and suitability for upgrade
- Systematically identify optimal package of improvements

Outputs

- Upgrades linked to waterbody improvements
- Uncertain investments removed from programme
- Catchment approach for optimal investments (review of 18 catchments)

Investment

12 months

Approx 2,000 man hours

2. INVESTIGATION/OPTIONEERING

Initial optioneering and costing of improvements

Create site information packs (background data)

- Asset data
- Generate population growth projections
- Compliance history
- Review site location/land
- Evaluate site consolidation opportunities
- Evaluate effluent transfer opportunities

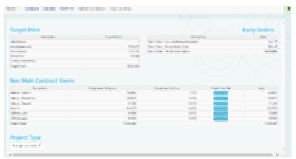
Generate process options

- Evaluate project scope
- Review AMP6 schemes
- Review innovative options
- Size consolidation sites
- Calculate process risk
- Review other site needs

Cost CAPEX and OPEX of solutions

- Use standard cost curves where possible
- Generate pricing rules to size assets
- Generate non-standard curves for innovative technology
- Calculate operational costs

Project cost estimates



Outputs

- 204 site information packs completed
- Over 280 different cost estimates completed
- 168 sites with TOTEX costs taken forward for Cost Benefit Analysis

Investment

8 months

Approx 5,500 man hours

3. FINALISING COSTS/BENEFITS AND CBA

Risk Appraisal and Review

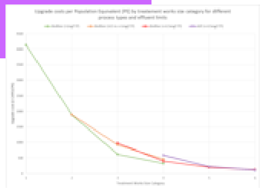
Review of apportionment of improvement costs by driver:

- UWWTD
- CRoW act (SSSI)
- Habitats Directive
- WFD no deterioration

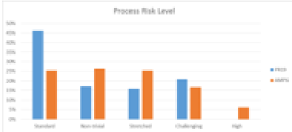
Review of scheme costs:

- Review of options selection
- Process risk review
- Finalise all costs for inclusion

Review upgrade costs per population equivalent



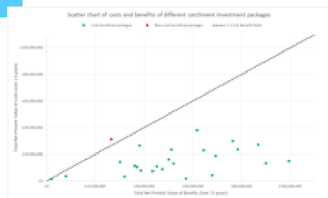
Compare process risk to AMP6



Detailed Cost Benefit Analysis

- Benefits assessment
- Benefit valuation
- TOTEX Cost benefit analysis

Catchment by catchment CBA



Outputs

22 catchments cost beneficial

1 catchment not cost beneficial

136 improvement schemes included in the plan

Investment

6 months

Approx 4,500 man hours

8.7.2 Cost adjustment claim: Water supply & demand

Our customers rely on a safe supply of water every day and they have told us that they want us to ensure that we have sufficient water available to provide this for them, now and into the future. They are content with our present level of protection against a 1 in 200 year drought but want us to ensure that we abstract water in a way that protects and sustains the environment. This business case describes our plans to secure sustainable water supplies during AMP7 and in the longer term.

8.7.2.1 Need for investment

The need for investment is driven by customer support, ensuring our abstractions do not damage the environment and adapting to climate change risk. Our proposed investment programme for managing supply and demand for water in AMP7 will ensure further progress, but does not duplicate schemes and benefits that we allowed for in the current AMP. It excludes expenditure relating to maintenance and growth.

In this section we set out our full supply / demand programme in line with our Water Resources Management Plan (WRMP) and the Water Industry National Environment Programme (WINEP). In Section 2 (need for a cost adjustment) we explain the element for which we are proposing a cost adjustment, and our rationale for doing so. Our water resources management plan analysis shows that we need to address a supply/demand shortfall of 133Ml/d in AMP7, growing to around 334Ml/d by the end of AMP8. Around 6.8 million people are served by the water resource zones that are projected to go into deficit by the end of AMP7.

This deficit is a consequence of:

- Reducing unsustainable abstraction from sources that are causing harm and contributing to the failure of Water Framework Directive objectives in water bodies across our region;
- meeting our statutory obligations – the 'no deterioration' requirements of the Water Framework Directive (WFD) – which will prevent us from increasing the amount of water we can take from many of our existing sources;
- future climate change, and the increasing uncertainty around reliable water resources;
- the demands of a growing population; and
- the sum of the above changes reducing our resilience to drought.

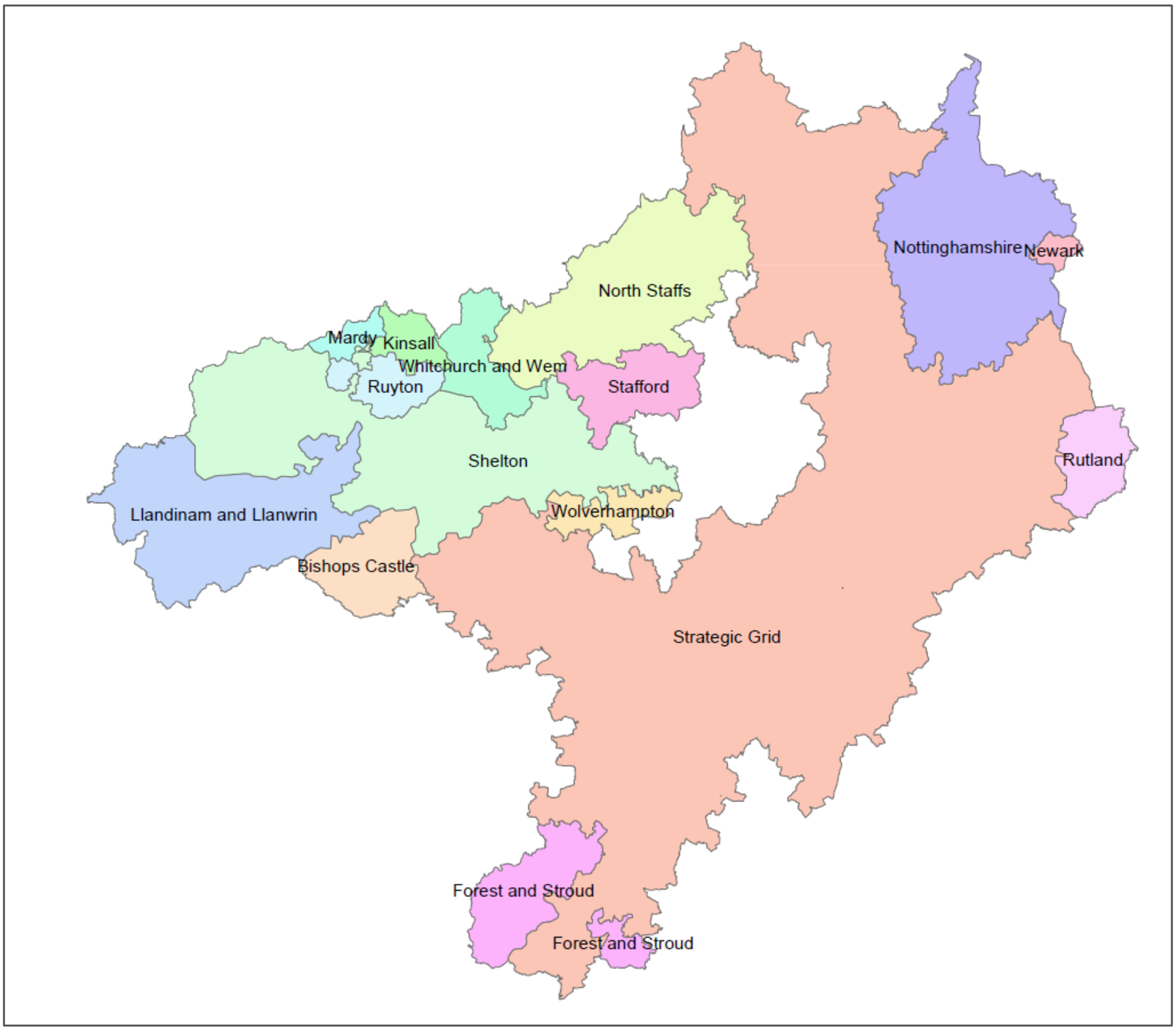
We are responding to changes in water supply/demand balance that exceed any that we have had to address since privatisation. The environmental and climate change pressures are expected to erode our supply capability by reducing the amount of raw water we are able to abstract in future AMPs. The need to ensure no future WFD status deterioration means we are also having to rethink the options that have been previously available to us, and reduce our reliance on many of our groundwater supplies. Defra requires the water industry to produce Water Resources Management Plans every five years. Defra's guidance for the 2018 plans was that in addition to planning to balance supply and demand, they address the requirements of River Basin Management Plans.

River Basin Management Plans are the implementation tool for delivering the objectives of the Water Framework Directive, which was adopted into UK law in 2003. Defra's guidance is that plans should ensure no further deterioration in water bodies, should support protected-area and species-protection objectives, and support the achievement of 'good ecological status' in water bodies.

We have responded to the challenge by adapting our long-term strategy: we will intervene to make the most of our sustainable abstractions, whilst developing an adaptive long-term plan to mitigate climate and environmental risks.

For the purposes of water resources planning, we divide the company supply area up into 15 water resources zones (shown below). These zones vary widely in scale, from the Strategic Grid zone which supplies the majority of our customers, to the small zones of Mardy and Bishops Castle which supply much smaller populated areas. Our zones have very different water resources concerns, depending on the mixture of groundwater, surface water and reservoir sources that supply them and the ecological status of the water bodies from which we abstract.

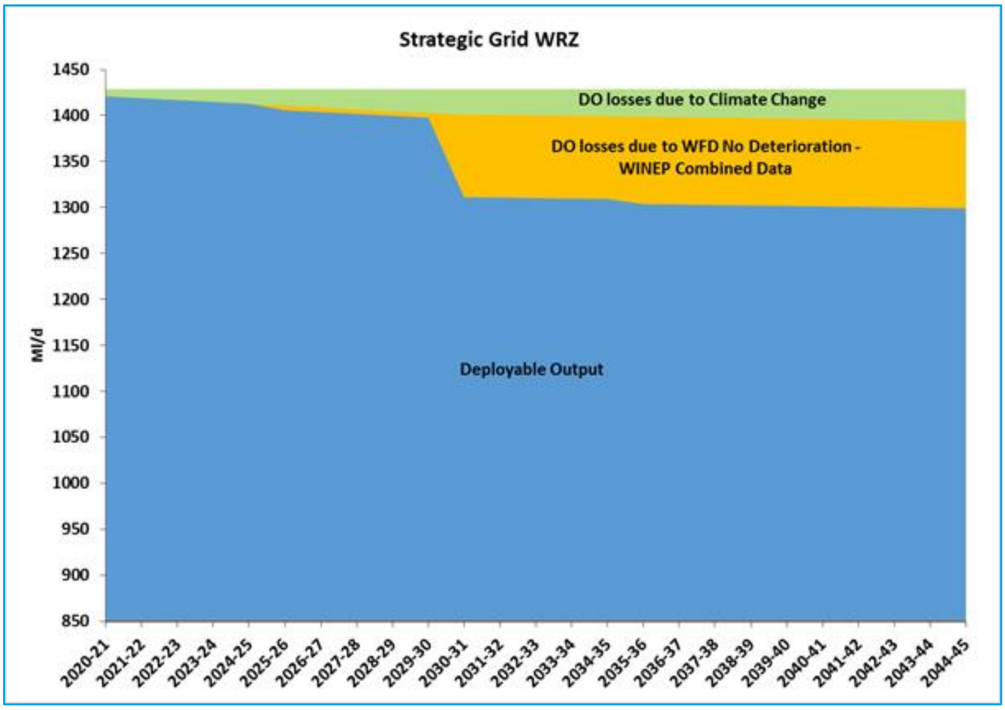
Severn Trent's water resource zones



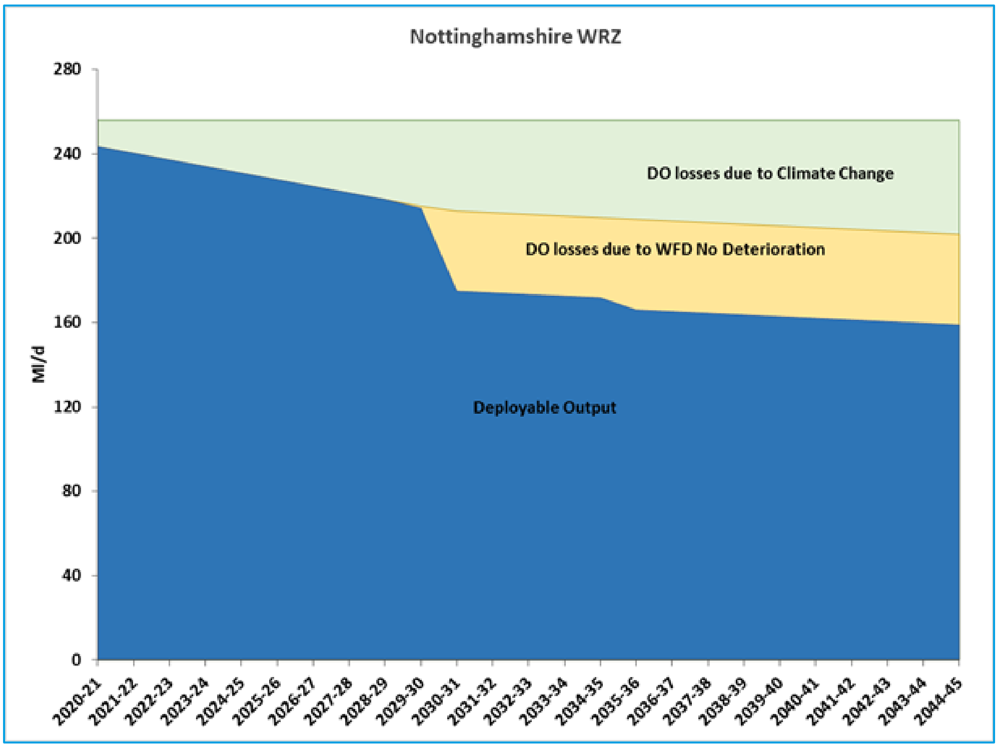
Compared to previous plans, the most significant new driver is the statutory need to ensure we do not cause future deterioration of WFD status. Parts of the Severn Trent region are particularly affected due to the reliance on groundwater abstraction and the characteristics of the water bodies from which we abstract, in particular the interaction between the Sherwood Sandstone aquifer and the associated surface water bodies. The water resource zones most affected are the Strategic Grid, Nottinghamshire and North Staffordshire. This business case focuses on the investment needed to preserve the long term supply / demand balance in those zones.   We will continue to manage leakage and demand in all other zones but this will be delivered through other parts of our AMP7 plan.

Typically, those zones that are reliant on multiple groundwater sources are most impacted by the need to reduce unsustainable abstraction and protect against future deterioration. Those zones that are reliant on upland reservoirs and river abstraction are most affected by the impacts of climate change. The figures below illustrate in more detail how this loss of reliable supply capability impacts the two zones most adversely affected in our WRMP; the Strategic Grid zone, the Nottinghamshire zone and the North Staffordshire zone.

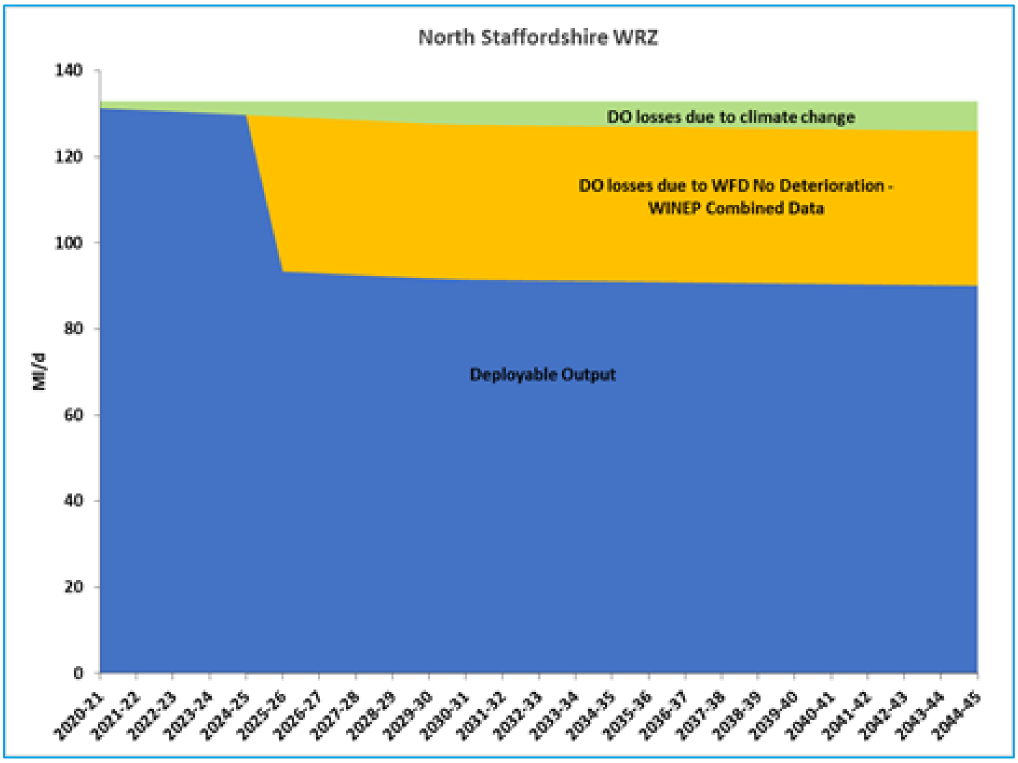
Forecast components of lost supply capability in the Strategic Grid zone



Forecast components of lost supply capability in the Nottinghamshire zone



Forecast components of lost supply capability in the North Staffordshire zone



Most water resource zones will see their headroom gradually eroded over time, and we are projecting that our Strategic Grid, Nottinghamshire and North Staffordshire zones will go into supply / demand deficit by the end of AMP7. In these three zones the expected loss of deployable output over future AMPs will impact on our supply / demand capability and will push them into an increasing shortfall over time.

Our WRMP describes how in the zones affected we need to address a supply/demand shortfall of 164Ml/d in AMP7, growing to 320Ml/d by end AMP8. The overall scale of the supply/demand challenge described in our draft WRMP is outlined in the table below. Approximately 7 million people are served in the water resource zones that are projected to go into supply/demand deficit by end AMP7.

Final WRMP19 baseline supply/demand projections (net position in each zone)

	Ml/d				
WRZ	End of Amp 7	End of Amp 8	End of Amp 9	End of Amp 10	End of Amp 11
Bishops Castle	3	3	2	2	2
Forest and Stroud	0	-0.3	-0.3	-0.4	-0.6
Kinsall	0	-0.2	-0.2	-0.3	-0.3
Llandinam and Llanwrin	6	6	6	6	6
Mardy	1	0	0	0	0
Newark	7	7	7	7	7
North Staffordshire	-34	-37	-38	-39	-41
Nottinghamshire	-15	-71	-81	-93	-93
Rutland	2	2	2	2	2
Ruyton	1	1	1	1	1
Shelton	14	5	4	4	3
Staffordshire	0.7	0.7	0.6	0.3	0.1
Strategic Grid	-84	-225	-217	-206	-228
Whitchurch and Wem	1	0	0	0	-0.1
Wolverhampton	8	7	7	7	6
SUM OF ZONES IN DEFICIT	-133	-334	-337	-339	-360

Note that the figures showing F**orecast components of lost supply capability** do not include the potential impact of climate change uncertainty. The key drivers and forecast reductions in Ml/d for these three WRZs that fall into deficit are set out in the table below.

Cumulative reductions (Ml/d) from base year 2016/17 by water resource zone

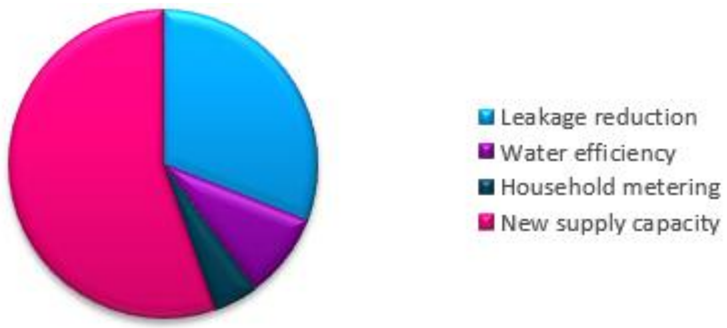
Ml/d Impact in the Strategic Grid zone	2020	2025	2030
Environmental (WINEP3)	0	5	90
Climate change	8	18	28
Climate change uncertainty	53	125	169

Ml/d Impact in the Nottinghamshire zone	2020	2025	2030
Environmental (WINEP3)	0	0	38
Climate change	13	28	43
Climate change uncertainty	1	1	2

Ml/d Impact in the North Staffordshire zone	2020	2025	2030
Environmental (WINEP3)	0	36	36
Climate change	2	4	6
Climate change uncertainty	1	2	3

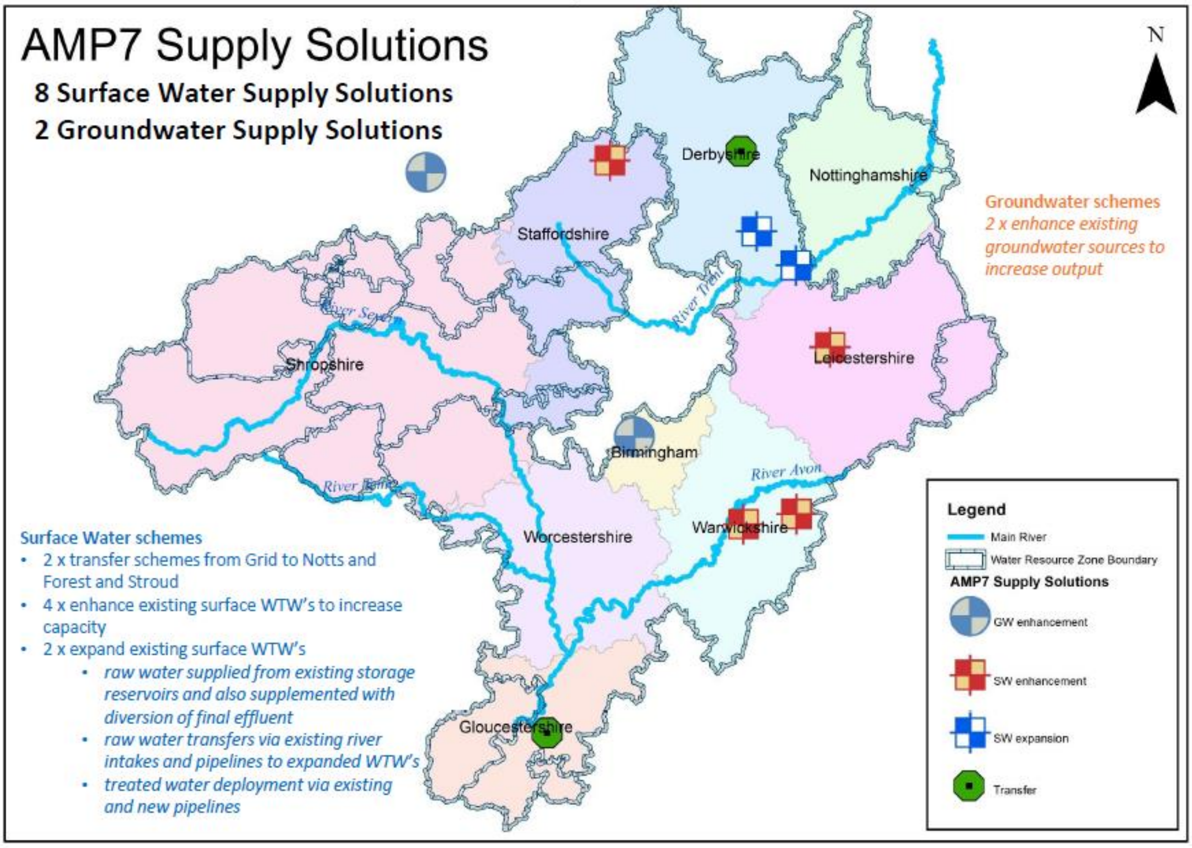
While this supply / demand challenge is larger than in any of our previous plans, our ability to respond has been further constrained by the statutory requirement to prevent future ecological deterioration, as required by WFD, which means previous supply options are no longer available to us. For example, we explain below how the risk of causing future WFD status deterioration means that we have had to move away from new supply options that involve increasing local groundwater abstraction, and instead we are recommending strategic solutions to transfer surface water from our Strategic Grid.

To meet these future challenges, we need to increase AMP7 and AMP8 investment in measures to reduce overall demand for water and in schemes that will replace the supply capability that we are losing. Our draft WRMP sets out the supply / demand investment options that we have considered and gives more detail on our options appraisal and decision making process. The figure below sets out the interventions that we are considering in AMP7 supply and demand measures to prevent deficits occurring.



Our strategy is to use leakage, metering and demand management to reduce the total amount of water we need to put into supply. We will also increase our supply capability by investing in expanding our treatment and strategic distribution capacity, prioritising solutions that make use of existing water supply assets. The figure below illustrates the new supply schemes that we are proposing over AMP7 to maintain the supply / demand balance into AMP8.

AMP7 supply enhancement schemes



Our customers want us to preserve our resilience to drought

Our current assessment shows that we are resilient to Defra's benchmark 1-in-200 year drought. Our customer research does not show support for increasing this level of resilience but equally customers do not want to reduce the level resilience that they have today (see section 4.1).

If we do not act, our resilience will be eroded and fall below the 1-in-200 year benchmark by 2025, owing to the combined effects of population growth, reductions in unsustainable abstraction licences, and climate change.

- Reducing abstraction from unsustainable sources will reduce the amount of water available to meet demand from current and future customers.
- Population growth will increase average demand and hence use water resources more quickly. In dry years, the effect will be increased.
- Climate change is likely to further exacerbate the tension between population growth and reduced abstraction.

The Water Forum has challenged, and accepted the need

We have worked with our Water Forum (customer challenge group) for over two years and have been actively debating and developing our proposals over that time.

The Forum has organised itself to focus on key issues associated with PR19 and as a result we have a number of separate sub-groups established to better understand and challenge particular areas. These sub-groups bring together a diverse range of expert skill sets. The Water Forum's investment sub-group (ISG) comprises members from: the Environment Agency; Natural England Consumer Council for Water (two members; one Chair of CCWater's Central and Eastern Region); Confederation of British Industry; the West Midlands Combined Authority; and two from industry leading engineering consultancies (one of which started his role on the Water Forum as Head of Scientific Consultancy at the Met Office).

The ISG (which has scrutinised and challenged this case) has been in operation for over 12 months and had a terms of reference to review all our cost adjustment claims. In total almost 100 challenges have been raised by the ISG and responded to. The Water Forum's customer research sub-group has also challenged our approach to research, and the performance commitments sub-group has reviewed our proposals for customer protection.

A key challenge from the Water Forum was in design of our research approach and deployment of the various techniques. Furthermore the Water Forum attended our deliberative research and witness for themselves the engagement levels and interest in the room. A significant amount of work and challenge took place in the 18month period. The Water Forum members wanted to understand;

- the challenge we are facing,
- the options we have considered,
- the benefits we are seeking to deliver, the preferences of our customers and
- how we are accommodating them and the areas of support we had for our proposed plan.

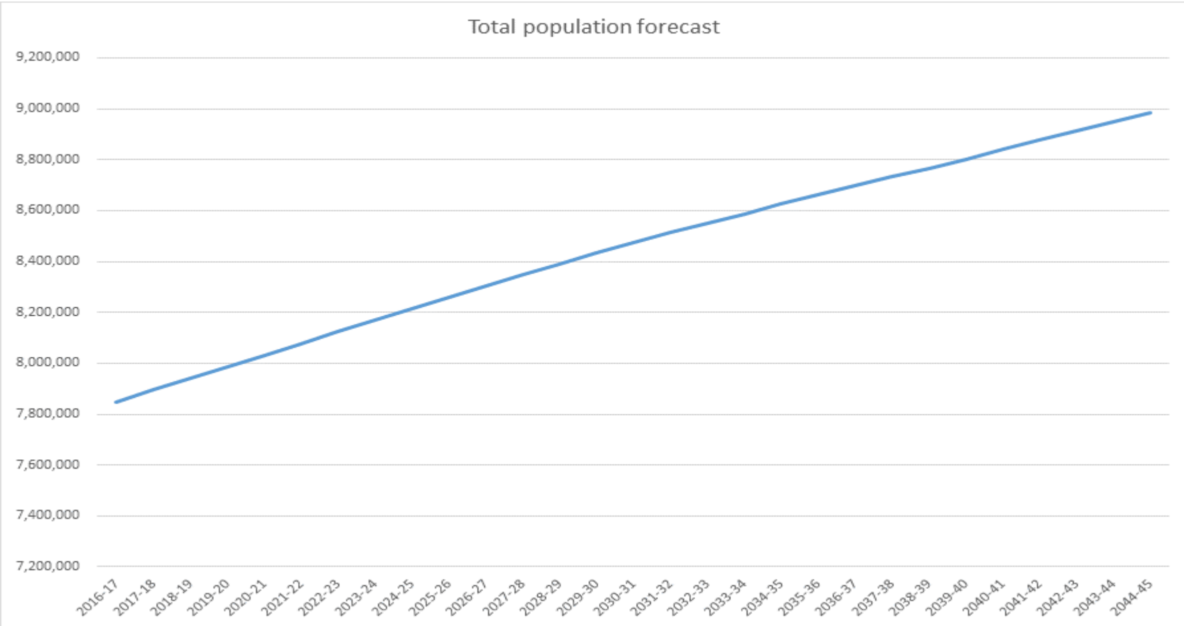
A fuller report on the findings and views of the Water Forum will be available in their report.

In relation to this investment case, the Investment Subgroup Group raised 57 generic and specific challenges, more information is shown in Section 4.6. While the Water Forum has yet to complete its final report, the ISG has reported to the full Forum that it believes the need for investment is supported by customers and well-evidenced to that effect.

We must meet the needs of a growing population in our region

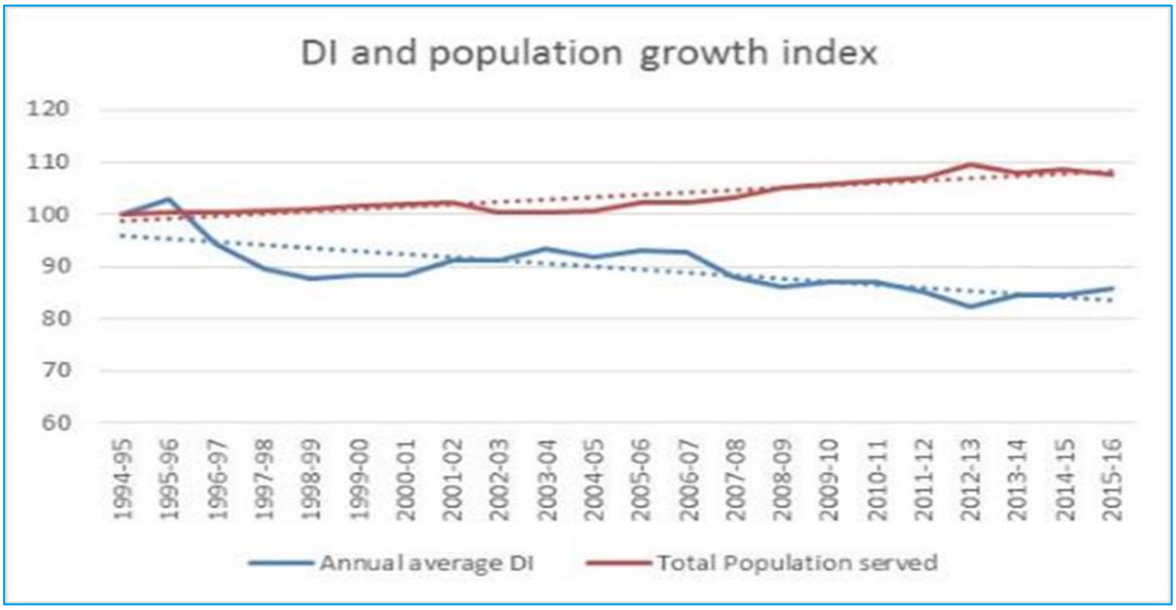
The population of our region is forecast to grow by about 1.1 million people over the next 25 years (see figure below), having already increased by some 500,000 people since the year 2000. We have built our projections using best practice UKWIR methods, and information from Local Planning Authorities and Office of National Statistics datasets.

The population of the Severn Trent region is expected to continue to grow, putting a strain our existing water resources.



Since 2000, we have been able to accommodate growth without increasing the amount of water we have to treat and put into supply. The figure below illustrates how our reduction in leakage, a reduction in household consumption and falling industrial demand have led to about 3% less water being put into supply now than in 2000, notwithstanding the total number of people we supply has steadily increased.

DI and population growth index



Despite our past success, the future demand needs of an additional 1.1 million people cannot be met from existing resources alone. We have already explained that we need to reduce abstraction and reduce our reliance on a number of existing sources in order that we can achieve WFD objectives. Therefore, while population growth is not a primary driver for supply / demand investment, we will not be able to be meet this growth if we do not offset the supply capability we will be losing over AMP7 and AMP8. Therefore, to meet future water demand without increasing the amount we abstract from the environment, we need to find ways to greatly reduce the total amount of water we have to put into supply. To achieve this, we need:

- Less leakage;
- Demand Management through:
  - More efficient use of water;
  - Increased water metering; and
- More flexible distribution, to move water to where it is most needed.

Our leakage and demand management activities will complement our plans to increase the supply capability from our most sustainable sources of supply.

Our investment is underpinned by legislation

Environmental needs mean that we will lose sources and need new ones. The Water Framework Directive (WFD) came into effect in 2009 with the objective of improving all rivers, lakes and groundwaters to Good Ecological Status (GES) by 2015, subject to this being technically achievable and cost beneficial. Application of 'disproportionate cost' criteria allows for the deferral of cost beneficial improvements to a backstop date of 2027. The WFD is delivered using River Basin Management Plans (RBMPs) which are refreshed on a six yearly cycle. RBMPs set out how stakeholders and regulators with vested interests within catchments, such as water companies, local authorities and others, can cooperate to improve the water environment. The WFD drives our investment in two ways.

First, the WFD includes a mandatory, 'no deterioration' objective – effectively prohibiting any deterioration in the water environment in the future. This could come about in circumstances where existing abstraction licences are utilised to their full extent more frequently, or if we are seeking to increase recent historic rates of abstraction from our sources. . This objective is not subject to cost benefit criteria and effectively locks-in current environmental condition.

Second, the WFD includes improvement targets for all waters to achieve good ecological status (or good ecological potential) by 2027 (where cost beneficial and technically feasible). This requirement is subject to the necessary improvements satisfying both cost benefit and technical feasibility criteria. Where improvements to achieve good ecological status are not technically feasible (e.g. due to natural background conditions), alternative objectives can be set.

The Environment Agency produce a database of 'reasons for not achieving good status' (RNAG) against the WFD. This dataset attributes, by sector and activity, the underlying causes for WFD non- compliance and is at waterbody level, in line with the classification data. Of the 2,664 individual reasons for not achieving good status[11] (RNAG) identified in our area, 772 (29%) are attributable to our activities.

To meet the WFD water resources objectives for the water bodies across our region, we need to reduce unsustainable abstraction and prevent future abstraction from causing ecological deterioration. We have already explained in the section above, that to accommodate these changes we need to invest in demand management and alternative supply solutions so that we can maintain the supply / demand balance. However, the scale of licensed abstraction reductions that are needed to achieve WFD objectives across our region and ensure no future deterioration amount to over 10% of our current deployable output base. To make all of

[11] Based on our analysis of the RNAG data published by the Environment Agency in 2013

these licence reductions within the EA's original target timescale of early AMP7 would put security of supply at risk, and the cost of providing alternative supplies in such a short time period would be unaffordable. Instead, we have worked with the EA to agree steps to achieve the WFD objectives in a way that minimises the potential scale of AMP7 alternative sources of supply, and spreads the supply / demand investment needs across AMP7 and AMP8.

Our approach is to prioritise action at those sites where the impacts of abstraction are well understood, and there is a high likelihood of future deterioration. These are the sites where we will reduce licence abstraction and provide alternative ways to meet customers' demand. At those sites where the effects of our abstractions are less certain, or where we believe we can mitigate for their effects, we will implement an AMP7 programme of environmental improvement and protection measures. This approach will allow us to continue using those sources where the environmental risks are relatively low and will allow us to better understand whether we need to make longer term changes in how we operate these sites. Our approach will also give us more time to reconfigure our supply system and implement the new strategic sources of supply that will be needed to ensure no long term deterioration occurs. Using this approach, we are proposing a ten year supply / demand and environment programme that will achieve all WFD water resources objectives before the end of AMP8. The benefit of this approach is that it is more affordable than trying to deliver this full programme in one AMP, ensures we will only provide new sources to those sites that actually need it and it balances the risks between environmental harm and customers' security of supply.

The AMP7 interventions needed to deliver these WFD improvements are set out in the table below.

Area	Needs
WFD Water Resources No-Deterioration schemes	No Deterioration: Mitigation and Prevention measures
	Environmental monitoring
Restoring Sustainable Abstraction schemes (WFD Improvement)	Restoring Sustainable Abstraction schemes (includes 19 schemes which will improve 26 waterbodies and 1 SSSI)
	Complete second stage of AMP6 Upper Worfe RSA solution
	Complete second stage of AMP6 Bromsgrove Groundwater RSA solution
WFD Water Resources Investigations (WINEP3)	WFD no deterioration investigations

In its document 'A Green Future: Our 25 Year Plan to Improve the Environment'[12], the government has set ambitious objectives for the environment. This includes that at least three quarters of our waters should be improved to as close to their natural state as soon as is practicable.

We must meet our statutory obligations to deliver the outcomes of the Water Framework Directive. These will require us to ensure that water abstraction is sustainable, to improve some aspects of the environment that have been affected by historic abstraction, and to ensure no further deterioration in the environment. The table below shows the Water Framework Directive drivers and the extent of choice over their timing.

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

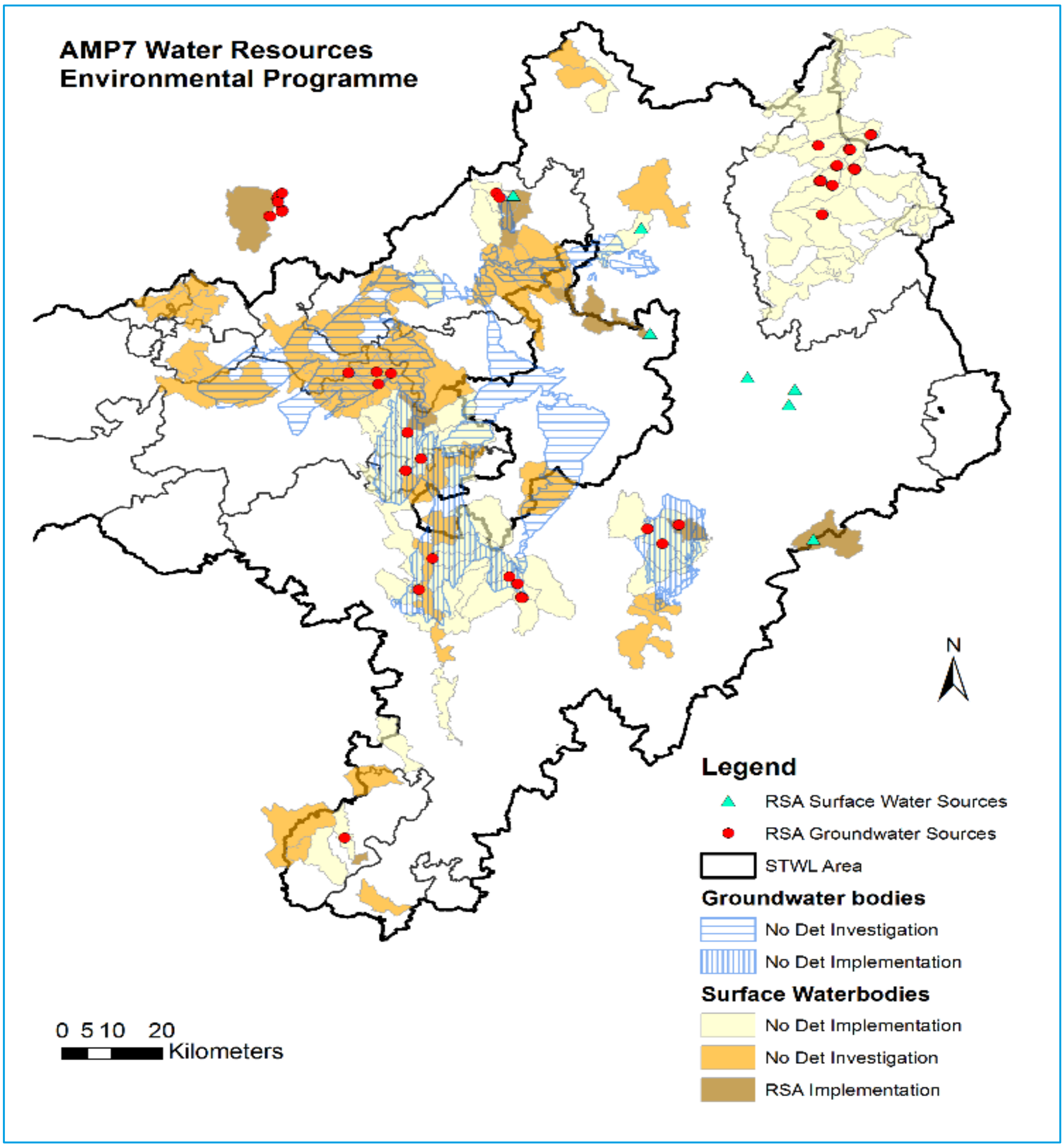
Legislative drivers for water supply demand enhancement **Statute**	**Area**	**Requirements**	**Timing**
WFD	'No deterioration' (*new driver for water resources*)	Mandatory	Mandatory - AMP7
	Improvement - good ecological status	Mandatory (if cost-beneficial)	Mandatory - 2027
	Restore sustainable abstraction	Mandatory (if cost beneficial)	Mandatory -AMP7

The Environment Agency is the authority responsible for implementation of the WFD. It sets out the actions that companies will need to complete to meet their obligations using the WINEP. Version 3 of the WINEP (WINEP3) – the final version – was published in March 2018. In line with Environment Agency requirements, we have included costs for all 'green and amber' measures (i.e. those with a very high level of certainty) in our programme.

As explained in *Section 3: management control*, this investment secures compliance but - through our collaboration with the Environment Agency – our WINEP3 already represents a phased delivery that reduces the risks to security of supply and the cost to customers in AMP7 compared to earlier versions of the WINEP.

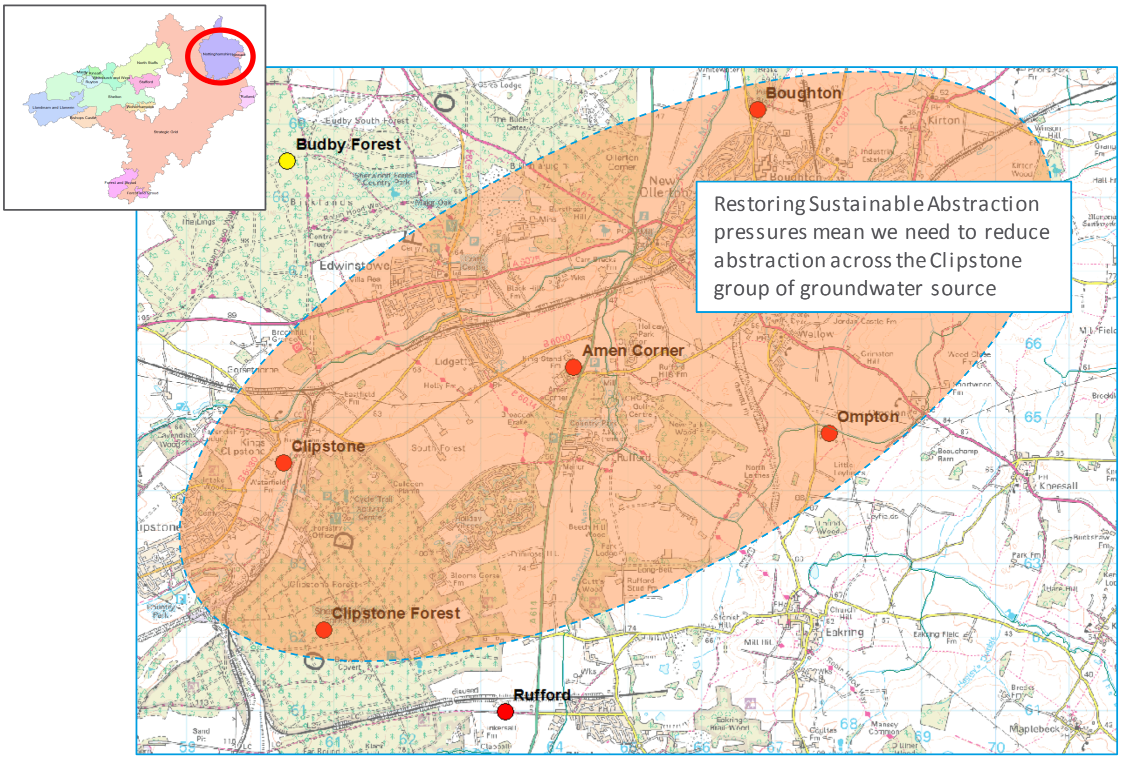
Our Water Resources Management Plan shows how we have carried out a detailed analysis of the requirements of the Water Framework Directive and Defra's guidance. The impact on ground and surface water abstraction is shown in the figure below, which illustrates where our least sustainable abstractions are located and shows the extent of the deterioration risk across our region. The combined effect means that we have needed to rethink parts of our supply system to make sure they are sustainable for the long term.

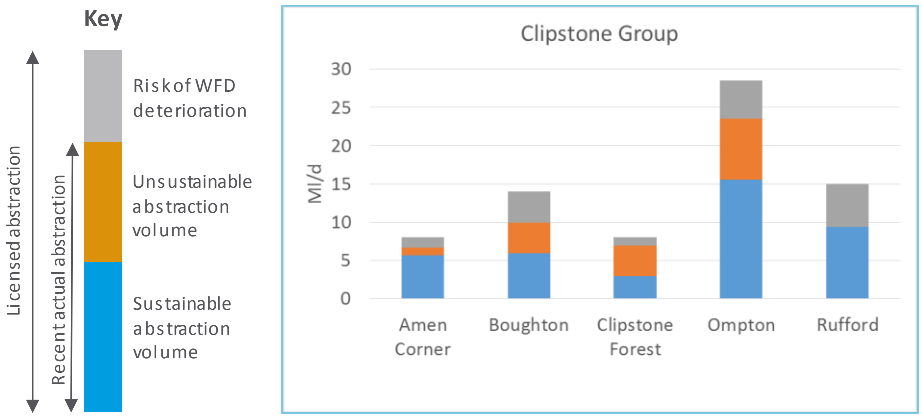
Unsustainable sources and water bodies at risk of future deterioration



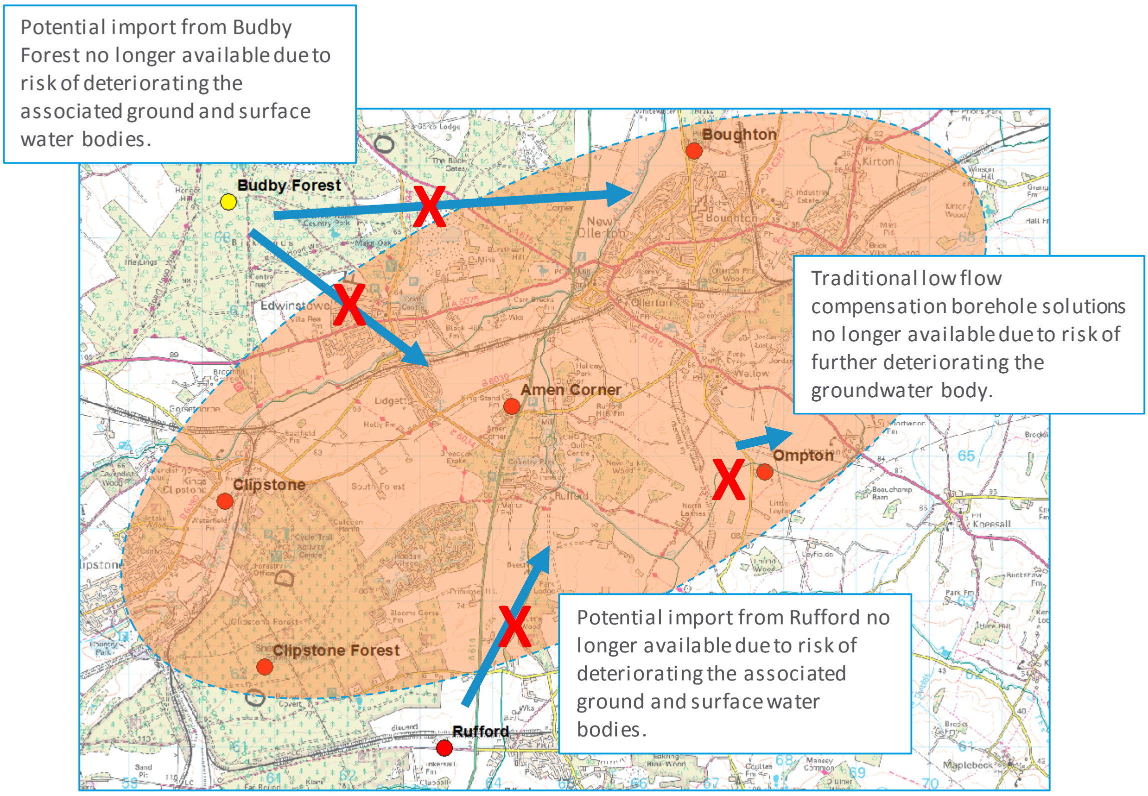
A good example is the impact on our Nottinghamshire water resource zone, where we need to address the legacy of unsustainable abstraction as well as preventing the risk of future deterioration. The two figures below illustrate how we need to change our Nottinghamshire abstraction regime to achieve WFD objectives. In this zone we face multiple RSA pressures (shown by red dots – RSA Groundwater sources [brown shading – RSA Implementation not shown simply for clarity]) which mean we need to reduce unsustainable public water supply abstraction. Our historic approach would have included augmenting low stream flows from compensation boreholes, or developing local supply options that redeploy surrounding sources to make up for these RSA output reductions. However, the need to ensure no future deterioration of the groundwater body or the associated surface water bodies, as required by WFD (shown by beige shading - 'No Det Implementation'), means these options are no longer available. Instead, our plan proposes strategic new supplies into the zone to address the combined RSA and WFD environmental pressures. Overall, the WFD constraints in this plan make it harder and more expensive to provide new sources of supply than was the case in previous plans.

Restoring sustainable abstraction pressures in the Clipstone groundwater group


Boughton
Budby Forest
Restoring Sustainable Abstraction pressures mean we need to reduce abstraction across the Clipstone group of groundwater source
Amen Corner
Ompton
Clipstone
Clipstone Forest
Rufford


Key
Risk of WFD deterioration
Unsustainable abstraction volume
Sustainable abstraction volume
Licensed abstraction
Recent actual abstraction
Clipstone Group
Ml/d
30
25
20
15
10
5
0
Amen Corner
Boughton
Clipstone Forest
Ompton
Rufford

The impact of WFD on our options to manage the reduction in abstractions



We are using real options to allow us to adapt to the uncertainty of climate change

Our supply / demand investment plan includes solutions that will allow us to maintain security of supply despite the significant uncertainty surrounding the potential impacts of climate change. We understand the scale of climate change risk presented by the UKCP09 scenarios for the 2030s and 2080s, and we have a dWRMP that shows how we would cope with those scenarios. However, the cost of accommodating that full range of uncertainty is significant and we want to avoid unnecessary expenditure in AMP7 on solutions that may not be needed yet. We understand how climate change uncertainty impacts on our investment needs, and we are developing an AMP7 decision framework to inform whether we need to commit to investment decisions over the next five years. That decision framework will be informed by best available lines of evidence, including:

- Ongoing monitoring for any evidence of increasing climate change impacts on our water resource availability. In Appendix A of our draft WRMP we explain how we have investigated whether any climate change signal is currently detectable in our river flows and how we carried out a series of statistical tests for trend detection. For a sample of catchment groups across our region, we used data from our extended historic record for the period 1884-2014. The results of this analysis indicate that there is no observed climate related trend for three of the five catchment groups. In the two catchment groups with an observed trend, both detect an increase in river flows over the 131-year analysis period rather than any reduction in available river flow.

  This trend analysis supports finding of academic studies such as Hannaford (2015) which have found that there is currently no strong evidence of anthropogenic warming influences on river flows in the UK. These findings are also supported by the Living with Environmental Change (LWEC) Water Climate

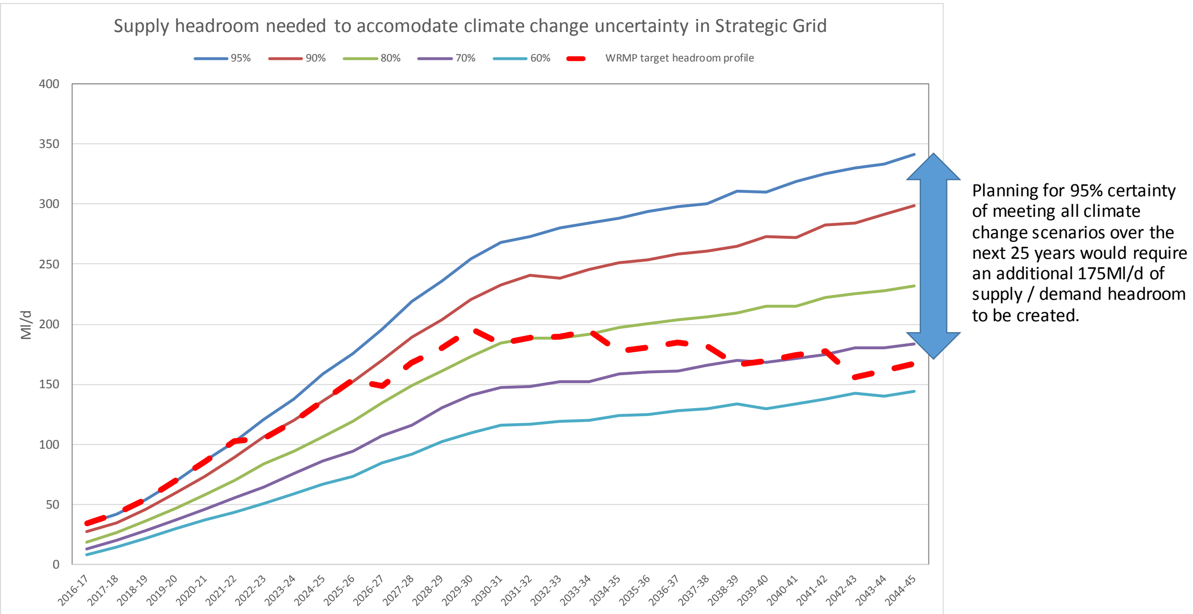
Impacts Report Card 2016; this document summarises the findings of a variety of research papers investigating climate change impacts on water.

Therefore, our draft WRMP assumed that we have not yet experienced any climate change related reductions in our base year deployable output, as at 2016/17, in accordance with the scaling method described in the EA's Water Resources Planning Guidelines (2012). We will continue to monitor river flows and climate signals to inform our AMP7 investment decision making.

- Using UKCP18 outputs when they become available to update our understanding of future climate risk. Consistent with the UKCP09 modelling that has informed our plan, the most recent IPCC modelling (CMIP5) still indicates that there could be a reduction in the likelihood of summer rainfall decreases (which appears key for large DO impacts) and so it is likely that this will be reflected in the new UKCP18 projections as they will include outputs from CMIP5.

  However, we note that the April 2016 DEFRA / DECC / Met Office / EA report 'Is UKCP09 still an appropriate tool for adaptation planning?' concludes that "...there are some differences between the projected summer rainfall changes. In this case, UKCP09 and CMIP5 agree to the extent that projected reductions are more likely than increases in the future. However, CMIP5 suggests smaller reductions, and contains few simulations projecting a drying response beyond the 50% probability level given by UKCP09 for England and Wales." And goes on to recommend that while UKCP09 is still suitable for planning decisions, the results of CMIP5 should be considered where summer decreases in rainfall are key in long-term planning.

As an example, the graph below shows the range of uncertainty from our climate change predictions on the available headroom within our strategic grid.



Our draft WRMP demonstrates that we understand what solutions would be needed to ensure that we can accommodate climate change risks over time and we understand when we would need to commit to those investment decisions. However, the nature of the WRMP process means that we will revisit our assumptions in five years and we have the flexibility to adapt our delivery plan as the evidence becomes clearer over time.

As set out in Section 8.3 Real options, in collaboration with the Water Forum we have used the existing ODI framework in combination with a trigger mechanism to create an uncertainty mechanism for two interventions:

- New supply schemes
- Metering

In this section we set out our full range of supply side solutions. If the future happens as forecast, we would expect to deliver these schemes in line with what is set out in out WRMP. For the purposes of PR19, we have included investment for three certain schemes and early feasibility for the remaining schemes and our potential DPC project.

If climate change does not lead to a reduction in deployable output at the pace and scale predicted then customers would face higher bills. This is because the supply schemes have a degree of irreversibility. Furthermore if we can identify cheaper solutions to reducing leakage it would change the balance of solutions, potentially leading to more demand side measures at PR24 and beyond.

However we recognise that there are uncertainties associated with both the speed and magnitude of the impact of climate change and also the willingness of customers to voluntarily adopt metering in such a large step-up.

Climate change uncertainty (new supply schemes)

The impact of climate change is uncertain. The consensus is that there will be less water available (and so less deployable output) in the future. To inform our future investment needs we have modelled a range of scenarios to estimate the change in deployable output, drawing on:

- the UK Climate Change Projections 2009 data set, issued by the MET Office and supported by BEIS and Defra; and
- a range of scenarios that depict different potential climate outcomes.

We used a combination of two approaches from the 2013 technical guidance. We carried out a vulnerability assessment which flagged high vulnerability in the Strategic Grid and Nottinghamshire zones which required us to follow one of the more rigorous methods. 10,000 projections were sampled down to 100 using Latin Hypercube Sampling. These were then sub sampled down to 20 using a drought indicator. For consistency we applied this approach to all zones, even groundwater only zones that had a low vulnerability.

Previous engagement with the EA and Natural England indicated they were supportive of the approach we used. However, despite our approach being in-line with the best practice guidance, <u>our approach shows that we would be an outlier in responding to climate change uncertainty</u>, as noted by several stakeholders in their responses to our draft WRMP.

Although the impact of climate change will inevitably be uncertain we note that there are two relevant factors that may reduce the uncertainty. The first is the updated data UK Climate Change Projections which will be issued in late 2018. This data set is being updated and improved through the publication of UKCP18. This includes both (i) refreshed data; and (ii) more granular data, so will support more accurate modelling.

The second element that reduces uncertainty is time, which allows for more empirical testing to understand the impact and speed of change. This point was underscored in CMA in the Bristol decision which noted that "as time progresses, the uncertainty relating to a future point in time will necessarily decrease, (all things remaining equal).[13]]

The conclusions we can draw from the above information are that:

- we need to reduce demand and/or increase supply in response to climate change (based on the best available modelling); and
- our response will be more effective if we can effectively defer so that we can reduce uncertainty.

Metering uncertainty

Our supply demand balance cost adjustment claim also contains a degree of uncertainty on the metering take-up rates. We've proposed a significant increase in metering to support both a reduction in leakage and provide greater focus on water efficiency. We've assumed that our metering programme will deliver 10.2 Ml/d reduction in demand by the end of AMP7.

The table below compares the metering programme under our PR14 metering policy with the programme in our PR19 plan. This highlights the scale of ambition of our PR19 programme, which involves meter installations that for AMP7 are more than 300% of the level under our PR14 policy.

Projected metering profile

		AMP7	AMP8	AMP9	AMP10
PR14 metering policy	Number of meter installations	147,878	134,619	122,549	111,560
	% households metered by end of AMP	55%	60%	65%	69%
PR19 metering policy	Number of meter installations	493,765	771,313	428,030	0
	% households metered by end of AMP	65%	88%	100%	100%

There are two key uncertainties associated with metering:

- whether it is possible to increase metering installations rates as quickly as planned; and
- whether the increase would deliver the forecast 10.2 Ml/d reduction in demand.

In response to our draft WRMP both Ofwat and the EA supported our ambitious programme but expressed concerns about the deliverability and the subsequent impact on meeting the supply demand deficit if the target is not achieved. In particular they noted that "given the uncertainties in delivery, the consequences of not meeting the ambitious metering target on the supply-demand balance should be tested and the impacts on other options presented."

Our view is that we should manage the uncertainty associated with the scale of the demand reduction that can be achieved through delivering our metering programme. However we do think there is material uncertainty over whether the metering programme can be delivered in full due to the level of ambition.
Further detail on this is included in Appendix A 8.3 –Real options.

Customer engagement on real options

[13] CMA page 214, https://assets.publishing.service.gov.uk/media/56279924ed915d194b000001/Bristol_Water_plc_final_determination.pdf

We have proposed the use of real option mechanisms after undertaking extensive engagement with our customers to understand their views on how to manage risk and the effects it can have on bill volatility.

One of the key themes that comes through in this research and our wider customer engagement is that customers expect that our services represent value for money, are efficient and that we are mindful of the bill impacts of our investment choices.

However this doesn't mean customers want us to pursue the cheapest option. As reflected in our deliberative research on supply demand, our customers explicitly want us to pursue best value options. Similarly customers do not want us to ignore risks to future supplies.

Rather what is revealed through our engagement is a much more nuanced view that seeks to balance issues such as affordability, long term sustainability and resilience.

Our engagement on real options occurred through both a deliberative workshop and engagement using our online community. Our Water Forum challenged us quite strongly on the need for the deliberative research to supplement the online community engagement. This is because the potential complexity of the issue and its forward looking nature means it is important to explore whether the results are different when customers have a more informed understanding.

Read more: Engaging customers chapter 6, Appendix A1 – Engaging Customers and Appendix A8 8.3 – Real Options.

Our investment is not affected by the boundary changes

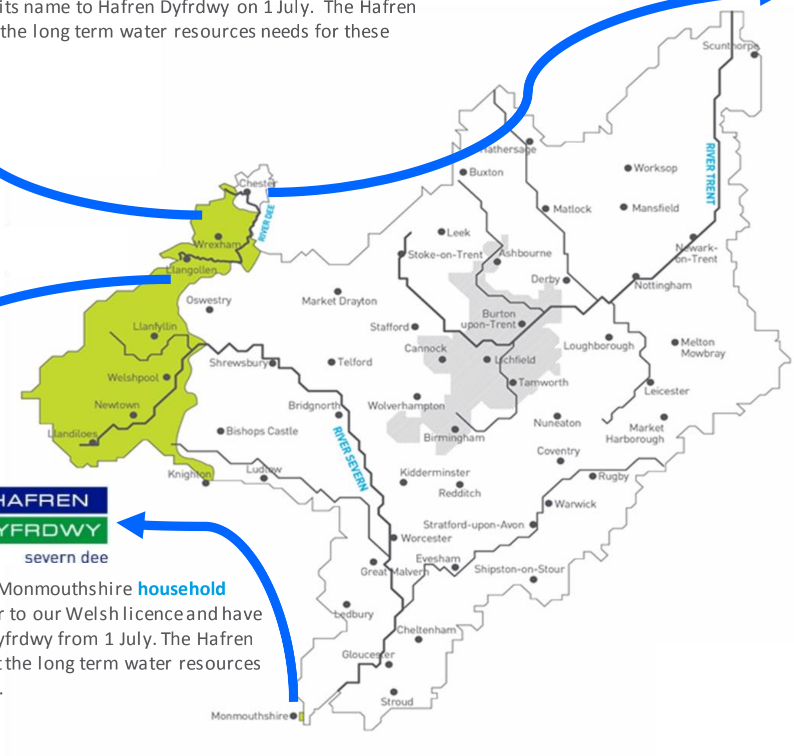
In February 2017, Dee Valley Water became part of the Severn Trent group. Earlier this year, Ofwat approval was received to align the boundaries of Severn Trent and Dee Valley Water to the national boundaries of Wales and England. In line with this approval, we launched our new name, Hafren Dyfrdwy on 1 July 2018.

The diagram below shows how customers have moved between the two companies. As the WRZs with deficits all fall completely within the English boundary of Severn Trent, there is no impact on this business case. Similarly, the Chester WRZ that was formerly part of Dee Valley does not have a supply demand deficit, so again has no impact on this business case.

How customers are affected by the boundary changes

Dee Valley's **household** customers in North Wales have remained as customers of Dee Valley, which changed its name to Hafren Dyfrdwy on 1 July. The Hafren Dyfrdwy WRMP will reflect the long term water resources needs for these customers.

Dee Valley's Chester **household** customers moved over to Severn Trent's English licence on 1 July 2018. The Severn Trent WRMP covers the need for these customers.



Severn Trent's Powys and Monmouthshire **household** customers transferred over to our Welsh licence and have been serviced by Hafren Dyfrdwy from 1 July. The Hafren Dyfrdwy WRMP will reflect the long term water resources needs for these customers.

8.7.2.2 Need for a cost adjustment

Impact of real options on our costs

To meet the challenge set out in section 1, we have followed a twin track approach that considers demand and supply interventions and also considers the implications of managing uncertainty using adaptive pathways. Our demand management solutions are significantly more ambitious than ever before and we've included progressive implementation of supply schemes where our analysis shows that there is an unequivocal need to act. We are confident that this approach aligns with our wider statutory, regulatory and customer driven expectations.

Alongside our demand side solutions, we have identified the need for 22 supply schemes in our final WRMP over the 25 year planning period (the same as our dWRMP, which included a similar programme of demand-side interventions).

We have tested the sensitivity of these identified schemes to major uncertainties, including:

- Climate change uncertainty (variance around the central view of climate change impact) and
- Scheme uncertainty (the Ml/d that the schemes will deliver, the cost of the schemes and the construction time required).

Our analysis shows that there is a high level of certainty that three supply schemes will need to start in AMP7 in order to solve spatially distinct deficits driven by WINEP3 abstraction reductions which cannot be solved by company-wide demand side solutions.

Schemes in our PR19 plan that will be delivered in AMP7

Scheme	Benefit (Ml/d)	Time to deliver benefits (years)
[Locations REDACTED] pipeline capacity increase	7.5	2
[Locations REDACTED] transfer solution	25	4
[Location REDACTED] asset and water treatment enhancements	36	5

The uncertainty with metering relates to the extent to which we can increase meter-uptake rates, which would represent around a three-fold increase on 2017/18 rates. We could respond to this uncertainty by simply scaling back our meter installation plans, and assuming a smaller increase. However, metering is a key part of our best value approach which recognises the need for a strong demand-side approach alongside the bringing forward of new supply-side initiatives.

We recognise the risk this approach could pass onto our consumers - bills would be increased during AMP7 regardless of the meter take-up actually achieved. We could include a true-up mechanism that returns money to customers if full delivery of our PR19 policy for AMP7 is not achieved, but that would still mean that customer bills in AMP7 would be higher than necessary. As we highlighted above, our customers have indicated strong support for the use of mechanisms that allow an intermediate approach to be adopted in these circumstances that reflects the uncertainties involved. Based on this, we have included £28.2m for our optants program and £38.4m for the company introduced metering program.

This cost adjustment is necessary to meet our future supply demand deficit

As we've described, the deficit is driven by environmental requirements, including the WFD 'no deterioration' requirement, climate change and growth. The scale of the deficit and cost of the interventions is not reflected in historic data and are unlikely to be included in Ofwat's cost modelling. Given the complexity of this area (balance between supply and demand, uncertainty in future projections, interaction with base costs (particularly costs for increased leakage expenditure beyond the sustainable level, we are uncertain as to how a deficit of the complexity and scale we are forecasting will be dealt with in Ofwat's cost modelling.

We have (1) assessed whether the overall cost estimate is commensurate for our projected deficit and (2) within this, we have made an assessment of the element that could be in the basic cost threshold.

The assessment of the overall cost estimate is based on Ofwat's PR14 approach. This provided a cost adjustment based on the deficit at an historic cost (in our case this was 30 Ml/d at a triangulated efficient unit cost of around £2.7m). Using this is simple approach would generate an enhancement cost adjustment of c£359m (based on a deficit of 133Ml/d). This is commensurate with central estimate (£218m) including the element (£121m) identified for inclusion in the real options mechanism.

We have derived an indicative implicit allowance by assuming:

- a supply demand model for supply side interventions can be developed on a similar basis to that seen at PR14;
- the additional information collected in cost assessment submissions will enable selective and optant metering models to be developed;
- a cautious approach to assessing supply demand deficit that needs to be closed in AMP7 will be used (even after consideration of our real options mechanism); and
- the need to make statutory ecological improvements will be considered on a similar basis to the PR14 un-modelled adjustment but with an acknowledgement that historic expenditure is not likely to be analogous to future requirement.

Water Supply Demand Program **Central estimate: £302m**			
Water SDB: driven by future supply and demand Central estimate: £218m		SDB: Environmental Central estimate: £84m	
Water SDB Cost Adjustment Central estimate: £80m	Water SDB Implicit Allowance Central estimate: £138m	SDB: Environmental cost adjustment Central estimate: £60m	SDB: Environmental implicit allowance Central estimate: 24m

We have also explored the validity of our unit costs, which suggests that variations between companies both in terms of size of deficit and available options call for a more bespoke approach to setting cost allowances to be used. We analysed the NPVs of supply demand interventions from water resources market information published by all companies in 2018, taking account of only preferred solutions so as to remove disproportionately costly solutions. We analysed the data by intervention type (new resources, bulk supplies, leakage, metering and water efficiency) and weighted to a supply-side, demand-side and company level.

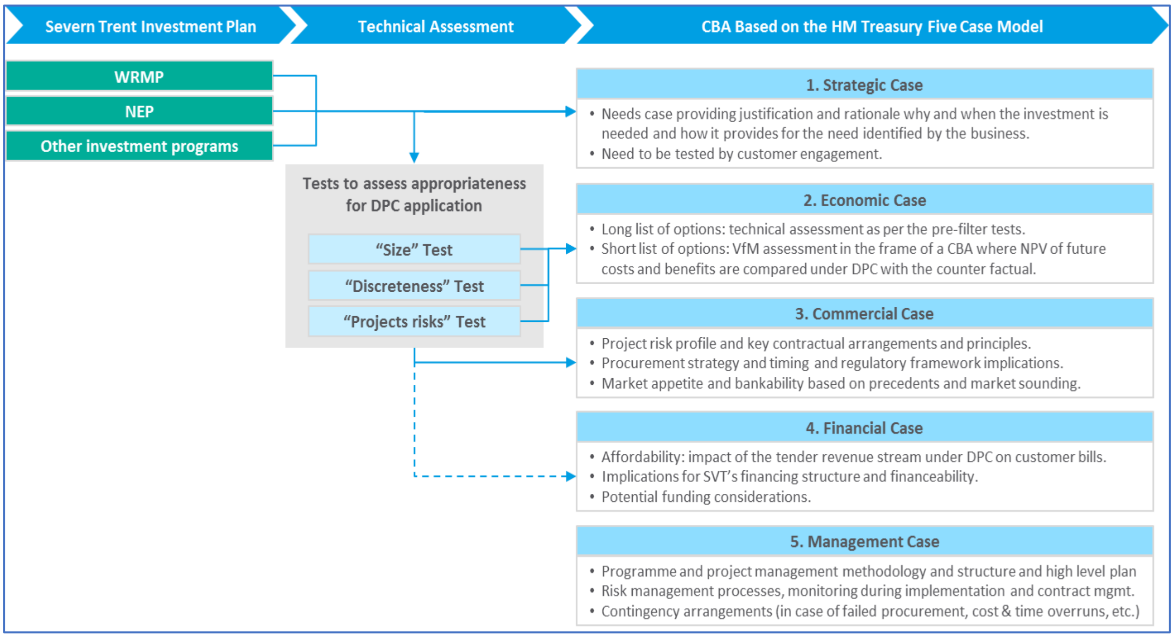
As well as looking at the published NPVs, we've assessed the opex and capex ratio for interventions in the market information submission (both at an intervention type and company level). For the opex component, we've then removed the effect NPV discounting effect to arrive at a 5 year opex value. This has enabled us to derive a supply demand unit cost (£m/Ml/d benefit delivered). The calculated unit rates are set out in the table below.

[Table REDACTED]

We have considered the potential for Direct Procurement for Customers (DPC)

We are supportive of DPC and recognise the potential to embrace markets in this way to deliver more benefits for customers. DPC is new to Severn Trent and so we sought specialist advice on understanding the concept and how to apply Ofwat guidelines with appropriate fairness, transparency and repeatability. This was to ensure that any scheme progressing via this route would provide genuine value for customers.

We have worked with KPMG to develop a DPC assessment framework (below) and for assessing potential discrete, large-scale enhancement projects expected to cost over £100 million whole-life totex that will represent the best value for money to consumers.



We have passed all projects and programmes of work with a totex of greater than c.£80M through this process.

Four projects passed the size test;

- three schemes in our draft Water Resource Management Plan and;

- one water trading project, an export to Anglian Water at Rutland that is in their dWRMP.

Three of these four projects failed the discreteness test (see figure below) as the activity was either disaggregated across many sites or highly integrated within existing processes.

PRIVATE AND CONFIDENTIAL

Direct Procurement for Customers (DPC) – Technical Assessment Methodology

'Discreteness' test - Summary

Criteria	Scheme A – East Midlands Raw Water Storage		Scheme B – Church Wilne WTW expansion		Scheme C – Enhanced Metering Programme		Scheme D – Transfer to Wing	
	Score	Justification	Score	Justification	Score	Justification	Score	Justification
Asset location	H	Standalone asset with limited integration with wider network	L	Highly integrated with SVT's ongoing operation at the site	L	Large number of meters highly integrated with SVT's existing assets and network	M	Standalone asset with construction having limited impact on ongoing SVT operation
Interfaces	H	A number of interfaces but considered relatively simple	M	A number of physical and informational interfaces with SVT	L	Significant physical and informational interfaces required between a number of parties	L	Physical and informational interfaces with SVT and AWS introduces complexity
Process	M	Some ongoing coordination with wider network required	L	High degree of coordination with wider network and existing assets required	L	Operation of smart meters highly reliant on other functions within SVT	M	Ongoing coordination required between DPC, AWS and SVT to balance flows across the network
Impact on service delivery	L	Impact of failure could impact quality and reliability obligations for SVT's customers	L	Asset failure would have significant and direct impact on SVT's customers	H	Impact on service delivery expected to be minimal with potentially some implications for SIM rewards/ penalties	M	Asset failure likely to impact AWS customers only however backup supplies available
Flexibility	M	Operational is potentially scalable in response to changing requirements	M	Scalable and adaptable if needs change over time	L	Risk of smart meter technology becoming redundant given relative infancy of the market	L	Transfer not scalable over time with limited alternative uses of the asset
Control	M	Ongoing and frequent coordination required with SVT network	L	Frequent and ongoing interaction required between wider network and existing WTW	L	Large number of ongoing interactions needed between smart meters, SVT and communication provider	L	Coordination required on an ongoing basis between all parties
Overall score	13		8		8		9	

One project (East Midlands raw water storage including new water treatment works) passed the discreteness test and progressed to the economic and commercial tests. This project includes development of raw water storage, abstraction from the River Trent and building of a new water treatment works. We are working with KPMG on this project to understand how the project compares against the economic and commercial tests. We have included £7m of expenditure for development, procurement and contract management costs in our plan to progress this; this can be seen on Appointee table 21.

Following consultation, no further schemes have been identified as being eligible for DPC. A detailed description of our methodology, criteria and assumptions used is available if required.

8.7.2.3 Management control

We understand the need to balance the value our customers attach to environmental improvements and drought resilience (and support for them), with how we best adapt to the uncertainty of a changing climate with the affordability constraints our customers face. While there are statutory drivers for this investment, and clear expectations set out national policy positions, we have challenged the need case and worked with the Environment Agency to manage down the volume of abstraction at risk. We have also developed creative approaches to defer investment schemes, such as river restoration techniques to protect ecology at the same time as providing other amenity and well-being benefits for our customers.

We've worked with the Environment Agency to reduce scope (but not outcomes) and phase delivery into AMP8

We've worked collaboratively with the Environment Agency throughout the WINEP process. This includes iterative reviews of the Environment Agency's evidence of need, taken a collaborative approach to how we best model and set targets for hydro-ecology and what the best ways are of achieving the outcomes.

We have worked with the EA to move from an initial precautionary scenario of needing to give up over 270Ml/d of potentially unsustainable abstraction before 2024, to a risk based environment programme that meets our WFD objectives over a 10 year period. The benefit of this approach is that it is more affordable, saving approximately £200m to £300m in AMP7 (assuming a notional £2m to £3m per Ml), it avoids unnecessary investment at lower risk sites and it gives us sufficient time to construct alternative sources of supply so that we do not destabilise public water supplies.

Our multi-scenario analytical approach and sensitivity analysis provided for transparent and productive collaboration with the Environment Agency.

We began developing our latest draft WRMP in early 2016, and in that time we have worked with the Environment Agency to develop a ten year delivery programme that prioritises interventions based on risk and cost-benefit appraisal. We have used the outputs from our AMP6 investigations into the environmental impacts of historic abstraction to inform our understanding of environmental risk and priorities. We will replace sources of supply where there are clear lines of evidence that future abstraction will be unsustainable. Where the evidence is less certain, we will retain our existing sources and prevent future growth in abstraction volumes. Underpinning this staged approach is our commitment to drive down demand for water and provide environmental mitigation measures to reduce the likelihood of future deterioration occurring. Our approach means we have been able to defer investment into AMP8, allowing more time for research into the need and for innovation in cheaper or more cost-effective solutions.

This is an evolution of the multi-AMP approach for ensuring a sustainable supply/demand balance that we took at PR14.

We have exploited synergies across our programme

From across our water supply demand investment programme and other areas of our wider investment programme we have looked for synergies we can make. For example:

- We have sought to optimise supply demand with improved resilience of our water supply system taking a system wide view.

- Employing river restoration techniques which provide more sustainable, lower cost solutions with added amenity and well-being benefit for customers.

Case Study – Improving Battlefield Brook brings wider environmental and amenity benefits
At PR14 the Environment Agency identified Battlefield Brook as a stream where abstraction change may be required to meet 'good' river quality status. Battlefield Brook rises on the Lickey Hills and flows south westwards to become the Sugar Brook in Bromsgrove. In its lower reaches it flows through Sanders Park which is a priority Biodiversity Action Plan site and an important public amenity. The section of the brook through Sanders Park was canalised and lined with concrete in the 1960s.

We investigated the effect of our abstractions on the local ecology between 2010 and 2013 prior to publishing 2014 WRMP. The brook flows over an 'over-abstracted' groundwater unit, so to make our abstraction more sustainable we are reducing long-term abstraction and providing flow support to the brook. We aim to complete this work by the end of AMP7 (2025).

Battlefield Brook also needs habitat improvements for it to achieve 'good' status. Our local solution will remove approximately 300m of the existing concrete channel, replacing it with a naturalised channel through the park. This will improve local habitat and provide an environment in which wildlife, such as the water voles, can populate and traverse between the natural upstream and downstream sections of the brook. The design follows best practice to create habitats for water voles.

We are designing the improvements in collaboration with Bromsgrove District Council, which has local knowledge of the area and its local vegetation.

Before and After – Battlefield Brook

We have built on this successful approach in our PR19 water resources management plan, but on a much larger scale, focussing on those water bodies with the greatest pressures.

We've used options that avoid the need for new supply capacity

Many of our existing sources of water abstract at rates below the amount that they are fully licensed to take. This headroom in our abstraction licences is vital as it allows us to meet increases in demand during hot dry weather and plan for any growth in demand resulting from population change and housing development.

Under the Water Framework Directive we have an obligation to prevent the deterioration of the quantitative and qualitative status of a waterbody. For example, deterioration of the quantitative status of a waterbody could arise if our abstractions increased in the future as a result of needing to meet growth in demand or replacing current unsustainable sources of supply.

This has a significant impact on our future supply capability and is a material change to our previous investment plans. To minimise the supply / demand impact, we have sought wherever possible to use solutions that mitigate for the effects of ongoing abstraction and that will reduce the likelihood of future deterioration from occurring.

We will take this approach at sources where we believe we understand the potential for future deterioration and we believe we can manage the risk through a series of preventative actions which are less costly than providing an alternative source of supply. Measures such as local low flow augmentation, river restoration measures to improve environmental resilience, catchment and partnership solutions or localised demand management will help us mitigate against the risk of deterioration. Other measures such as enhanced source abstraction management controls through better instrumentation control and automation and telemetry and new distribution links to more sustainable sources of water will help us to prevent increasing overall abstraction from the water body and further reduce the risk of deterioration. Whilst this activity has a cost to it in AMP7 and AMP8 we estimate our savings now to the customer are in excess of £100m in AMP7. Some projects may ultimately require us to intervene with a traditional scheme but our sensitivity analysis suggest we would need to be significantly wrong to adopt this cautious approach before it would turn out to be not cost beneficial.

We will also use the Abstraction Incentive Mechanism as a tool to help prevent increasing abstraction above the sustainable rate at a number of sites and incentivise us to abstract less from these sites ahead of the formal restrictions coming into force.

Where new capacity is needed, we've used options that maximise the utilisation of existing assets

Despite our efforts to mitigate and prevent future deterioration from occurring, we will still need to adapt parts of our supply system and provide alternative ways of meeting future demand. We need to do this at those sources of supply where we know that deterioration is likely to occur if we increase our future abstractions. This is particularly the case in waterbodies where the sources targeted for restoring sustainable abstraction, coincide with sources that pose a high risk of future WFD status deterioration (see previous figure).

For example, the combination of environmental pressures on groundwater bodies in our Nottinghamshire water resource zone tells us that we need to reduce abstraction from our numerous borehole sources, and make strategic changes to the way we supply water to this zone. This means that we have had to rethink our approach to dealing with unsustainable abstraction, and we are having to think about the needs of the entire water body and supply system, rather than just the localised impacts of our individual sources.

One of the key lessons we learned from our experience of the Birmingham Resilience Project at PR14 was to ensure we understand the capabilities of our current assets and utilise them where we can to minimise any costs. Where we see that new supply capacity is needed to maintain the supply / demand balance, we have prioritised solutions that make the best use of our sustainable sources of supply. We have focussed on solutions that:

- increase the flexibility and resilience of our supply system, such as the new strategic supply links from our Strategic Grid zone into the groundwater fed Nottinghamshire zone;
- increasing or optimising deployable output from existing, sustainable sources where possible, such as increasing the treatment capacity of our existing Church Wilne and Little Eaton water treatment works;
- make use of potential trades in and out of our region to optimise national use of resources.

The table below demonstrates how the source to distribution components of the new supply schemes that we are proposing for AMP7 will make use of existing assets and minimise the need to construct brand new storage, treatment and distribution assets.

How AMP7 supply enhancement scheme utilise

[Figure redacted]

We're exploiting the potential of innovation

We have used innovative techniques to help us develop a manageable and affordable investment plan that will achieve WFD environmental objectives without putting our customers' security of supply at risk. We are employing innovative solutions that will help us to achieve our leakage and demand management ambitions, and we are proposing innovative ways to improve ecological resilience in those water bodies at risk of future deterioration.

Investment planning and decision making

Our plan looks ahead at the possible water supply and demand issues that we face over the next 25 years and longer. Many of these issues are very uncertain in terms of the magnitude of their impact, the likelihood of them occurring and the timing of when they could occur. We have used a variety of methods to manage this uncertainty and to test the impacts on our long term plans. Through our approach, we have produced a plan that considers short, medium and long term risks and that recommends investment decisions that appear under the widest range of scenarios and are flexible enough to adapt to a changing future.

We have used advanced investment modelling techniques to derive the optimised investment programme that could be used to meet our supply / demand challenges. Our Water Infrastructure and Supply / Demand investment model (WiSDM) allows us to test the very long term, holistic investment decisions needed to both maintain the performance of our water distribution network and improve the balance between future supply and demand.

The WiSDM model tests the costs and benefits of different levels of mains renewal, leakage reduction, demand management and metering alongside options to increase supply capability. The model allows us to predict the future performance of our water distribution assets, the investment needed to achieve different levels of performance, and the scale of investment needed to make sure we have sufficient water supply to meet future demand. As a result, we can be confident that we are able to generate a truly optimised package of demand and supply investment measures, and we can fully explore the economics of different leakage decisions. Our approach means that the supply and demand solutions included in our draft WRMP are fully integrated into the broader PR19 investment plans. Our different elements of the WISDM model combine to derive the holistic least cost plan to achieve supply / demand and infrastructure maintenance needs.

The outputs of our approach have allowed us to generate a number of potential long term investment programmes which represent different ways of securing our long term supply and demand objectives. We have also used the model to test the costs and benefits of adopting different top-down policy decisions on issues such as leakage, metering and the pace at which we adapt to Water Framework Directive requirements. We have also been able to examine how water trading options could impact on our long term investment needs, and what investment would be needed to achieve the strategic objectives of Water UK's Water Resources Long Term Planning Framework.

We have made enhancements to our WISDM model to allow the investment optimisation to more explicitly account for uncertainty parameters around the supply and demand options, as well as considering a range of alternative future scenarios. This Decision Making Upgrade (DMU) to our WISDM investment model has given us the ability to compute large amounts of supply / demand and options data and present it in a repeatable format. This has informed our internal decision making, and our ability to test the cost implications of meeting different stakeholders' expectations and what our whole life cost investment plan might look like under a range of alternative futures.

We have used the DMU to model a large number of different supply / demand scenarios to examine how sensitive our investment decisions are to different planning assumptions. These scenarios represent different possible 'alternative futures' which have allowed us to test the sensitivity of our plan to different combinations of events. These alternative futures were generated by varying those supply / demand factors that have the greatest uncertainty, including sustainability reductions, impacts of Water Framework Directive, climate change and future demand for water. Each scenario used a bespoke "water available for use" profile reflecting the deployable output impacts of the component being investigated and a "high", "mid" or "low" demand profile.

In August 2017, we ran 6,000 DMU supply/demand investment optimisations, covering 60 different possible future scenarios. Scenarios covered the range of high / medium / low demand, WFD and climate change scenarios, along with multiple combinations of these different possible futures. We used frequency analysis to examine how different scheme options are chosen in the 6000 different optimisations, how certain we can be that different options will deliver the expected benefits, and to investigate how sensitive our investment programme is to the different supply / demand planning assumptions.

The outputs of this analysis informed the pace and magnitude of our chosen leakage and demand management targets, and tested how robust our supply / demand choices are in a range of possible futures. For example, the DMU scenario testing demonstrated that it would be preferable to stagger the abstraction changes needed to meet WFD and sustainable abstraction objectives in our Strategic Grid and Nottinghamshire water resource zones over a ten year period. Our DMU modelling showed that making these abstraction licence reductions in a shorter time period would put security of supply at severe risk, and would drive very high cost, short term investment decisions. The DMU showed us that if these changes were to be made over a ten year period, this would produce a lower whole life cost investment programme and would mean much lower risk to security of supply. It was through this kind of analysis that the DMU outputs shaped the underlying supply / demand planning assumptions used in this recommended draft WRMP and the investment decisions that we are proposing.

Achieving leakage and demand management ambitions

We want to reduce leakage by 15% over the course of AMP7, and move towards upper quartile performance in this area. This would require significant totex costs using current methods, assuming it would be technically feasible. Leveraging innovative thinking and cutting edge solutions will be critical in ensuring that performance targets are achieved and sustained within reasonable cost limits. To address this challenge, we are exploring new technologies and working with potential partners who can offer innovative solutions to tackle our leakage challenge. Over the past year, Severn Trent has been proactive in sourcing innovative solutions, and has engaged with global “best-in-class” organisations to seek out the latest cutting edge technologies.

Examples of our how current innovation will help us to deliver against our AMP7 leakage and demand management ambitions include:

- **Leakage detection robot**
  In January 2018, a full scale trial was conducted at our leakage training facility with a start-up company from MIT, which has developed a robot prototype for advanced leakage detection. This soft, tether-less robot is able to accurately detect small leaks while covering a range of pipe sizes (including small sizes, down to 2”). The robot’s unique design allows it to be inserted into the network from T-junctions and hydrants without shutting down the water supply. In addition, a cloud based analytics platform can create a map of the leaks found, informing the pipe operator of the leaks’ location and size, and providing repair recommendations.

  Next steps are currently being discussed, and we envisage further work and input being carried out so that a solution can be created to help meet our leakage challenge.

- **Alternative repair methods**
  We currently carry out 55,000 leakage repairs across our network each year, at a total cost of around [REDACTED]. Unfortunately, the nature of our repairs can cause inconvenience for our customers. Identifying less intrusive and more cost effective solutions would complement the implementation of advanced leakage detection methods as an overarching solution addressing both detection and repairs. Our global horizon scanning exercise, where we can learn from leading companies operating in the worldwide innovation arena, will identify the best new technologies and methods for carrying out leakage repairs in this manner. We will benchmark and trial these solutions in comparative scenarios.

- **Customer supply pipe leakage and plumbing losses**
  An estimated 20% of our overall reported leakage originates from customer supply pipe leakage, although this could potentially be as high as 30-50%. Whilst plumbing losses are not directly reported

as leakage, underestimating this element of consumption can result in an elevated leakage value, making our active leakage detection activities inefficient. Our domestic metering penetration is currently only 43%, which makes identifying and quantifying our customers' supply pipe leakage more difficult. A programme to significantly increase our metering stock would require substantial investment and could take several AMPs to implement. To overcome this, an innovative new technology is being trialled that utilises temperature data to identify customer supply pipe leakage and internal plumbing losses. Initial trials of this solution have led to the development of cost effective surveys, which are able to locate these leaks and losses. In addition, targeted water efficiency campaigns, in the areas of greatest need, can be delivered through the application of this new technology.

- **Fixed acoustic network monitoring**
  The current leakage level within our DMAs requires substantial opex investment to find and deal with active leaks. Improving our productivity in finding active leaks will positively impact our leakage performance. New acoustic sensors are available which offer a cost effective and technologically advanced solution versus standard low-tech methods. They identify leakage at a higher resolution than at the DMA level, and more quickly.

  Initial small-scale trials have demonstrated a 42% improvement in cost per Ml/d for overall leakage reduction, of which using acoustic network sensors was a key component. The trial is too small to have confidence in extrapolating the efficiency savings – but it has given us sufficient evidence to scale up the deployment. We aim to further develop this approach by assessing a suite of specifically selected network sensors, both mobile and fixed, to understand the appropriate application of each technology. We also hope to better understand the costs and benefits associated with finding leaks quicker at a street or asset level, rather than at a DMA level.

Achieving WFD objectives and minimising the impact on supply / demand

Our plan includes short and long term measures to remove or offset the environmental impacts of abstractions, and to help the associated water bodies achieve Water Framework Directive objectives. In the short term we propose localised environmental protection measures that will allow us to continue to abstract from some sources until we can put longer term solutions in place to reduce or stop abstraction.

In those water bodies where local environmental protection measures could work as mitigation for abstraction impacts, we will engage with local stakeholders and landowners and aim to develop catchment partnerships to assist in the implementation of these schemes. We will also work with existing partners and collaborated with the Catchment Based Approach (CABA) network to deliver these improvements.

The localised environmental measures that we propose include:

- Local flow support measures

  These types of options involve providing additional water to localised river reaches in times of low flow. This can be achieved in river reaches below reservoirs by releasing water into the river to ensure flow does not get too low and by providing some variation in the amount released through the year. In rivers that are not downstream of a reservoir water can be added from another source, such as groundwater if water is available.

- Catchment and river restoration improvements

> Many streams suffer from a range of problems that exacerbate the impacts of low flow, such as modification of the channel, lack of instream habitat, pollution, sedimentation and barriers to the movement of fish. Reducing abstraction without also addressing other issues in the waterbody will only provide limited benefit, whereas improvements in stream habitat it will improve the stream in the short term and also enhance the environmental benefit of the longer term reduction in abstraction.
>
> The main types of environmental improvements that could be made include realignment and changes to make the shape more natural, instream measures to improve the diversity of habitat types, riparian management such as fencing and buffer strips to reduce nutrients and sediments entering rivers, fish passes and removal of instream barriers.

We will use Ofwat's Abstraction Incentive Mechanism (AIM) as an innovative way of helping prevent future deterioration. The AIM works by rewarding or penalising abstractors based on the amount they take from a source over the year, with reference to an environmentally sustainable threshold. We are proposing to adapt the AIM approach as a mechanism to help reduce the likelihood of future water body deterioration. We propose to use AIM at a number of sites with the potential to cause future deterioration, and set abstraction performance targets that are based on maintaining recent actual rates of abstraction. The proposed AIM approach would incentivise us to reduce abstractions earlier (during 2020-2025) in key areas where we have sustainability reductions planned in the future.

We've worked collaboratively to achieve successive reductions in scope and cost

As already described, under WFD we have an obligation to prevent the deterioration of the quantitative and qualitative status of a waterbody. Deterioration of the quantitative status of a waterbody could arise if our abstractions increase in the future due to growth. If this occurred, we would be taking more water out of the environment. Taking action to prevent deterioration now will prevent us from having to repair damaged waterbodies in the future, which would be more expensive. Our abstractions need to be more sustainable and we need to achieve this without compromising the supply of water to our customers.

In early 2016 the EA first shared with us their risk assessment of the likelihood of our abstractions causing deterioration, carried out as part of the second cycle of river basin management plans (RBMPs). This assessment followed a precautionary approach based on the potential for all licences being used at their full capacity. The conclusion from that initial assessment was that significant quantities of currently licensed abstraction would need to be given up across our region in order to prevent future deterioration from occurring. From that point, we have worked closely with national and local EA teams to better understand the likelihood of our abstractions causing future deterioration and to develop a proportionate, more risk based response to deal with this issue.

In October 2016, partly informed by our impact assessment, the EA indicated that their initial assessment could have a significant impact on our security of supply and would drive unnecessary investment. Following this statement, the EA issued a second assessment, which was more risk-based and considered to be more representative of the actual risk of deterioration. The trigger to assess whether deterioration would occur was set by using a future predicted scenario based on PR14 WRMP planned growth figures. These figures were used in combination with the Environmental Flow Indicator (EFI) as a means to undertake a nation-wide screening of ecological impact related to a future deterioration risk. The EFI, which is a hydrological indicator, is the EA's best available, nationally consistent indicator of the impact of abstraction on flow and ecology.

Waterbodies, and consequently abstractions from those waterbodies, were grouped into categories, depending on where the planned growth falls against the EFI. A planned increase in abstraction may not pose a deterioration risk if flow is currently above the EFI and is likely to remain above the EFI with the planned growth in abstraction. The EA grouped waterbodies in the following categories:

- Category 1: Waterbodies suffering from seriously damaging abstractions
- Category 2: Waterbodies where deterioration is likely to occur by 2027
- Category 3: Waterbodies where deterioration is likely to occur by 2040
- Category 4: Waterbodies where deterioration will not occur by 2040

The EA's guidance required that sources abstracting from Category 1 and 2 waterbodies would need to have abstraction licences reduced by 2021. Using the EA's approach, we determined that 83% of our existing groundwater abstractions would be classified as either Category 1 or Category 2, putting at risk over 200Ml/d of source deployable output, and would require huge investment in new, strategic alternative sources of water supply to make up for that loss.

Replacing deployable output on such a scale would not be affordable or deliverable to achieve the EA's original target deadline of 2021. Therefore, we wanted to improve our understanding of the risk associated with taking more water from water bodies that may be subject to deterioration. We took the EA's work a step further as we wanted to further explore the potential impacts on water supply to our customers. Our first step was to undertake our own growth assessment, and use this to understand where growth may occur.

In 2016, we obtained the most recent Local Authority house hold year by year growth figures and we mapped these to our Water Quality Zones (WQZs). We then mapped WQZs to the individual sources supplying these WQZs. We used the most up to date housing and population growth data and combined it with our latest projections of per capita consumption so that we could better understand which sources of water had the greatest potential for increased output, and over what time periods this might occur. We classified sources that had planned abstraction growth by 2027 as Category 2 sites while we classified those that had planned abstraction growth by 2040 as Category 3 sites.

As a result of our more in depth analysis, we managed to reduce the number of category 1 and 2 water bodies from 139 to 134. This still meant that for our groundwater sources, approximately 160 Ml/d of our deployable output was at risk. We shared our assessment in advance of the EA releasing their 1st Water Industry National Environment Programme (WINEP 1) in March 2017.

Following WINEP1 release in March 2017, we have worked with the EA teams to understand the proportionate response to this deterioration risk. Because the scale of source deployable output at risk was so significant, we sought to prioritise where we need to action in AMP7. Our prioritisation approach has led us to categorise our investment into the following categories:

- **Sources that require an adaptation approach**: these are sources where we are confident that deterioration will occur if we increase our abstractions. There are also multiple drivers (WFD no deterioration, restoring sustainable abstractions, resilience, catchment wide water quality issues, etc.), often within the same WRZ. We want to take action now to prevent future deterioration and we realise that we need alternative sources of public water supplies to replace these unsustainable abstractions. These are the sources that contribute to our strategic supply / demand investment needs.

Constructing alternative sources of supply will take time to deliver, and will not be available before the end of AMP7. In the interim period, we will use catchment and partnership measures as alternative measures while the strategic solutions are being delivered. We believe that this is a more cost effective way of delivering solutions across the short, medium and long term. As specified in WINEP3, we will use the EA's 'up front permitting' approach and make licence changes by 2025.

- **Sources that require prevention/mitigation**: These are sites where we believe we can manage the risk through a series of actions that will prevent deterioration occurring. Environmental solutions to mitigate the risk of deterioration include localised measures such as local flow support, hydromorphology improvements, catchment and partnership solutions and localised demand management.

  We will also use invest in localised asset improvements that will reduce the likelihood of deterioration, such as enhanced source abstraction management controls through better Instrumentation Control and Automation (ICA) and telemetry and new distribution links to more sustainable sources of water.

  These approaches will minimise the potential deployable output loss, but they will still ultimately prevent increases in use of these sources in future, and will lead to a net reduction of our current supply / demand headroom. We have therefore accounted for a consequent loss of deployable output in our WRMP by 2030 in our central best estimate for each source in this category.

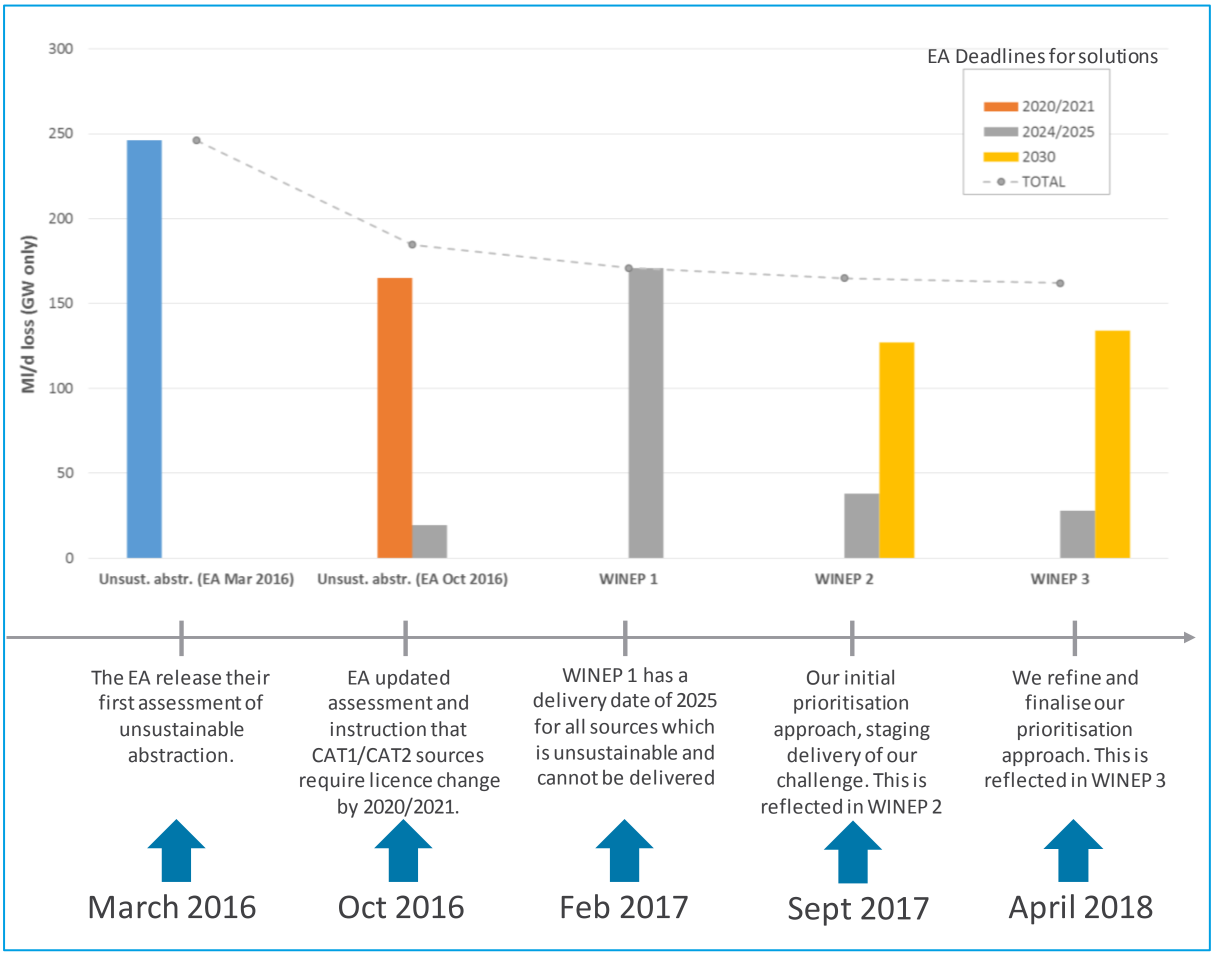
- **Sources that require investigations and options appraisal in AMP7**: these are sources where we have no environmental data and therefore do not fully understand the risk of deterioration. We believe that we will need to collect data and undertake further assessments to improve our understanding of the risks.

The benefit of our approach has been to improve our understanding of the risk of future deterioration, which in turn has reduced the quantity of deployable output at risk. Our approach also means that we are taking proportionate measures over AMP7 and AMP8, prioritising investment based on an understanding or environmental and security of supply risk. The key stages in our approach are summarised in the table below.

Date	Description
Mar 2016	The EA release their first assessment of unsustainable abstraction based on the PR14 WRZ growth figures. No clear guidance provided on delivery timescales. We use a very precautionary approach in assessing the potential environmental risk.
Oct 2016	Initial EA guidance is provided and indicates that CAT1/CAT2 sources require licence change by 2020/2021. We refine the growth assessment using our own growth figures and this allows us to be slightly less precautionary therefore reducing the total GW DO at risk.
Mar 2017	We advised the EA that early AMP7 delivery of sustainability reductions as indicated in the guidance was not achievable as we needed to investigate the potential environmental risk associated with No Deterioration. Consequently, WINEP 1 was issued with a delivery date of 2025 for all sources. In the meantime, while we continued to liaise with the EA, we refined our approach by undertaking further assessment of risk to supply and to the environment, thus refining our understanding of the problem. We realised that the scale of the investigation programme and subsequent delivery in AMP7 was not achievable due to the magnitude of the resources required.

Sep 2017	The assessment, based on our historic environmental datasets obtained from past RSA programmes, better informed our understanding of the risk to the environment and to water supply. This allowed us to take an adaptive approach: we chose to deliver strategic solutions where we were confident that we would cause deterioration. We are proposing to deliver the sustainability reduction by 2030. Where a strategic solution is not required, a sustainability reduction will be made by 2025. This approach is reflected in WINEP 2.
Mar 2018	We work with the EA to develop the No Deterioration guidance which is issued in December 2017. We refine and finalise our approach in WINEP 3 on the basis of this guidance.

The figure below illustrates the benefits of the approach we have taken since the EA's initial risk assessment in early 2016. It shows how we have reduced the overall scale of groundwater deployable output that is at risk, and how we have moved from having to make all licence reductions by 2021, to a more risk based delivery profile that sees the impacts of licence changes staggered over AMP7 and AMP8.



8.7.2.4 Best option for customers

Our customers told us that they want the best value options. Our programme is consistent with our customers' and stakeholders' views. In line with what our customers have asked, we turned first to demand reduction and have our most ambitious plan ever to reduce the supply/demand deficit by 75Ml/d through leakage reduction, increased metering and water efficiency. However, despite these ambitious proposals, we cannot avoid investment in new sources to maintain the security of supply and replace those sources where continued abstraction will deteriorate the water environment. We have utilised our existing abstraction capacity and existing assets to the full before seeking new sources of investment. Our proposals have been built iteratively and collaboratively, allowing for successive rounds of challenge and engagement. As well as challenging ourselves to deliver successive cost and scope reductions, we have listened to our customers and sought to exploit the potential to deliver multiple benefits.

Using our real options approach, we have reduced the expenditure we are requesting in this business case and developed a mechanism that will allow us to fund schemes as potential future deficits become more certain.

The extent of our work in formulating this business case includes many thousands of hours of engineering and customer research time. Our optioneering has been extensive. A summary of the scale of activity is shown in Annex 1 which includes a high level review of optioneering (excerpt only as the data is extensive and cannot be captured so that it is legible on one sheet), and a simplified process to explain key stages and activities.

Our decision making approach has gone beyond a simple financial cost / benefit appraisal, and has explicitly considered the environmental and social benefits of our supply and demand options by using a Strategic Environmental Assessment (SEA) approach. Our SEA thinking has led us to make decisions that are not solely based on least cost appraisal, and that can contribute to wider environmental objectives.

In addition, the investment programme described in this supply/demand business case, and the appraisal of different investment choices, has been developed in parallel with our wider water distribution and supply resilience strategy. We have ensured that we understand the holistic totex implications of our investment choices, and we can derive a fully integrated, optimised supply/demand, infrastructure and leakage investment plan.

Our supply / demand decisions are underpinned by our broader capital maintenance and water quality investment programme. At the same time, the schemes and activities included in our plan not only contribute to addressing future supply/demand challenges, but also deliver broader benefits to our customers by creating more resilient supplies.

We have taken account of the recommendations made in Water UK's Long Term Water Resources Planning Framework, which explored ways of increasing national drought resilience, including the use of new strategic water transfers. The options we have considered within our long term investment plan would facilitate new strategic transfers if needed in the future.

The Water Forum has challenged our approach. We have worked with our Water Forum (Customer Challenge Group) for over two years. While the Forum will report its view independently in its report, it had indicated that:

- the need for the investment is supported and well evidenced;
- our proposals offer the best option for customers – in line with customer preferences for our approach; and
- our proposals include good levels of customer protection.

We have tested uncertainty, and challenged the basis for need and cost to keep interventions affordable. Our supply/demand investment plan is being shaped by many different long term pressures, all of which have varying degrees of uncertainty. We have considered a wide range of potential future scenarios to test the cost and risk implications of coping with this uncertainty.

We have used our understanding of environmental and supply risk to prioritise our investment programme. By working with the Environment Agency, we have to a risk-based programme that meets our WFD objectives over a multi-AMP period. The benefit of this approach is that it is more affordable, avoiding unnecessary investment while we gather more evidence at lower risk sites, and it does not destabilise public water supplies. This approach has reduced the EA's initial precautionary assessment of needing to replace around 270Mld source deployable output in AMP7, to a more phased 73Mld in AMP7 and a further 100Mld in AMP8. To enable this phasing of the supply / demand solution, we will invest in environmental improvement and protection measures where necessary to mitigate for the effects of our ongoing abstractions in AMP7.

We have used advanced investment modelling techniques to derive the optimised investment programme that could be used to meet our supply/demand challenges. Our Water Infrastructure and Supply/demand investment model (WISDM) allows us to test the very long term, holistic investment decisions needed to both maintain the performance of our water distribution network and improve the balance between future supply and demand. Our investment modelling approach has allowed us to test the costs and benefits of adopting different supply options as well as policy decisions on issues such as leakage, metering and the pace at which we adapt to WFD requirements. Our investment modelling approach has been updated since PR14 to reflect the adaptive planning approach endorsed by UKWIR, and it has been reviewed by Atkins as part of the Water Resources Management Plan assurance process.

As well as optimising our overall supply/demand investment programme options, we have conducted scheme level cost optimisation and feasibility assessments to make sure that scheme scope and costs are efficient. We have followed an option screening process to help us capture a wide range of these potential options early on, and that has helped us to screen out those options that we do not consider feasible for consideration in this plan. For these feasible options we undertook scenario planning against 6,000 scenarios. These cost and benefit values were then then used in our investment modelling so that we could understand what the optimised balance of leakage reduction, demand management and new supply investment might look like.

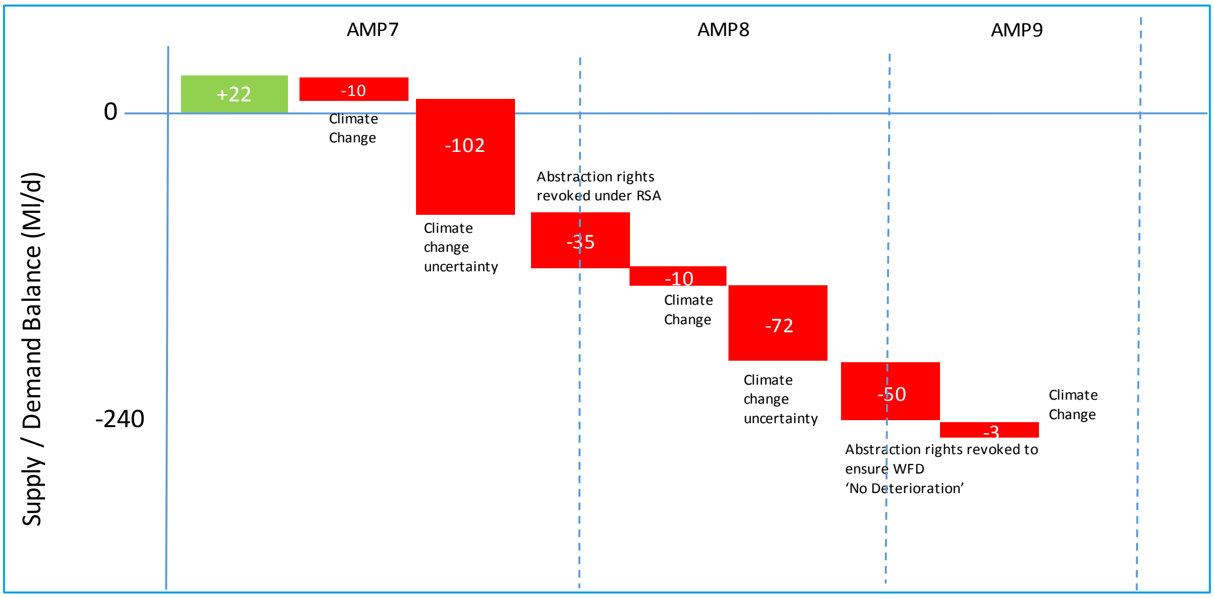
We are proposing a modular, multi-AMP investment programme that does not commit us to inflexible, very long term investment decisions. In AMP7 we will focus on demand management and leakage interventions while investing in schemes to increase the deployable output from existing treatment and distribution assets. In AMP8 we will focus on solutions that increase the amount of raw water available from existing sources of abstraction. The nature of these solutions mean that our programme can be adapted over time as long term planning assumptions change.

Our investment delivers multiple benefits for customers and the environment. As a consequence of the interventions that will be delivered, our customers will benefit from:

- our lowest ever levels of leakage – with a 15% reduction over the next AMP;
- more help for customers to reduce their demand, giving them greater control over their usage;
- an accelerated programme of domestic metering – increasing coverage to 65% (against our previous AMP7 projections of 55%);
- the restoration of sustainable abstraction;
- no future environmental deterioration as a consequence of our abstraction (under the WFD); and
- the restoration of river habitats and greater ecological resilience.

Our leakage and demand management targets are explicitly driven by our supply / demand needs and we will be focussing AMP7 activity in the zones that have the most acute water resource pressures and that are expected to go into deficit. Regardless of the risks and uncertainties around these options, prioritising leakage and demand management in these zones form part of our most certain solutions because we know that sustainable water supplies will become increasingly scarce in these zones over future AMPs.

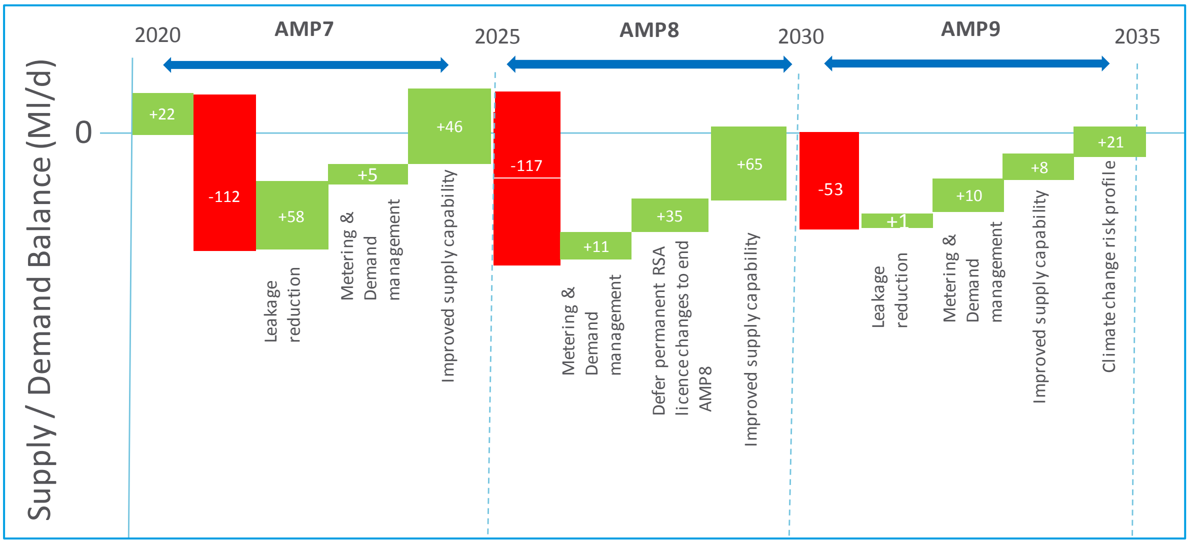
The figures below illustrate how our multi-AMP approach will meet the supply / demand deficit in the Strategic Grid zone. The first figure shows the combined impacts of reducing unsustainable abstraction, giving up licensed abstraction in order to prevent WFD status deterioration, climate change and increasing uncertainty all add up to an increasing supply / demand shortfall. Note figures relate to draft WRMP.



The second figure below illustrates how the different elements of our supply / demand investment programme will offset these supply pressures, and maintain the balance over future AMPs. We will prioritise leakage and demand management in AMP7, while we invest in the new supply capacity needed to come on line for the beginning of AMP8. In AMP7 we will also invest in the environmental mitigation and prevention measures that will allow us to defer many unsustainable abstraction licence permanent reductions at until later in AMP8. This helps to minimise the scale of new supply / demand capacity needed at end AMP7, while preventing environmental damage without putting security of supply at risk.

As a result, we have developed a 10 year, two AMP programme that will allow us to maintain the supply / demand balance while meeting our environmental obligations in an affordable and flexible way.

Strategic Grid supply / demand investment programme



Our programme has been shaped, and is supported, by our customers

Our extensive research catalogues, compiled using many data sources and over many years, tell us customers take their water supply for granted until something goes wrong - they are not aware of, and therefore do not readily think about, issues such as our responsibilities, planning for long term, drought, how to manage consumption better and the options we have available to us. We asked customers to document what they associated with water and no issues related to long term planning, instead Customers overwhelmingly see providing safe, clean drinking water as the key responsibility for Severn Trent - a typical quote from the deliberative workshop (see below) was "[Severn Trent's responsibility is] To supply good quality water and to get rid of your waste in a healthy way". Most customers we spoke to had had limited experiences of disruptions to their water and waste water service. Taken together with our work on resilience customers have expressed concern that the thought of not having water at all times was very concerning - a selection of spontaneous quotes from the deliberative workshop (see below) covering supply demand and also resilience on supply demand were; “You just always expect that it’s going to be there, and so we just don’t think about it"; "I’m surprised by the amount of water ST deals with on a daily basis and how wide an area they supply"; "I’ve never thought that water might not be there. I would freak out if I didn't have any water.”

Given this background, we re-designed our approach to customer engagement in PR19 so that we could ensure our customers could contribute in a meaningful, informed way on these matters. We have supplemented our more traditional research methods [tracker analysis and valuation studies] with revealed insight [social media ‘scraping’ and customer contacts] with a programme of deliberative research with a representative cross section of customers. This took two forms; a workshop (for those who felt comfortable contributing in an open environment) and for those we considered vulnerable (i.e. those with special requirements - financial or health) we conducted 1-2-1 home interviews (duration 1 hr) to ensure their opinions could be factored in to our work. The deliberative workshop was focussed but extensive in its content. Our independent experts who specialise in seeking accurate, informed customer views, led the workshops and with our input (only on the technical challenges), designed the agenda. We spent over 6hrs with our customers so we could explain exactly the challenges we are facing. We elicited both a spontaneous view and a much more informed view. The agenda covered company core service, challenges we are facing from disruptive events such as drought and longer term climate change and environmental constraints, growing population, and options we have to respond to these in order to allow customers to provide informed responses to our proposals. We also undertook two deep dives on; metering and switching water source.

In order to ensure the event was as objective as possible customers had no prior sight on whether they were seeking to change our work done at that point in time or whether they would be endorsing what we were already planning. Additionally we did not share the detailed content of our plan at the workshop nor did we express preferences on what we should do unless specifically asked. Instead we presented the challenges and options we have to respond to these. The outputs from the deliberative research demonstrate that customers are able to engage in, and understand, complex issues and comment in a meaningful and informed way, specifically;

(a) what level of protection against drought customers require,
(b) what are the causes of our long term water supply challenges,
(c) what options we should consider (but leave the detailed technical appraisal to us), how long they will take to implement and the relative cost of these options and,
(d) what preferences they have.

We believe the deliberative workshops fulfilled our objectives and helped significantly our customers understand what issues we are facing. Typical customer views expressed at the end of the sessions included; “A good, informative session. Made me think about my water usage in the future.” “I think it’s been really good, lots of information I didn’t know about.”

Views that customers formed as a result of the deliberative workshops are that;

(i) solutions could be prioritised according to various criteria e.g. encouraging responsible use through to environmental impact,
(ii) customers were comfortable with the level of drought resilience we are providing and do not want to increase protection (as it is seen as very rare),
(iii) customers would like us to do more on education to help them manage water better,
(iv) metering is strongly supported and our objective should be to bring everyone on to a meter over time,
(v) looking for solutions that deliver beyond just the short term is important,
(vi) bills should be affordable over the long term,
(vii) switching water source is acceptable but addressing needs through more local infrastructure is preferable.

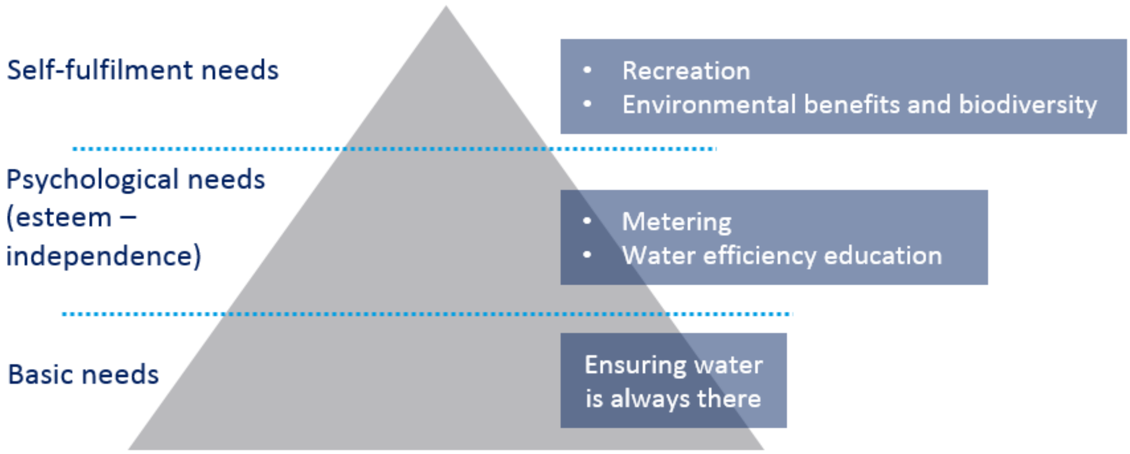
Given these explicit findings we have responded by;

(a) reflecting customers top priorities we are planning to deliver solutions that manage down demand and well as increase our leakage repair rate,
(b) seeking to maintain our current level of drought resilience
(c) increasing our education activity to help customers save water and use it more responsibly,
(d) setting out a long term plan to bring everyone on a meter over the long term (15yrs)
(e) ensuring our proposals plan for the long term as well as short term,
(f) ensuring investment is structured in a way that avoids large bill increases early on,
(g) developing a suite of new supply solutions and continue with our current imports.

At the heart of our strategic approach to customer insight is developing a more holistic understanding of the people and communities in our region, and understanding how we can make a positive contribution to their lives. As we have developed this understanding we have reflected on the fact that not all customer needs are equal. There is a hierarchy of needs and the tools which we use to understand these will be different at each level. Our categorisation of customer needs draws on Maslow's three levels – delivering basic needs, meeting psychological needs and creating opportunities for self-fulfilment (see figure below).

Our research consistently shows that customers take their water supply for granted, and ensuring water is always there is a basic need that, once met, is not given much further thought. Once this need it met, there are aspects within the delivery approach (in terms of how we balance supply and demand) which can meet higher needs. By giving customers information and choice more psychological needs are met, for example by giving customers the tools to reduce their bills through water efficiency advice and metering. Customers and their families can also benefit from our public access sites, such as reservoirs, and river restoration projects. These can provide the opportunities for people to meet many different needs, for example basic needs in terms of promoting health and wellbeing whilst also providing opportunities for self-fulfilment through recreation and enjoying nature.

Categorisation of customer needs



Our approach to understanding customer views

Our Water Forum challenged us early on to be more strategic in our research design, taking into account:

- where the topic sits within the hierarchy;
- the extent to which the topic is conscious in customers' mind vs unconscious; and
- whether the topic/issue occurs today or could occur in the future.

Our insight in this area is now rich and comes from a number of sources – aspects such as leakage tend to be top of mind and our evidence sources include our analysis of customer contacts, social media scraping and numerous research projects. For other aspects such as metering and water efficiency we have used co-creation to work with customers to understand how they can be part of the solution. Since customers are not necessarily aware of the future pressures on water availability we have also used deliberative research to explore perceptions of water stress and the best way we can meet these challenges. It's only when prompted that customers recognise the pressures of ensuring there is sufficient availability of water for future generations and understand that everyone has to play their part to make this happen.

We've used the expertise of our stakeholders

We have drawn on the expertise of our regional stakeholders to develop our proposals. In addition to our ongoing collaboration with the Environment Agency, in March 2016 we held a programme of workshops with our stakeholders to discuss how we can best address the future challenges we face. We also heard from a wide variety of stakeholders through the WRMP events that we held throughout 2016 and 2017.

Through the water resources stakeholder forum events we gathered hundreds of items of feedback through the interactive breakout sessions and follow up correspondence. The material presented at the forum events along with the stakeholder feedback is visible on our website here https://www.severntrent.com/about-us/future-plans/water-resource-management/water-resource-managment-plan/

Throughout our stakeholder engagement and discussions with regulators, we heard some clear messages as set out in the table below.

What our stakeholders told us	How we have responded
Delivering WFD objectives by 2027 should remain a priority	Our plan is focussed on achieving our WFD objectives by 2027
We need to be more ambitious with our leakage reduction targets.	Our plan will reduce leakage by around 15% over AMP7, taking leakage down to record low levels targeted in the zones that have the greatest supply / demand pressures.
Improving customer understanding is the biggest issue when tackling water efficiency	Our plan prioritises demand management measures. We will use education and incentives to help our customers become more efficient with their water use, and encourage them to pay by meter.
We should explore opportunities for more partnership working. We should explore innovative ways of broadening our catchment management thinking beyond just drinking water quality protection to deliver wider benefits such as biodiversity	Our plan includes a large scale programme of catchment restoration and river improvement schemes that will mitigate for the effects of our water abstraction. We will rely on partner organisations to help us deliver this programme, and we will work closely with the CABA networks.
New water supply schemes should deliver multi-benefits and we should explore options for water / waste water catchment thinking	Our options appraisal process has evaluated a wide range of potential new supply options, including options to trade water within and between catchments, as well as solutions that utilise our waste water discharges. Our plan prioritises solutions that make use of existing water treatment and supply assets wherever possible.

The Water Forum has challenged our approach

In addition to undertaking customer research to understand the views of our customers and shape our plan accordingly, we also worked closely with our Water Forum (WF) (our Customer Challenge Group) over 18months. A key challenge from the WF was in design of our research approach and deployment of the various techniques. Furthermore the WF attended our deliberative research and witness for themselves the engagement levels and interest in the room. A significant amount of work and challenge took place in the 18 month period. The WF wanted to understand:

- the challenge we are facing,
- the options we have considered,
- the benefits we are seeking to deliver,
- the preferences of our customers and
- how we are accommodating them and
- the areas of support we had for our proposed plan.

We explained the two levels of optioneering we have done to respond to the challenge, namely; optimising the programme and optimising solution choice given the extent of project development. The WF tested how we had arrived at the size of proposed programme. We explained how we had been involved in extensive negotiations with the Environment Agency (EA) to avoid the need to include inflexible solutions that would, lock-in costs based on future predictions.

We have negotiated with the EA and avoided heavy capital investments where the environmental need is not yet confirmed. This has removed the need to put full costly capital solutions in place to address 112 waterbodies. Instead we are planning a combination of preventative/mitigation solutions together with an extensive investigation programme to confirm the need, until we can be clear on the environmental impact. We estimate that this has removed c.£100m capex when compared to the cautious approach the EA sought to adopt at the start of the negotiations. Some of these solutions may not address the existing problem but we believe that by taking this flexible, lower cost risk approach given the uncertainty, is the most appropriate course of action.

We have also negotiated the timing of the reduction/revocation of abstraction licences to ensure our investment can be phased across a number of AMPs to avoid large bill spikes and ensure they schemes can be delivered in a practical cost effective way. We also explained our approach to climate change modelling and one of the members from the sub-group (former head of Scientific Unit at the Met Office) reviewed it in detail. He confirmed he was of the view that it was proportionate. Taken together the environment and climate change are the key drivers of the scale of the programme and we are confident we have scaled both these appropriately. They wanted to see evidence of the optioneering we have applied at a project level once they were satisfied the programme wasn't over-scaled. We explained our ambition on leakage, water efficiency and metering and how that reflected customer needs to have an ambitious plan that was cost effective. We then explained how our solutions to reductions/revocations have to consider the impact of the WFD and how this changes solutions compared to previous investment periods. We used the Cliptone Control Group to illustrate this by explaining how our WiSDM modelling capability allows us to select the best value programme given the outcomes we want to achieve and how the DMU module allows us to test the sensitivity of our scheme solutions to ensure we select the right schemes under various scenarios.

One area the WF pushed particularly hard at was in making sure we articulated the line of sight from Customer research to investment proposal. This has resulted in a Line-of-Sight document (Annex 2) which not only links customer views gathered through research to proposal, but also references the research data sets and weights the strength of feedback. The WF also pressed hard to understand the costs associated with each intervention we are planning - we were challenged to provide a full suite of metrics from total costs, enhancement only costs, cost per MLD and whole-life-cost (for which we used 'Average Incremental Cost') to demonstrate that we have considered properly all aspects of costs from a customer perspective.

While the Water Forum has yet to complete its final report, the Investment Sub-Group has indicated that it believes our approach is well evidenced as reflecting the priorities and views of our customers.

We have planned to meet our statutory obligations in the most cost effective way

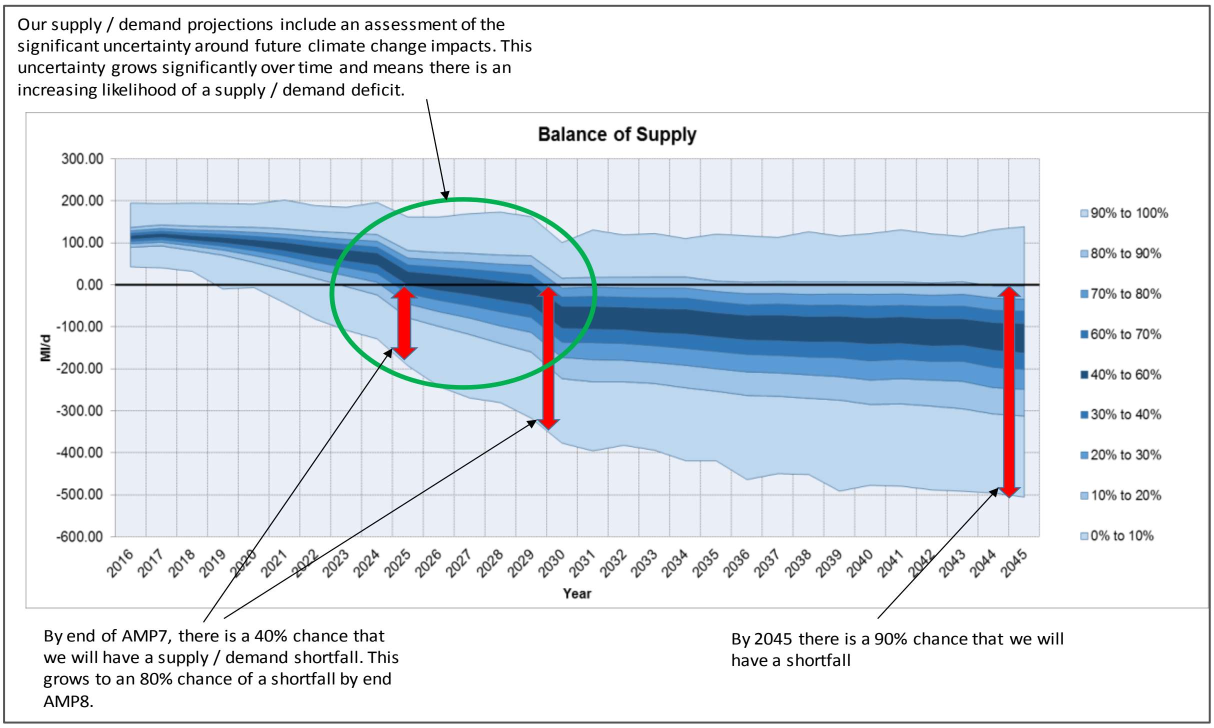
Whilst the need to deliver environmental improvements is both mandatory and challenging, we have many options in the way we meet the needs. Our planning process focused on:

- Assessing what the need is. We worked with the Environment Agency to confirm where the statutory WFD obligations would require a response from us.
- Confirming where abstraction changes can offer a meaningful solution. We paid close attention to the benefit that could be delivered by adapting our abstraction regime.
- Searching for cost-beneficial solutions that address the needs at a cost which is affordable to customers.
- Searching for solutions that solve more than one problem at a time – solutions that deliver 'multiple benefits'.

Our planning has followed Defra's guidance on delivering River Basin Management Plan objectives, as well as the Environment Agency's guidance for water resource management plans.

We confirmed that the need exists at a local level

We constructed detailed scenarios for demand and supply, including climate change and the pace at which we achieve WFD objectives. From these we identified key periods in which demand could outstrip our ability to supply. The figure below shows the combined effects of population growth, environmental legislation, and climate change in our Strategic Grid zone – the three key drivers of change in our WRMP. We included uncertainty analysis, which helps us to understand how soon a solution will be needed. The percentile ranges show the probability of supply meeting demand in future years given the uncertainties that have been assessed for each of the key planning components.



Our conclusion was that the abstraction licence reductions needed to comply with our legal obligations under the Water Framework Directive would threaten our ability to meet foreseeable demand and accommodate the potential impacts of climate change. Our analysis tells us that by end of AMP7 we have only around 60% certainty that we will be able to satisfy dry weather demand, and by the end of AMP8 this falls to around 20% certainty. Therefore, we need to intervene to restore the supply/demand balance.

However, we recognise that there is great uncertainty around the potential climate change impacts over the long term, and so we have adopted a response that we believe is realistic and proportionate. In the near to medium term, our plan gives us a high degree of confidence that we can reduce unsustainable abstraction and accommodate the plausible uncertainties around the potential impacts of climate change. Over the longer term, our investment plan reflects the fact that medium to long term uncertainties can be managed over time, and that it would be inappropriate to plan to maintain a high level of target headroom throughout the whole planning period. Instead, we plan to accept an increasing level of risk in our longer term planning horizon, and we will adapt our response as the impacts become clearer over time.

We have identified areas for research where it would be too risky to invest now

Our initial options list included 22 options where we do not know enough today to determine what needs doing without undertaking further research. These options appear to offer worthwhile benefits but their scale is not well enough understood, nor are the potential dis-benefits fully understood.

We will carry out further research on these uncertain schemes before committing investment. The research will strengthen our confidence in the likely benefits to the supply/demand balance, the activities that would be necessary to implement each option, and the environmental impacts. It will provide the information necessary to screen these options for our 2024 water resources management plan.

We assessed a wide range of strategic options

We identified and assessed a wide range of strategic options to balance supply and demand, including:

- Leakage
    - Universal leakage reduction.
    - Targeted leakage reduction.

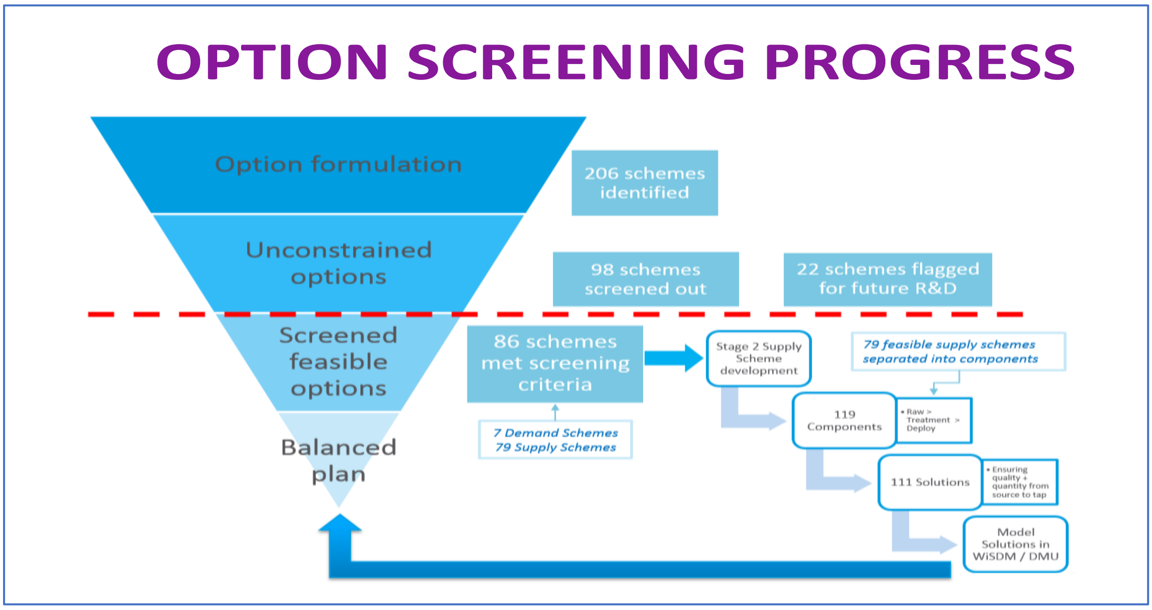
- Demand management
    - Improved water accounting through metering options (e.g. universal, change of occupier, incentivised, passive).
    - Water efficiency measures (e.g. incentivised, passive).
    - Financial measures (e.g. tariffs).

- Making more use of existing strategic assets and abstractions, for example:
    - Increasing capacity of sustainable existing abstractions (e.g. by modifying assets or abstractions, by changing the operational regime).
    - Developing transfers from areas of surplus to areas of deficit (e.g. with neighbouring water companies or within our water supply region).
    - Where improvements in wastewater quality could augment river flow and improve abstraction potential.
    - Transferring abstraction from unsustainable to more sustainable locations – e.g. by moving the abstraction point down-catchment to a location with greater flow.

- New supply options.
    - Develop new water resources.
    - Water trading outside of the water industry.

From this list we developed 206 initial options. These could all improve the supply/demand balance but had not been assessed for their feasibility, costs, benefits or environmental impact. The figure below illustrates how the options screening process was used.

Option screening process



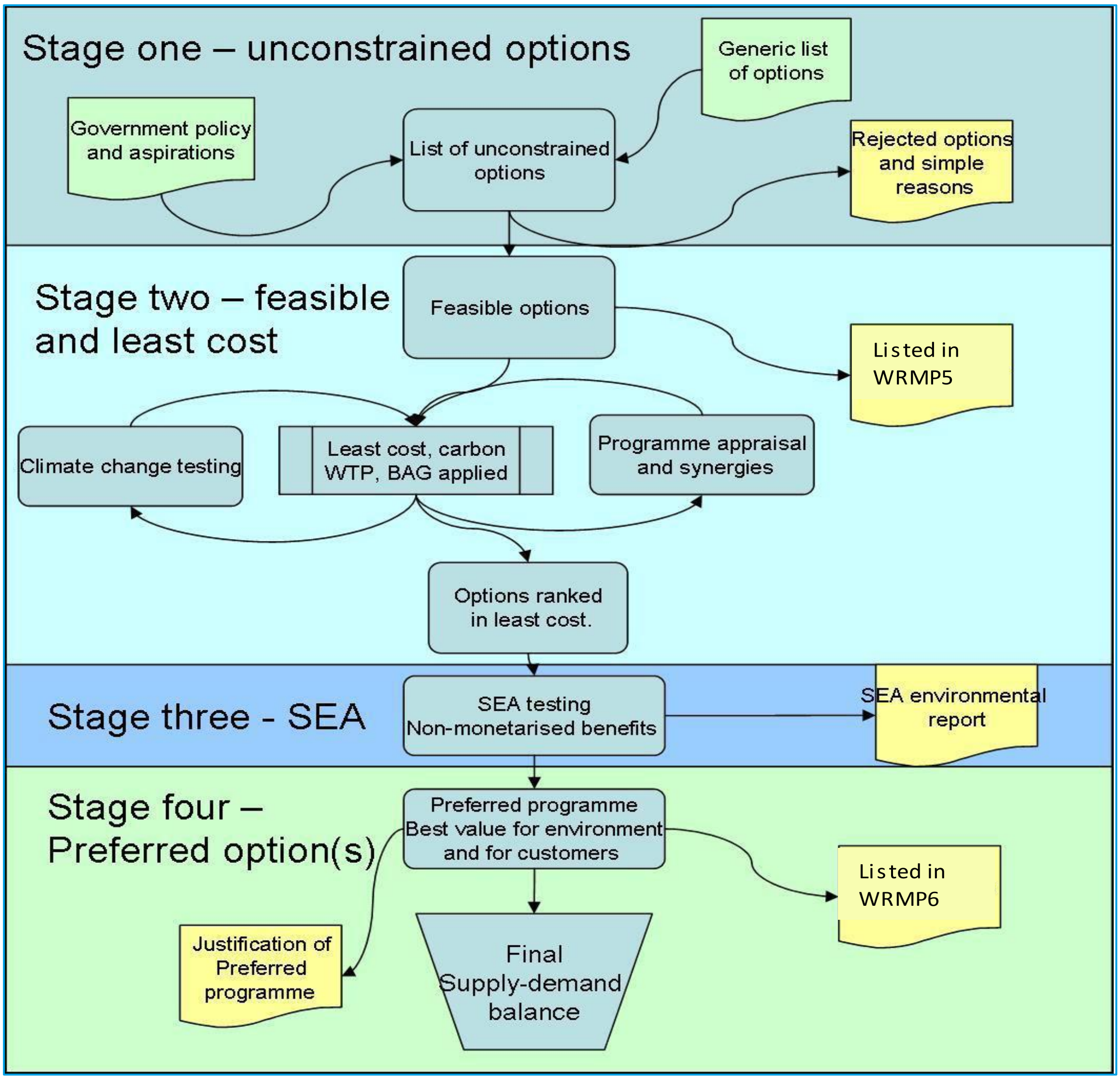
We investigated the feasibility, scope and costs of many tactical options

In line with the water resource planning guidance, the initial list of options was subject to outline feasibility assessment. We assessed the timing constraints of each option and the likely benefit to the supply/demand balance. Options that were clearly unlikely to be feasible were discarded.

We assessed the financial credentials of each feasible option, considering:

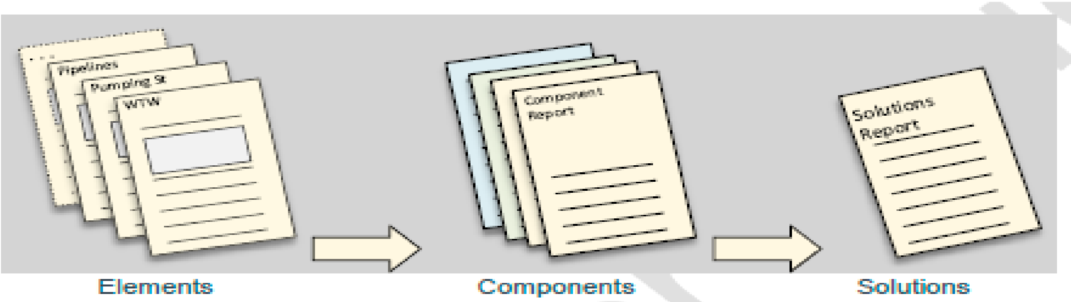
- Long-term totex.
- Willingness to pay for the option.
- Benefits of the option (following the benefits assessment guidelines).
- Climate change mitigation impacts including the cost of carbon.

The screened options were then suitable for detailed assessment and cost-benefit analysis. The figure below shows the main stages of our option appraisal process. The process includes a Strategic Environmental Assessment (SEA) of the options and overall programme, willingness to pay (WTP) studies and economic appraisal using tools such as the EA's benefits appraisal guidelines (BAG).



The focus of our options appraisal is a repeated assessment of costs, benefits and environmental impacts. We also considered the lifetime of each option, so that interim options could be used if necessary.

We developed a standardised process for detailed feasibility assessment, based on the common parts of each solution. In our planning approach, a *solution* is constructed from *components*, each of which may contain several *elements* as shown below.



Elements are standard items such as boreholes, pipelines, river abstractions, pumping, etc. (as shown in the figure below). Other elements were developed for non-standard items such as new resources, raising the height of a dam, water trading, etc. Elements are closely aligned to the cost assessment process, map to our unit cost curves and clearly identify items requiring bespoke cost estimation. This process helps to reduce cost uncertainty by allowing a level of confidence to be assigned to each cost. Our approach to categorising different cost elements has led us to develop a suite of solutions that are modular in nature, meaning that we do not need to commit to very long term construction projects and we can adapt our plan as necessary over time.

Element Allocation	Pipelines	River Abstraction	WTW	Pumping	Borehole	Quarry	Dam	Not allocated / Existing Asset

Where necessary we sub-divided elements to provide the granularity necessary for detailed high-quality estimates of the operating costs. For example, water treatment process costs may be:

- Non-variable operating cost – abstraction licence, bulk import availability fees, trading retainers, etc.
- Variable, dependent on flow – power, sludge recycling, disinfection, ozonation, organics removal, metals removal, plumbosolvency treatment, UV treatment, etc.
- Variable, dependent on asset size but not flow – staffing, water quality analysis, hired and contracted services, routine inspection and maintenance, GAC regeneration.

Our costs include an allowance for the contractor's design fee so that we have a design-and-build estimate. We have included our own staff costs to procure and manage the project, ensuring that customers are protected by adequate supervision of the whole process. A small allowance for optimism bias is based our experience of the tender-to-outturn ratio of similar activities.

The cost of each option is the sum of costs of the relevant components, which are themselves the sum of their elements. Our approach has given a detailed build-up of costs with each estimate making best use of standard cost data and our own delivery costs.

The outputs from this costing exercise were then used in our investment optimisation scenarios to generate potential supply/demand investment programmes.

We optimised investment at the programme level

Section 8.6 describes the advanced modelling techniques that we have used to build the optimal mix of long term supply and demand investment. Our modelling allows us to combine the costs and benefits of mains renewal, leakage reduction, demand management, metering, and options to increase our supply capability.

Our water infrastructure supply demand investment model (WISDM) is a non-linear optimisation tool that allows us to test very long term, holistic investment decisions. It can apply intermediate and advanced elements of the UKWIR economics of balancing supply and demand (EBSD) methodology[14]. We have further upgraded WISDM's decision optimisation engine since PR14, and our ongoing engagement with other companies and consultancies who focus on asset management lead us to believe it retains its industry-leading status.

We have engaged with a wider range of partners to develop strategic transfers (imports and exports)

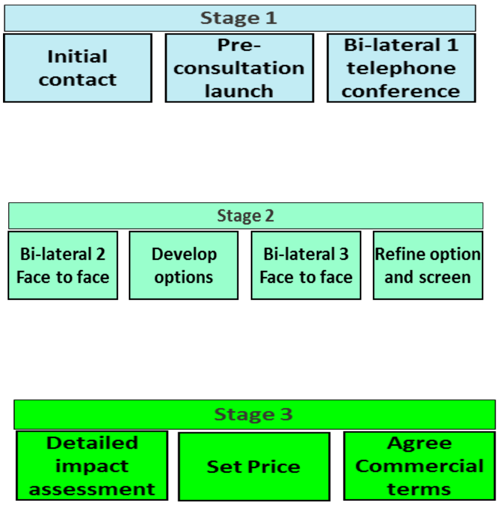
We have actively participated in all regional working groups and national studies as part of developing our WRMP and as a result have been able to use this work to feed into our PR19 proposal.   Our activities include:

- **Water Resources East**; we have helped shape the modelling process and offered seven transfer options into the options process.
- **Water Resources South East**; we participated in the steering group to ensure that the Severn to Thames Transfer scheme was appropriately represented in the WRSE models.
- **Water Resources North**; we are founder members and have brought our experience in developing our own trades and membership of other groups to form the terms of reference.
- **West Country Water Resources Group**; we are helping to shape opportunities for transfers
- **WaterUK Water Resources Long Term Planning Framework** (WaterUK); members of the steering committee.
- **Preparing for a Drier Future (National Infrastructure Commission)**; peer review of some technical elements.

This work has led to us reviewing 30 viable import and export opportunities to help our deficit issues and the deficit issues of others. We have proactively investigated opportunities to trade or share water resources with third parties (see figure below) and have met with our neighbouring water companies and potential suppliers from other sectors on a bi-lateral basis. We have worked within regional water resource initiatives to scope out and agree viable options. The 30 potential trades that we considered viable (i.e. cost effective) have identified import options of up to 354Ml/day and exports options to 475Ml/day (Annex 3). We assessed potential import options alongside our internal supply and demand side options and have taken an holistic view on imports and exports forming part of our overall best value plan. Where our best value or least cost plan options may impact the availability of water resources (committed or planned) for other water companies, we are working collaboratively with them exploring the feasibility and wider implications.

[14] UKIWR is the UK water industry's collaborative research body. The economics of balancing supply and demand methodology was developed with the water companies and the Environment Agency.

Three stage approach to identifying third party water resource options



Communicate need and opportunities
Using multiple channels to ensure the broadest engagement, we approached potential third party suppliers from inside and outside our region directly to inform them of the opportunity.

Develop technically viable options
We had constructive dialogues with interested parties, discussing need and capability before working up options and reviewing collaboratively to determine feasibility, costs and benefits

Agree options to pursue; outline commercial terms
Review shortlist options following least-cost modelling and explore commercial terms with our import and export partners.

Annex 3 shows some detail around key schemes we have investigated with Thames Water, Anglian Water, Yorkshire Water and united Utilities. Generally benefit, cost, timelines, environmental and logistical issues have been reviewed for each opportunity. A significant amount of work has taken place on the River Severn to River Thames transfer and, given the national importance of this scheme (recognised by the National Infrastructure Commission report '*Preparing for a Drier Future'*), we will continue to review the technical and logistical issues throughout AMP7 notwithstanding that it appears that it is unlikely to appear in Thames Water Final Water Resource Management Plan. The investment associated with this work is not part of this business case.

We have not stopped looking for opportunities after exhausting options with other water companies, we have gone beyond the water sector and have engaged with other third parties; Canal and River Trust, Coal Authority, Energy companies, Agriculture and industrial customers.   Opportunities are shown in Appendix 3.

We tested the robustness of schemes against a wide range of scenarios

It was very important to us to understand how sensitive certain investment decisions are to our supply and demand assumptions and uncertainties. We used scenario planning to investigate the impact of different development pathways on our conclusions about the supply/demand balance over the long term. We also explored how uncertainties around the costs, benefits and deliverability of our different options could affect our investment decisions.

We developed scenarios recognising that the pace of social and environmental change could differ from any single value used in planning. Scenario analysis allows us to understand how variations in the pace of change could affect the need for action. We developed 60 different supply/demand scenarios or 'alternative futures' from different combinations of climate change, environmental and demand planning assumptions that affect Water Available For Use (WAFU), demand and target headroom. We developed uncertainty analysis recognising that the assumptions about individual options are not fully certain. For example, there is uncertainty in the amount of leakage reduction that could be achieved per pound spent, or on the impact of metering. Uncertainty analysis allows us to understand the potential range of benefit that an intervention could deliver.

Our uncertainty analysis used multiple sampling of the cost and benefit uncertainty ranges. Each of the 60 scenarios was optimised with 100 uncertainty iterations, so that overall we carried out 6,000 iterations to solve all scenarios posed. Scenario planning allowed us to understand which interventions are most often preferred under the range of situations. They form the basis of an adaptive plan that works under the widest range of our tested futures. The pace and extent of climate change impacts is an area of great uncertainty and so we tested the effect that alternative UKCP09 derived climate scenarios had on the optimised plan. When we removed all climate change-driven needs, 21 of the 23 most frequently selected interventions were still selected.

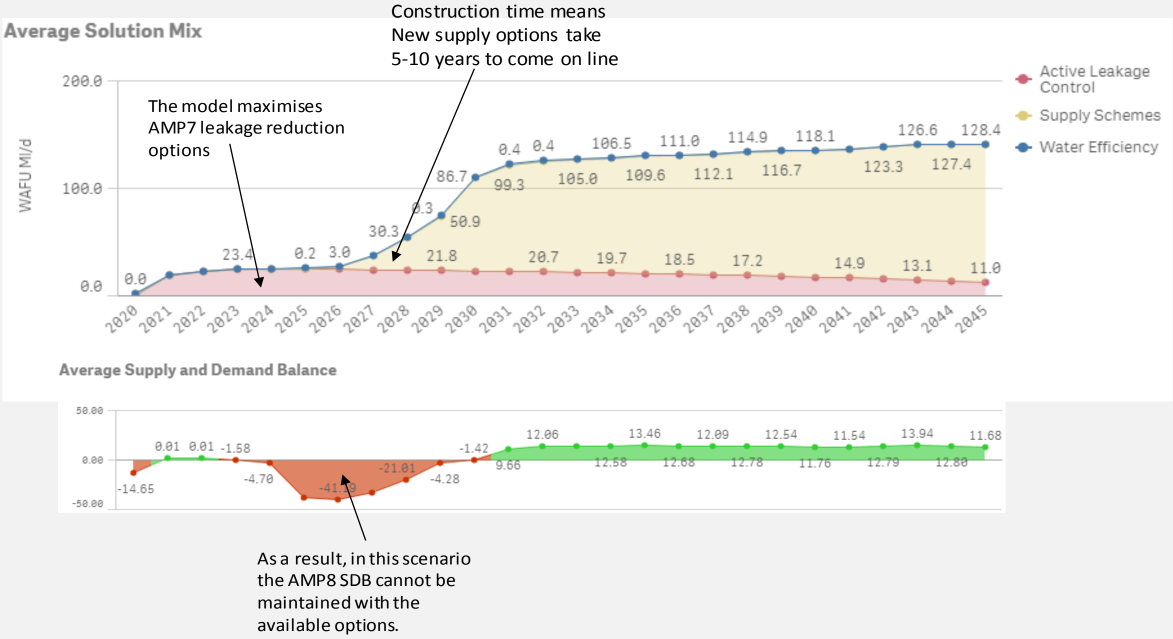
The outputs of this analysis informed the pace and magnitude of our chosen leakage and demand management targets, and tested how robust our supply /demand choices are in a range of possible futures.

Accelerating Water Framework Directive improvement would have increased cost and put supply at risk.
Making WFD abstraction licence reductions much more quickly would have put security of supply at severe risk, leading to very expensive short-term investment decisions. But if the changes were made over ten years, the whole life cost would be less and there would be much less risk to the security of supply.

Scenario testing showed that it would be preferable to stagger the abstraction changes needed to meet WFD and sustainable abstraction objectives in our strategic grid and Nottinghamshire water resource zones over a ten-year period.

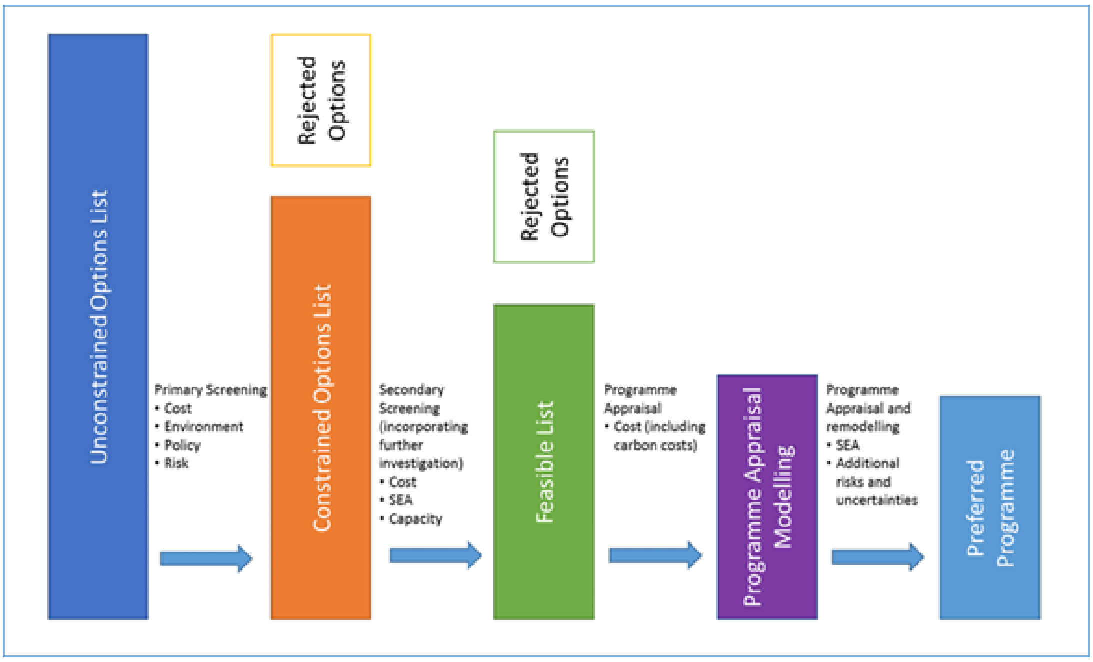
The figure below illustrates the outputs from an early sensitivity run that demonstrated the potential impacts of implementing the full extent of the potential RSA and WFD abstraction licence changes in the Nottinghamshire zone before the end of AMP7. The upper graphic illustrates the least cost mix of modelled investment solutions needed to meet the long term supply/demand balance. However, the middle graphic illustrates that the modelling found that AMP8 security of supply would be put at severe risk due there being insufficient supply intervention options or leakage options to close the supply/demand gap in such a short space of time (2024 – 2030). We used these model outputs to inform our decisions to stagger any abstraction licence reductions over the ten years of AMP7 and AMP8, focussing on the highest risk sites first.

Optimisation scenario showing the supply/demand impacts of implementing Nottinghamshire sustainability reductions in just one AMP.



We considered the social and environmental impacts of our different options

We followed national water industry guidance on applying strategic environmental assessment (SEA) to the development of our WRMP and thus this carried forward into our scheme options for PR19. Figure 30 summarises our overall approach to SEA, from the initial screening of the 'unconstrained' options through to the alternative programmes produced by the intervention modelling.



Our approach to SEA added detail as the options became more detailed from first identification through to detailed options. We considered both social and environmental criteria, including:

- Habitats Risk Assessment (HRA) and Water Framework Directive (WFD) compliance risks.
- Key risks to the water environment.
- Key risks to important landscape, recreation and heritage features.

Options with extreme adverse effects were rejected. The three shortlisted programmes from modelling were assessed for their environmental performance through SEA, HRA and WFD assessment. The findings helped us decide which of the three to adopt for our draft WRMP19.

We have recently trailed the use of natural capital appraisals and early results suggest we will embed this into our project delivery (detailed feasibility and design) processes notwithstanding that we have a long track record of installing solutions that offer natural capital enhancements whilst delivering the traditional needs of our customers. In the current AMP (across our whole investment programme) we are;

- delivering improvements to SSSIs,
- undertaking hydro-morphology improvements through river restoration work,
- delivering aquifer improvement work,
- constructing reed beds to delivering our WFD obligations,

- installing Sustainable Urban Drainage Systems,
- working with farmers to reduce their impact on the environment and
- constructing wetlands.

However our traditional appraisal tools used at a project detail level do not help us assess the full impact of these solutions, albeit that WiSDM helps with outline assessments). Generally in the past we have not sought to appraise the enhancement value associated with these type of investments, nor the wider natural benefits any of our investments may create over and above the principal benefits we are seeking to achieve (such as WFD improvement). Natural capital appraisal tools should help us do this in future and thus help us make more balanced decisions and we have been using the services of a specialist independent supplier in this area to help us. We are in discussions with them to understand how we can upskill our engineers to undertake this work as a matter of routine.

To date we have looked at the following appraisal tools to help us beyond the level of planning we are at today;

- The 'EA's natural capital tool' for assessing the appropriate costs and mitigations following pollution events.
- The 'Water Appraisal Tool' (which the EA use for WFD assessments) to augment our cost-benefit assessment of catchment management interventions.
- The 'UKWIR Tool' on a number of case studies (Sutton Park post pollution, Waterside Care etc). Phase 1 has been released – scope for Phase 2 being assessed.
- The B£ST Tool to set incentives for our bespoke sustainable drainage ODI for AMP7 to better value the natural capital of SUDS features in the community.

In AMP7 we will be undertaking a natural capital stocktake on all our major sites which will allow us to benchmark improvements across the Company, across the AMP.

We are proposing a step up in meter coverage across our region

Our customer research clearly shows that customers support more metering. At our Deliberative Workshops they expressed clear views that have helped shape our plan. Customers fed back to us that metering, in their experience, encourages behaviour change, through more personal responsibility and creates the opportunity to save money. They have told us they strongly support interventions that encourage responsible use of water, are sustainable in the long term, offer value for money and are good for the environment. When presented with the options to help manage the supply-demand challenge metering was the most favoured intervention. Customers also told us that metering is fairer and in line with other utilities they receive and pay for. At the deliberative research workshops customers also recognised the benefits metering can provide to us in terms of as we get a more accurate picture of usage and it will help us identify leaks.

Customers with meters have told us they use water more responsibly than prior to a meter. Our previous Water Resource Management Plans have set out an ongoing approach to household metering that has been led by customer demand for the free meter option. As a result, only around 41% of households in our region currently pay by meter. Our last WRMP projected that this would grow to around 70% by 2040 based on our current metering policy. Clearly this does not meet the expectations of our customer today.

We have described our ambition to achieve a step change in leakage reduction and demand management, and we believe that metering will play a crucial role in enabling that ambition. Experience reported by Southern

Water, Thames Water and Affinity Water during AMP5 and AMP6 suggests significant demand reductions of between 8% and 16.5% can be achieved as a result of large scale metering roll out as well as a 10% reduction in peak demand. This investment proposal is dependant, in part, on us delivering a more customer focussed metering plan.

We have explored a range of metering growth strategies that could accelerate the pace of meter coverage. Options included:

- continue current free meter optant programme,
- change of occupier metering,
- proactive metering and,
- compulsory metering.

Maintaining historic growth strategies would not support our ambition to proactively help customers reduce demand for water or support our leakage reduction targets. Our Change of Occupier initiative in AMP5 experienced high abort rates (refusal of fitting, refused access and missed appointments) and subsequently high costs. Although not directly assessed, compulsory metering would mirror our proposed proactive metering programme, with the difference being customers would be forced to adopt measured charges rather than our proposed approach for 'persuaded optants'. We do not currently have the power to implement a compulsory metering programme as we are not classified by the Environment Agency as a seriously water stressed area.

When developing options we assessed different delivery profiles, with the recommended approach being a scale up through AMP7 targeting deficit areas. Accelerating meter installation during AMP7 with options with an ambition to get to full meter coverage by the end of AMP9 (we recognise the challenge around this but note the planning horizon available – in particular we expect the final element of our ambition to be most difficult to achieve so we will develop a comprehensive monitoring plan to ensure we are on-track to deliver this. Aspirationally our metering plan is no different from other multi-AMP plans where we don't have the full delivery tactics because it is simply too early to establish these – innovation will be required to achieve our 100% ambition, non-intrusive clamp on meters and ultra-sonic flow meter technology may develop to allow us to install in currently un-meterable properties. As a company we believe we have a track record of delivery with similar challenges e.g. committing to deliver Low 'P' effluent before technology was proven).

Notwithstanding the learning from other water companies we are currently initiating a trial to help us fine tune our AMP7 implementation tactics and prepare for the significant increase in metering activity – particular areas of focus are; demand impact, communications, meter and meter reading technology, leakage impact, meter location and existing pipe material 'hot spots'.

Based on the benefits reported by other companies, we believe that achieving full meter coverage could deliver up to an 80Ml/d demand benefit. Our current thinking is that to secure the full 80Ml/d reduction would require us to adopt an external metering policy and combine this with a policy of helping customers tackle supply pipe leakage on their properties.).

Given the views our customers have expressed (fairness, responsibility, leakage, behaviour change) and our learning from other companies as well as our own, we are intending to implement a 'persuaded optant' strategy in AMP7 - installing meters proactively and offering customers the opportunity (but not forcing) to switch based on information on what their measured bill would be.

We will follow an area by area approach, targeting the water resource zones with the greatest supply/demand deficit (Notts, North Staffs and Strategic Grid). This will complement our longer term plans for new water source development, as we want to (and will need to demonstrate to planners and regulators that we have) fully explored options to manage water demand before we seek to develop new sources of water.

As a result of this metering policy change, we expect the rate of meter coverage to accelerate in AMP7 and we aspire to achieve full coverage by the end of AMP9 (although as noted above we do not have the full tactics developed for this yet). We have considered the cost / benefit implications of a range of metering delivery profiles, and we have tested different options for increasing the pace of delivery and for prioritising which zones to focus on. The expected meter coverage that our recommendation will deliver is set out in the table below

Household meter installations and coverage per AMP

		AMP7	AMP8	AMP9	AMP10
Current metering policy	Number of meter installations	147,878	134,619	122,549	111,560
	%age of households metered by end of AMP	55%	60%	65%	69%
Recommended new metering policy	Number of meter installations	493,765	771,313	428,030	0
	%age of households metered by end of AMP	65%	88%	100%	100%

We expect the increase in meter coverage to deliver an average demand saving of around 10Ml/d by the end of AMP7. This is based on an assumed realistic (taking on board lessons from others water companies) consumption saving of around 10% and includes benefits from finding and fixing leaking supply pipes. To maximise the supply pipe leakage reduction opportunity we are proposing to install meters externally at the property boundary.

However, we believe that there are wider demand management benefits that will result from increasing metering coverage, especially if we target the delivery on a geographical basis. In particular, we view the need for increased meter coverage to be a crucial enabler to delivering our very ambitious leakage reduction strategy – decoupling the two ambitious initiatives we have will cause a significant challenge for us as they are interlinked.

By increasing the number of metered properties on our network, we will have greater visibility of changing water demand patterns and better control of our network performance. This will make leaks easier to detect, and will mean we are able to deploy leakage repair more effectively and efficiently. A further advantage gained from our roll out of metering at the customer boundary will be the identification of remaining lead pipework both in our network and customers supply pipes, providing the opportunity to advise customers as appropriate.

Exploiting further multiple benefits in the future (to maximise cost benefit)

Improvements are needed to replace the output from unsustainable sources of abstraction, accommodate the potential impacts of future climate change and to give us the capability to meet future demand without putting the Water Framework Directive objectives at risk.

Broadly, the challenges around unsustainable abstraction mean that there is a need to reduce pressure on the groundwater bodies from which our borehole sources abstract. In the future, to prevent deterioration there can be no sustained increase in the amount we abstract from a number of our region’s groundwater bodies. As a result, our proposed improvements in supply capability focus on making more use of surface water sources of supply. The new schemes that we propose in this investment plan largely involve making more use of our existing river abstractions, our existing storage reservoirs and the treatment works that we use to deploy that water to avoid the need to develop new costly sources of water and the associated infrastructure. We also propose to enhance our strategic water distribution links so that we have more flexibility to move water around our system to the locations that need it most.

Our accompanying WRMP looks ahead over the next 25 years, and we recognise that there is increasing uncertainty over the scale and timing of some of our future needs. The actions we are proposing reflect the different degrees of confidence we have about our short, medium and long term supply / demand needs. The costs of delivering the schemes needed to meet our supply / demand needs over AMP7 and into AMP8 directly inform this PR19 business case.

We are confident that the schemes we are proposing for the AMP7 period will be needed to meet the environmental challenges of reducing unsustainable abstraction and ensuring our existing sources do not cause future environmental deterioration. We also understand which schemes are needed to accommodate the potential impacts of future climate change. The table below summarises the new water supply schemes that we propose to deliver over the five years 2020-25 actedas the first phase of our long term water resources strategy. These schemes all involve making better use of existing, sustainable sources of supply and enhancing our ability to deploy this water.

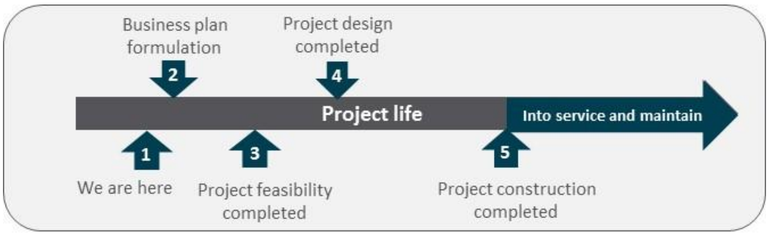
New supply and transfer schemes

[figure REDACTED]

Looking further ahead, there is less certainty about the scale and timing of when additional new supply capability is needed. We are proposing further investment in new supply capability for the period 2025-45 to address these long term challenges, and to cope with future uncertainty. The nature of these longer term solutions is to try to make use of existing water supply assets, and to focus on innovative and sustainable use of surface water supplies. This business case includes the early feasibility and design costs of these longer term solutions to improve our understanding of any associated environmental, delivery risks and have them ready for implementation at PR24 and beyond.

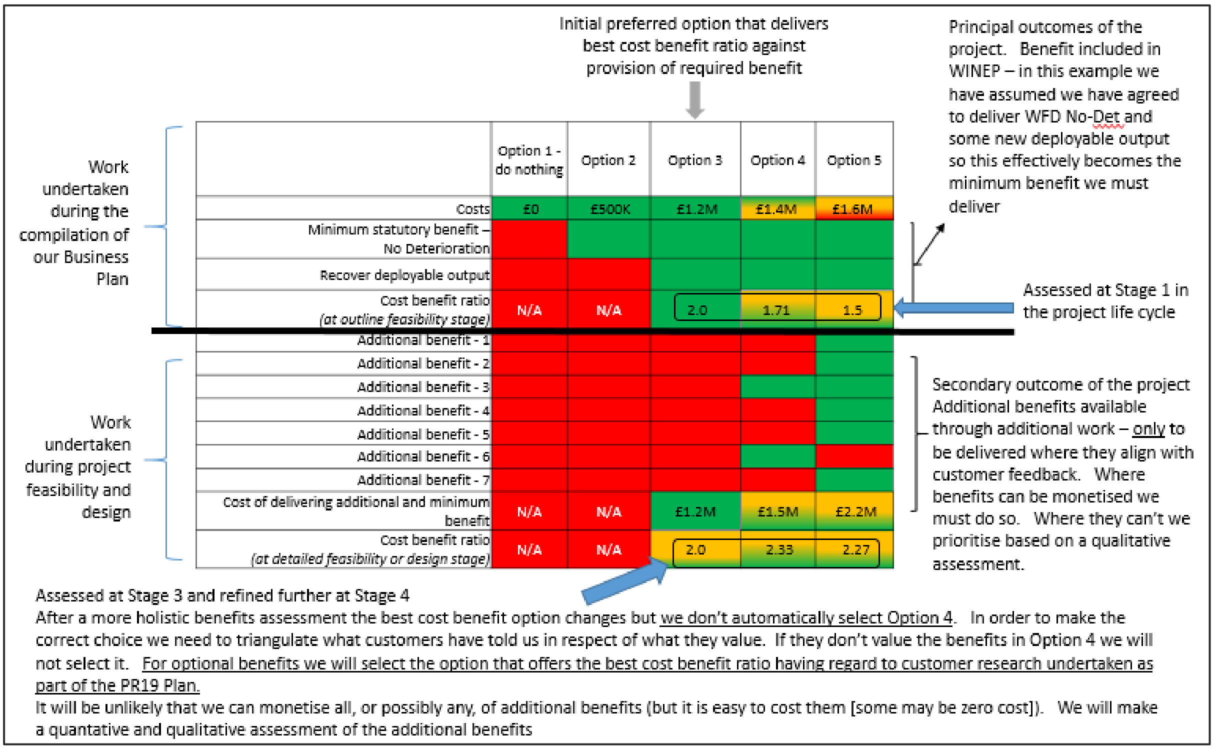
Our process for exploiting more benefits in the future (to maximise cost benefit)

We have actively sought to deliver customer benefit through the work we have done in the planning and optioneering process to date. Notwithstanding this extensive broad review of primary and secondary benefits we recognise the work we need to undertake in the future will offer further opportunity to refine our thinking. We are confident that there will be more optional benefits we can exploit as we progress further through the project lifecycle. We are currently at stage 1 of the project lifecycle, indicated in the figure below.



At this point, we've undertaken cost benefit assessments to which ensure we deliver the minimum benefits under the principal driver. This is illustrated at the **stage 1** point in the figure below.

We will have the opportunity to find further benefits as we progress through the project lifecycle



	Option 1 - do nothing	Option 2	Option 3	Option 4	Option 5
Costs	£0	£500K	£1.2M	£1.4M	£1.6M
Minimum statutory benefit – No Deterioration					
Recover deployable output					
Cost benefit ratio *(at outline feasibility stage)*	N/A	N/A	2.0	1.71	1.5
Additional benefit - 1					
Additional benefit - 2					
Additional benefit - 3					
Additional benefit - 4					
Additional benefit - 5					
Additional benefit - 6					
Additional benefit - 7					
Cost of delivering additional and minimum benefit	N/A	N/A	£1.2M	£1.5M	£2.2M
Cost benefit ratio *(at detailed feasibility or design stage)*	N/A	N/A	2.0	2.33	2.27

As we progress the detailed feasibility we may uncover other benefits for example those associated with the wider environment or wider societal benefits (natural and social capital). However, as these secondary outcomes and additional benefits remain optional under the principal driver for this investment, we will only liberate them subject to alignment with our customer research. Where we can, we seek to monetise these and bring them into the financial option analysis. In the example above:

- Option 1 does not achieve the minimum requirement so is rejected.
- Option 2 achieves the minimum statutory requirement but does not deliver full deployable output.
- Options 3 achieves minimum statutory requirements and goes further and recovers full deployable output.
- Option 4 achieves minimum statutory requirements and goes further by improving the environment through habitat enhancement work.
- Option 5 achieves minimum statutory requirements and goes further by improving the environment and delivering some amenity improvement at reasonable cost.

We therefore have options to pursue Option 3, 4 or 5. Given the value our customers place on the natural environment, we would seek to do more where we can - so we would pursue Option 5. However, we would only do this where the option continues to be cost beneficial and but does not become disproportionately expensive (and unaffordable) - as customers have told us they are concerned about bill impact and therefore in this illustrative example we may actually choose Option 4.

Throughout our work we have sought to integrate customers in shaping our proposals by listening to what they have told us and bringing those views into consideration. However we will have further opportunities for our customers to be involved in the delivery phase of the proposals themselves, particularly as we seek to identify additional (secondary) benefits and confirm which our customers' value. We will continue our research throughout AMP6 and AMP7 (using our 'Tap Chat' on-line community panel amongst others) and will test for customer preferences so we can better factor into our cost benefit assessments any secondary benefits. This work will represent a major step change in our approach to understanding and responding to customers in a much more dynamic and meaningful way.

8.7.2.5 Robustness and efficiency of costs

As outlined in Sections A8.1 and A8.2, we have set ourselves stretching efficiency targets across our plan.

You can read about this in Chapter 20 – Securing cost efficiency, where we've explained how we are planning to build on our strong AMP6 efficiency performance to deliver 13% efficiency on wholesale costs. We also conducted a number of external benchmarking studies to build and test the efficiency of our costs including construction contract costs, construction on-costs and support costs. The range of studies helped to ensure we avoided potential bias from not comparing costs on a like-for-like basis and, as we also repeated some PR14 benchmarking, provided a consistent analysis. The analysis proved to be an eye opener, helping us to find and prioritize specific areas of opportunity to build into our PR19 efficiency plans. We've summarised the results of our benchmarking analysis in Chapter 20, and have included the studies in this Appendix.

Delivering cost efficiency in Severn Trent Water

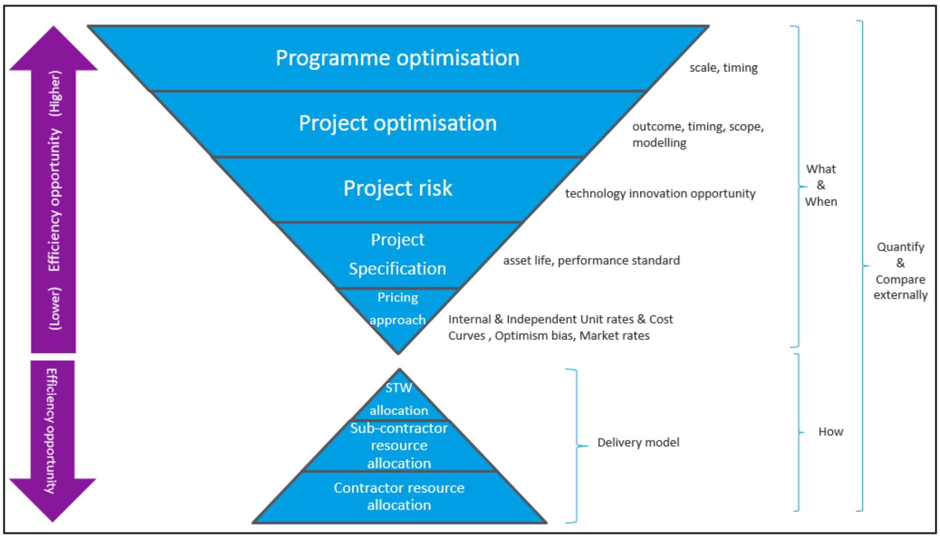
For this business case we have adopted a proportionate approach to risk and cost having regard to our customers' needs. They have told us that they think of value [of investments] in terms of 'effectiveness and spreading the cost over time and not the lowest cost option', so it is clear they have sophisticated expectations in this area. The linking of solution effectiveness, time and low cost, suggests to us that our customers expect:

- our work to be phased in such a way to avoid large changes in bills (wherever we can);
- solutions that do not deliver short term cost savings at the expense of long term cost increases;
- our solutions need to be reliable over time; and
- have an associated benefit stream that addresses the challenge sufficiently.

Our cost efficiency strategy seeks to deliver on all these expectations.

There are multiple strands to delivering cost efficiency as shown in the figure below.

Our model for delivering cost efficiency



The most significant savings exist when looking at the proposal from a programme position; scaling the investment proposal offers the most significant level of savings to our customers. In order to establish the appropriate scale of investment we have worked with our regulators to understand if investment needs actually exist or not. We have also sought to understand the optimal time to deliver any investment that may be required.

The work we have done with the EA has ensured we have reduced the scale of investment now by in excess of £100m. We have challenged the need on numerous water bodies and have confirmed with the EA that we will only invest at those sites where we there is a strong body of evidence to suggest that our activities are have a detrimental impact on the environment. We have secured the agreement of the EA to deliver these investments over a 10 year time line, commencing 2020 to ensure we can properly plan this long term complex infrastructure.

Where the impact of our activities on the environment is not clear we will be implementing a flexible, adaptive, low risk approach which allows us to scale up investment at some point in the future but only when the body of evidence is more compelling. We are doing this through our environmental investigation programme and our environmental prevention and mitigation programme. Again we have also secured agreement with the EA to deliver improvements, should they be necessary within a 10 year timeline commencing 2020. This will allow us to take the results of the investigations or the prevention and mitigation work and deliver any necessary solutions.

We have also looked at how we can optimise projects in terms of outcomes, timing and scope. Our modelling (WiSDM) allows us to optimise our selection of projects based on a range of options with varying levels of benefits (deployable output), costs and timing of projects (the scope within each option reflects the benefits sought). We are able to then review which projects are selected by WiSDM most frequently and these have been put forward in our plan so as to maximise the likelihood of success and minimise the risk of any abortive investment.

Project scope is selected according to the most optimal way of delivering the benefit in the particular project circumstances. Scope is determined by understanding the building blocks that will lead to delivering the benefits. We have then been able to select elements of work within projects and cost these using our cost tools. We have followed a structured approach to building cost estimates – this is contained in our 125page Cost Methodology Report. The scope also embeds the level of project risk we are undertaking and these grouped according to themes e.g. engineering risk, water quality risk, environmental risk, land/planning risk, construction. Technology innovation, where appropriate, is included in the engineering risk assessment – for example for our proposal at Church Wilne we have assessed the need for innovative Advanced Oxidation to manage the process security.

Finally we have sought to deliver multiple benefits beyond just achieving ‘supply demand’ benefits where they exist. This ensures that customers benefit from minimising scope whilst delivering maximum benefit across different programmes of work. The project proposed to address the supply deficit for Peckforton also provides resilience benefit to that area as well which we were planning to deliver through our Groundwater programme. The project proposed to address the supply deficit for North Nottinghamshire will also provide resilience benefit to that area as well which has negated the need to deliver resilience through our Groundwater programme.

The costs of the projects which have been selected and included in our Plan have been established through the use of the following estimating tools;

- STW cost curves established, updated and refined over the last 15yrs for similar activity;
- STW unit rates established, updated and refined over the last 15yrs;
- Cost data provided by an independent engineering consultant with specialist cost data sets;
- Best practice guidance on understanding and applying an appropriate level of optimism bias within our projects; and
- Market rates where they exist and can be applied to our work.

We have then tested the efficiency of these using an independent expert (Turner & Townsend) by;

- Benchmark testing a selection of representative projects;
- Benchmark testing a number of programme level costs e.g. feasibility fee, design fee, project support costs.

Cost efficiency benchmarking is set against the background of having secured programme optimisation and project optimisation savings such that they accrue in their entirety to Customers. On this programme of work we estimate that these costs are in excess of £100m capex.

The results of the benchmarking exercise are set out below;

Industry standard guidance on Optimism bias for typical projects contained in the Supply-Demand programme are 44%. We have reduced this by 36% following a review of component weighting following a review of what elements of uncertainty are not captured elsewhere – this has avoided double counting of risk and uncertainty.

A project containing elements of work that are replicated across the whole proposed programme has been tested for cost efficiency by our independent third party specialist cost expert (Turner & Townsend). This project contained; river intake enhancements, treatment works extension, pumping station and cross country trunk main.

[REDACTED]

8.7.2.6 Customer protection

Our long-term adaptive plan will deliver incremental change as the need arises. This approach is flexible and greatly improves the focus of investment. It ensures that customers do not pay for improvements to water supply until they are needed, but delivers quickly when required.

To give additional protection to customers given the uncertainties inherent in long term planning, our supply/demand investment plan are accompanied by a performance commitment and financial ODI focussing on supply capacity delivered. We will incur financial penalties if we fail to deliver against this commitment.

As described in section 1, 2 and appendix A8.3, we have used real options to reduce the expenditure in this plan, and developed a mechanism to invest in supply schemes should future deficits become more certain. We have also protected customers from potential under delivery of our ambitious AMP7 metering program.

Our optimisation has focused on the least cost way to maintain the short- and long-term resilience of our customers' water service. It controls the cost through good timing and with a series of iterative changes. It seeks synergies with other programmes, such as improving leakage control and metering, and meets customer demands for a fair allocation of costs.

The plan will benefit three outcomes:

- We will provide a thriving environment.
- Water is always there when our customers need it.
- Water that is good to drink.

We have taken care to ensure that our plan protects customers from unnecessary costs in three ways:

- Our adaptive plan minimises the risk of stranded assets.
- Our adaptive plan minimises costs to customers until the capacity is needed.
- We propose a performance commitment that reduces the cost risk to customers.

Our adaptive plan avoids the risk of stranded assets

Our adaptive plan includes proactive monitoring of changes in the supply/demand balance. If the balance does not change at the pace, or in the places, that we expect then we will not spend our customers' money. This has the advantage of removing the risk of building potentially expensive assets that are subsequently not required.

Our adaptive plan minimises costs to customers until the capacity is needed

Our adaptive plan invests just in time to protect the supply/demand balance. By adapting gradually, our customers only pay for capacity increases as they become necessary. We avoid the expense of a major new asset which would have to be paid for by our current customers, even though its capacity would not be fully utilised for some time to come.

We have a strong track record of delivering improvements for our customers

We have successfully delivered previous supply and demand improvements so that we continue to meet changing demand for water and preserve the security of our supplies. We have maintained our record of having no drought related water use restrictions since 1995-96 despite some challenging rainfall patterns since then.

Between 2010 and 2020 we will have reduced leakage by 72Ml/d (15%), and reduced water consumption by around 45Ml/d through our water efficiency programme. As well as reducing leakage, we have invested in new and improved sources of water to maintain the security of supplies to customers. Significant improvements include:

- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

We have also used other, innovative ways to improve the security of our water supply.

In 2015 we agreed to purchase 31Ml/d abstraction rights from a third party on the River Severn, for use at Trimpley water treatment works. This increases our strategic grid deployable output, drought resilience and operational flexibility. It defers the need for some of the planned water resources schemes outlined in our last plan. An abstraction rights trade on this scale had not been completed before in England and Wales.

Our ambitious catchment management programme is protecting our sources from pollution and improving 750km of rivers in our region. It supports our supply/demand plan by helping ensure reliable and sustainable output from our existing sources. We are engaging with 680 farms, covering almost 300,000 acres which impact on 38 water bodies.

We have achieved the Environment Agency's top 4* rating twice in last four years, and our water environmental programme is a key component.

We are also delivering an ambitious AMP6 environmental programme to improve over 115 water bodies, together with improving the condition of 75 hectares of SSSIs. We are removing or reducing the impacts of our abstractions on river ecology, to improve 258km of river reach. We are carrying out our largest ever programme of Restoring Sustainable Abstraction investigations, covering 37 of our abstractions (29 groundwater and 8 surface water), which provide up to 191 Ml/d of current abstraction.

Our supply/demand investment plan builds on our track record, but includes a further step change in our ambition to respond to the increasing water supply challenges.

Notwithstanding this, we recognise the size of our AMP7 programme means delivery will be challenging. Customers will be protected from the risk of under-delivery by either statutory enforcement action (where schemes are mandatory) or in the case of water supply demand improvements to which our cost adjustment claim relates, a performance commitment.

We are proposing a performance commitment that reduces the cost risk to customers

Our performance commitment will ensure that customers receive value for money, regardless of the uncertainties caused by the water resources management planning legal process.

- Early investment has more certainty than the longer-term adaptations and we are confident that the majority of interventions proposed for 2020-2025 will go ahead;
- If interventions are delayed or cancelled, customers will not pay for them;
- If interventions cost more than we expect, customers will not pay extra; and
- If interventions cost less than we expect, we will share the savings with customers.

The definition of our proposed performance commitment is included in Appendix 3.

Our Water Forum has reviewed, and not raised any concerns with, our proposed approach to customer protection.

8.7.2.7 Affordability

We have carefully considered the affordability implications for our customers. Where we have discretion over pace (the 12-year Water Framework Directive improvement programme), we have sought to phase improvements so that we balance affordability needs in each AMP with delivering the 12-year programme as efficiently as possible (using the right solutions at the right time). We have sought to deliver an affordable plan by only investing at known problems while securing Environment Agency agreement to investigate only (not invest) where the problem is uncertain. We are phasing our investment across AMP7 and AMP8 to ensure bill impact is minimised where we can.

We have carefully considered the affordability implications of our supply demand proposals, and sought to drive down scope and cost wherever possible.

As our plan has developed, we have engaged with the Water Forum about the balance of priorities, the extent of the efficiency challenge and the overall implications to the bill. We have tested the overall plan with customers in our acceptability research. The results of this are presented in Chapter 7 – Addressing affordability and vulnerability, and appendix A2.

Our integrated plan will deliver our statutory obligations as well as meeting our customers' and stakeholders' needs. We considered a wide range of options from 'do nothing' through to major new resources. Our modelling included various levels of leakage reduction, metering, new resources, and modifications to the network. We also included education, local environmental improvements, and more detailed investigations into different ways of achieving the Water Framework Directive objectives.

Our plan will benefit customers in several ways:

- An affordable plan that develops our resources and networks only as the need arises;
- Addressing multiple challenges with the minimum change to our water resources and network;
- A plan that is based on our best available information, but that allows us to adapt our approach as we gain better evidence and understanding over time, meaning that we avoid unnecessary expenditure; and
- A plan that keep pace with change, so that water is always there when our customers need it.

Each of the benefits is summarised below.

An affordable plan that develops our resources and networks only as the need arises cognisant of the implications for customers' bills

We will use demand management measures to partially offset resource reductions and climate change impacts. Demand management will reduce the amount of water we put into supply and hence mitigate the need for increasing abstraction. It also brings environmental benefits and satisfies the customer wishes to focus on responsible use of water.

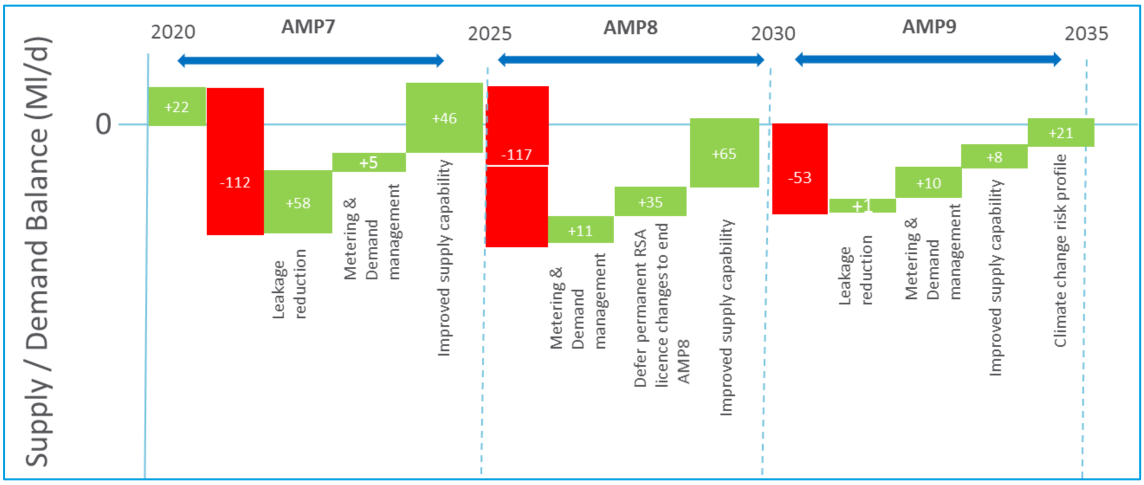
We will further reduce leakage on our network, helping to offset the impact of resource reductions and climate change. Innovation will play a major part, as we seek to deliver a step change in leakage detection and repair costs, reducing leakage to our lowest-ever levels.

We will reduce the need for new sources by:

- Increasing or optimising deployable output from sustainable sources.
- Increasing the flexibility of our supply system.
- Restoring the environment of some catchments to make them more resilient to low flow.
- Using catchment management to protect existing sources from pollution risk.
- Exploring water trading to optimise the use of water resources.

Where new resources are required, our phased investment will smooth the impact on bills and protect customers from uncertainty. The graph below illustrates the example of how our sequenced investment will address the needs in the Strategic Grid zone as they arise. The graphic is illustrative and shows AMP by AMP how we have phased our cumulative interventions to address the expected supply/demand deficit as it emerges.

Our phased intervention plan for one of our resource zones (Strategic Grid) balances demand-side and supply-side action only as the need arises.



A plan that keeps pace with change so that water is always there when our customers need it

Each of our proposed interventions can be delivered within a 3-10 year timescale. Our plan is being developed into a fully adaptive pathway so that it can be revised as the future unfolds.

Our programme of monitoring water resource zones will show how demand is progressing compared with our forecasts. We will be able to accelerate, hold back, or change our plan in line with actual developments. This adaptive approach provides security of supply whilst avoiding the need for a major new construction in the medium term.

Because we have tested multiple alternative supply/demand futures through our investment optimisation modelling, we have a good understanding of what our alternative plans would look like, and what our preferred alternative options might be. Our approach gives us the flexibility to change our plans over time, and we do not need to commit in AMP7 to individual large-scale schemes that will take multiple AMPs to deliver.

We'll review affordability again in the context of our overall plan

We have carefully considered the affordability implications of our water supply demand programme, and sought to drive down scope and cost wherever possible.

We have not submitted a request to the Environment Agency for elements of WINEP3 to be phased across AMPs 7 and 8. Phasing delivery of WINEP3 is likely create affordability and delivery pressures in early AMP8, given the WFD backstop date of 2027. This is not to downplay the challenging programme contained in our WINEP3 list of obligations, but we recognise that phasing is unlikely to address any affordability risks in the long run.

A key reason for not asking for a phased approach to WINEP3 is that we are already anticipating a need for further water supply demand investment in early AMP8. We have already worked with the Environment Agency to develop a phased plan across AMP7 and AMP8 based on where there is high confidence of investment needs, environmental priority and where investigations are required to prove if intervention is required and, if so, what the best course of action would be.

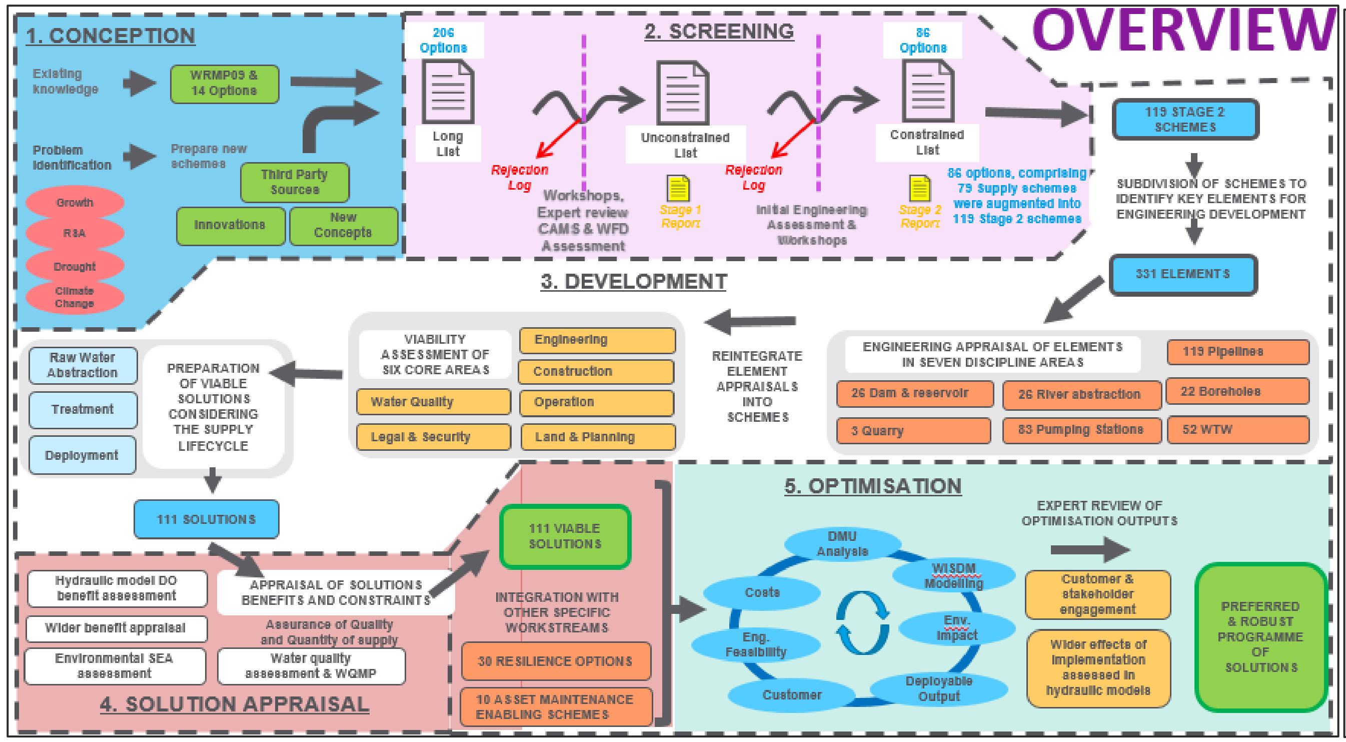
8.7.2.8 Board assurance

Working with Pricewaterhouse Coopers, we designed a bespoke assurance framework to support the development of our plan to the highest quality. This Board-led framework builds upon our well-established and robust annual assurance processes. Each 'building block' within our plan was assessed for 'bottom up' risk to include the individual components (e.g. data/source, methodology, judgements and assumptions) against our likelihood factors (level of change, complexity, roles and responsibilities and subjectivity) and our impact factors (financial value, customer impact, competition, statutory/regulatory requirement).

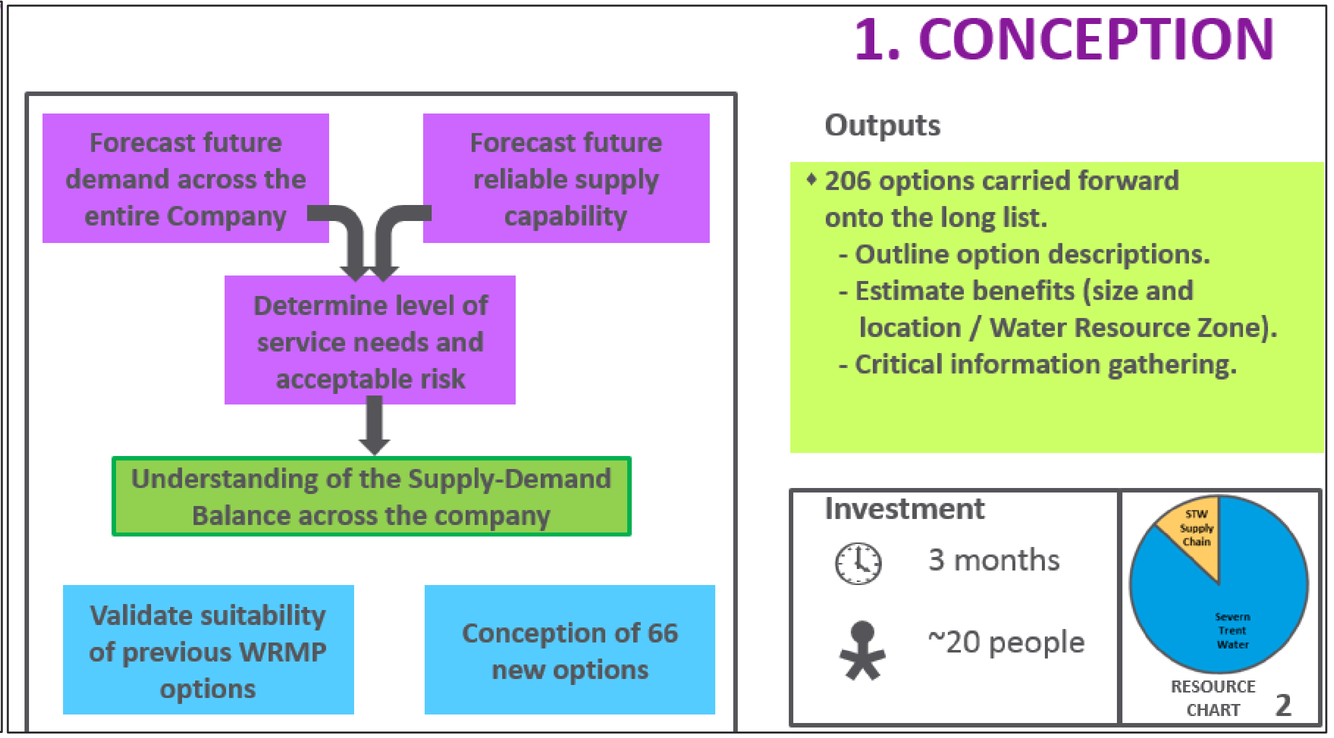
The level of risk determined the type and level of assurance required with significant or high risk building blocks allocated to an independent third line assurance provider depending on the particular expertise required (technical/regulatory, financial, specialist model expertise etc.). This framework was applied to our cost adjustment claims which were assessed as high risk and therefore were assured through all three lines of assurance. Assurance was undertaken in stages and took account of costs, the need for the claim and testing of solutions. For more information on how we developed and applied our framework to our cost adjustment claims and the findings of the assurance, please read our ‘securing trust, assurance and confidence’ chapter and supporting appendix.

Annex 1: Scale of activity undertaken, option analysis (excerpts only as full list is too extensive) to develop this business case and simplified process and activities

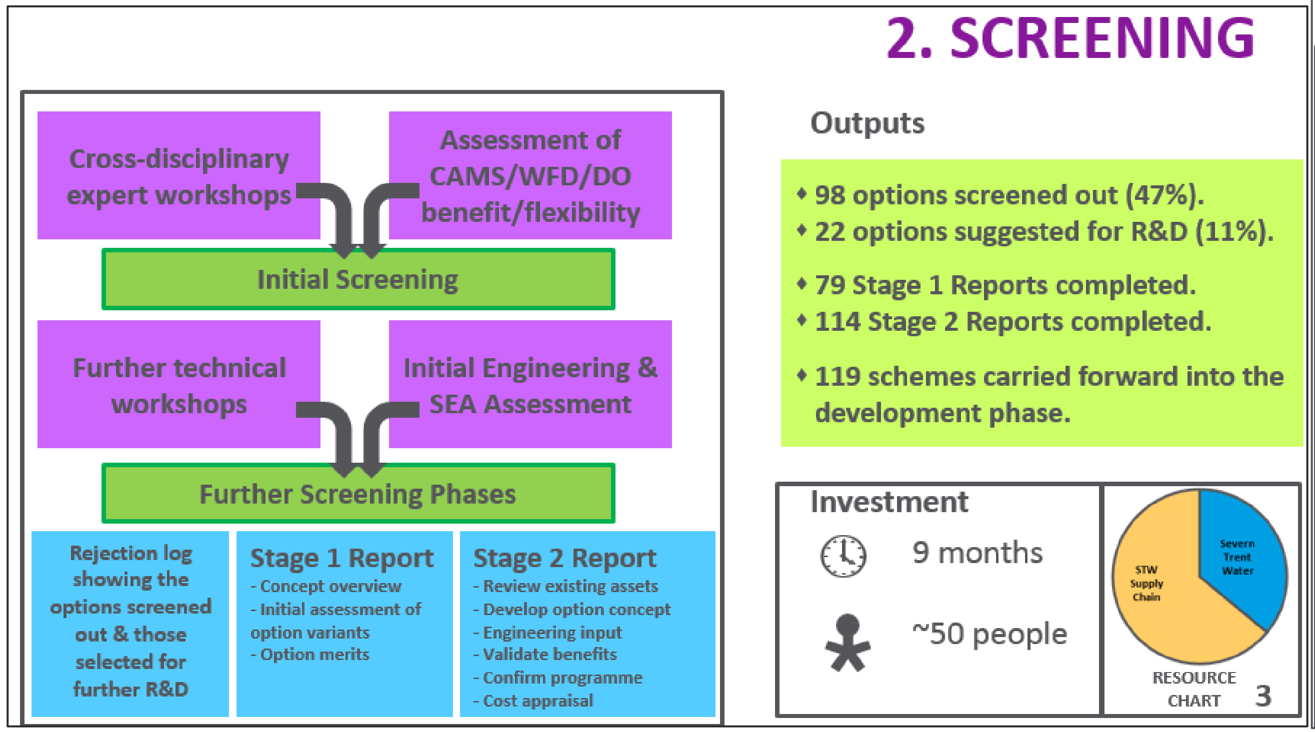
[REDACTED]



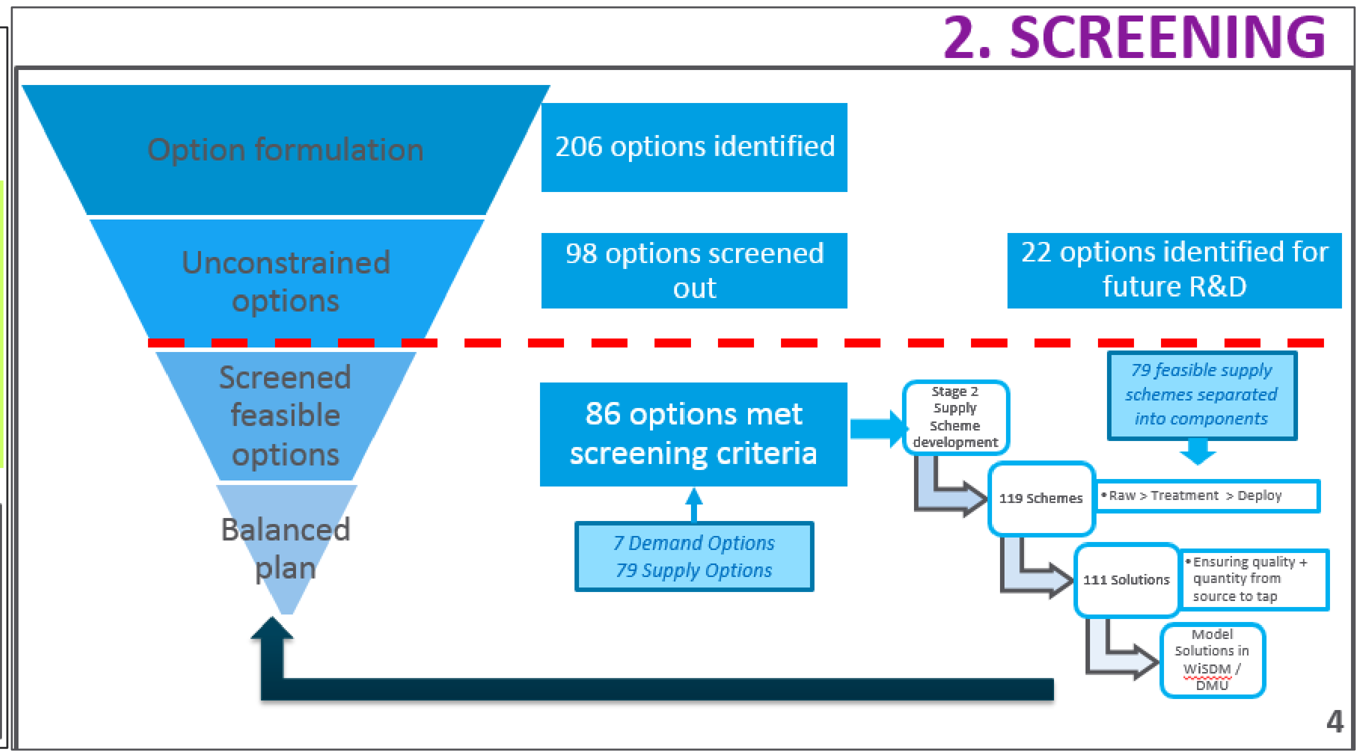
OVERVIEW
1. CONCEPTION
Existing knowledge
WRMP09 & 14 Options
Problem identification
Prepare new schemes
Third Party Sources
Innovations
New Concepts
Growth
RSA
Drought
Climate Change
2. SCREENING
206 Options
Long List
Rejection Log
Workshops, Expert review CAMS & WFD Assessment
Unconstrained List
Stage 1 Report
Initial Engineering Assessment & Workshops
86 Options
Constrained List
Stage 2 Report
86 options, comprising 7 demand and 79 supply schemes were augmented into 119 stage 2 schemes
119 STAGE 2 SCHEMES
SUBDIVISION OF SCHEMES TO IDENTIFY KEY ELEMENTS FOR ENGINEERING DEVELOPMENT
331 ELEMENTS
3. DEVELOPMENT
ENGINEERING APPRAISAL OF ELEMENTS IN SEVEN DISCIPLINE AREAS
115 Pipelines
26 Dam & reservoir
26 River abstraction
22 Boreholes
3 Quarry
83 Pumping Stations
52 WTW
REINTEGRATE ELEMENT APPRAISALS INTO SCHEMES
VIABILITY ASSESSMENT OF SIX CORE AREAS
Engineering
Construction
Water Quality
Operation
Legal & Security
Land & Planning
PREPARATION OF VIABLE SOLUTIONS CONSIDERING THE SUPPLY LIFECYCLE
Raw Water Abstraction
Treatment
Deployment
111 SOLUTIONS
Hydraulic model DO benefit assessment
Wider benefit appraisal
Environmental SEA assessment
APPRAISAL OF SOLUTIONS BENEFITS AND CONSTRAINTS
Assurance of Quality and Quantity of supply
Water quality assessment & WQMP
4. SOLUTION APPRAISAL
111 VIABLE SOLUTIONS
INTEGRATION WITH OTHER SPECIFIC WORKSTREAMS
30 RESILIENCE OPTIONS
10 ASSET MAINTENANCE ENABLING SCHEMES
5. OPTIMISATION
DMU Analysis
WISDM Modelling
Costs
Env. Impact
Eng. Feasibility
Deployable Output
Customer
EXPERT REVIEW OF OPTIMISATION OUTPUTS
Customer & stakeholder engagement
Wider effects of implementation assessed in hydraulic models
PREFERRED & ROBUST PROGRAMME OF SOLUTIONS



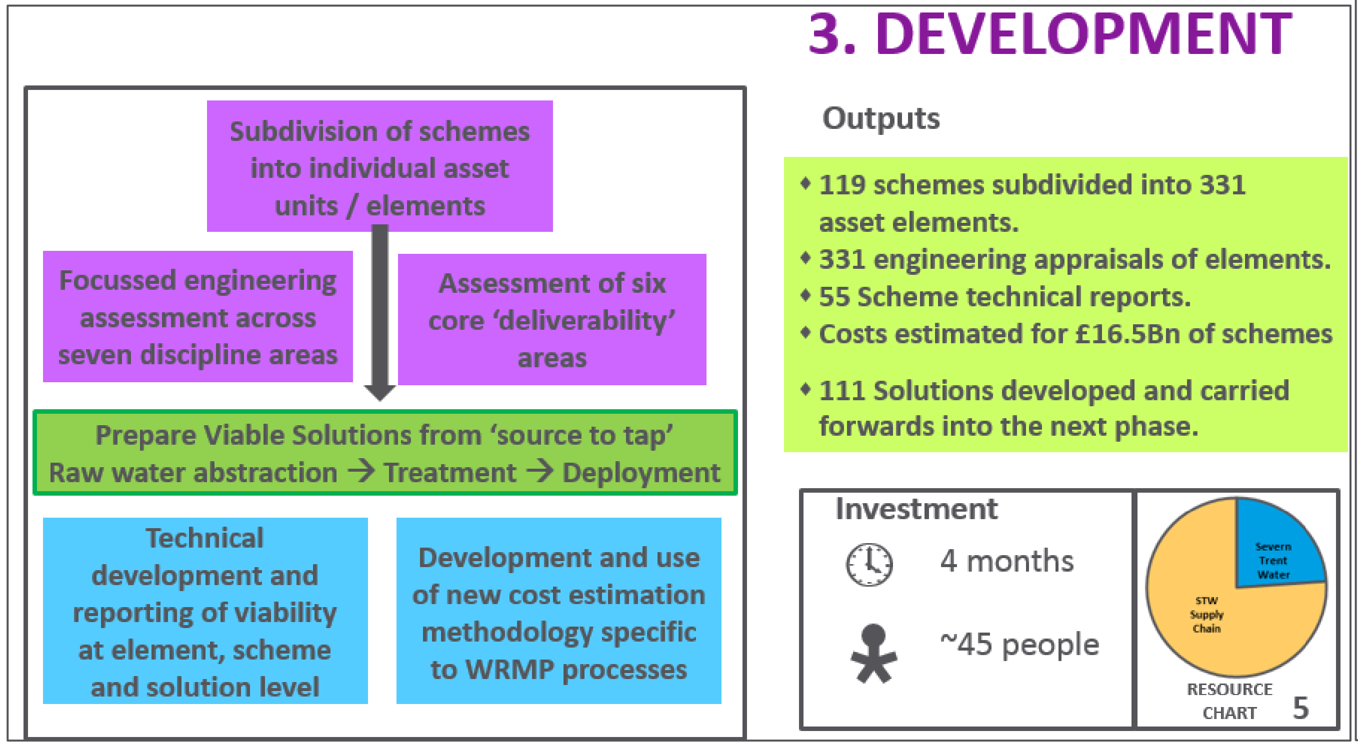
1. CONCEPTION
Forecast future demand across the entire Company
Forecast future reliable supply capability
Determine level of service needs and acceptable risk
Understanding of the Supply-Demand Balance across the company
Validate suitability of previous WRMP options
Conception of 66 new options
Outputs
• 206 options carried forward onto the long list.
- Outline option descriptions.
- Estimate benefits (size and location / Water Resource Zone).
- Critical information gathering.
Investment
3 months
~20 people
STW Supply Chain
Severn Trent Water
RESOURCE CHART
2

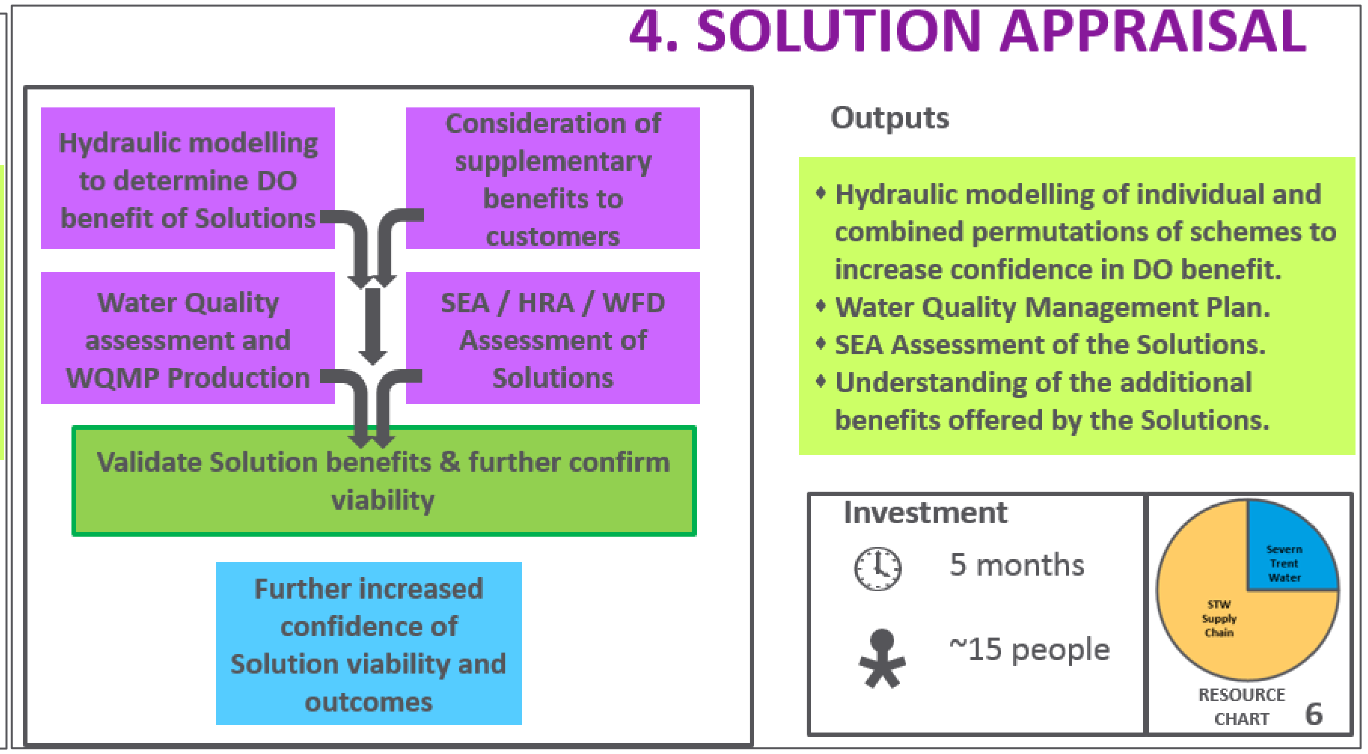


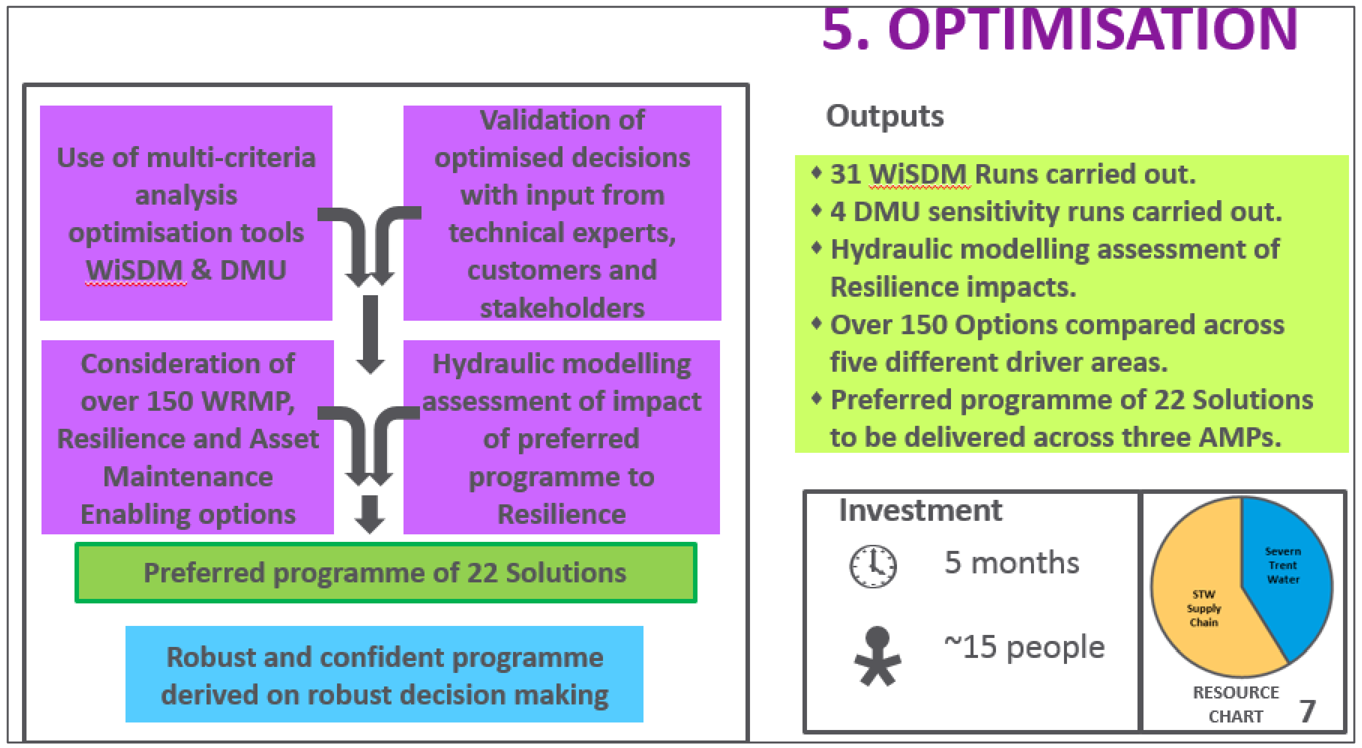
2. SCREENING
Cross-disciplinary expert workshops
Assessment of CAMS/WFD/DO benefit/flexibility
Initial Screening
Further technical workshops
Initial Engineering & SEA Assessment
Further Screening Phases
Rejection log showing the options screened out & those selected for further R&D
Stage 1 Report
- Concept overview
- Initial assessment of option variants
- Option merits
Stage 2 Report
- Review existing assets
- Develop option concept
- Engineering input
- Validate benefits
- Confirm programme
- Cost appraisal
Outputs
• 98 options screened out (47%).
• 22 options suggested for R&D (11%).
• 79 Stage 1 Reports completed.
• 114 Stage 2 Reports completed.
• 119 schemes carried forward into the development phase.
Investment
9 months
~50 people
STW Supply Chain
Severn Trent Water
RESOURCE CHART
3



2. SCREENING
Option formulation
Unconstrained options
Screened feasible options
Balanced plan
206 options identified
98 options screened out
22 options identified for future R&D
86 options met screening criteria
7 Demand Options
79 Supply Options
Stage 2 Supply Scheme development
79 feasible supply schemes separated into components
119 Schemes
• Raw > Treatment > Deploy
111 Solutions
• Ensuring quality + quantity from source to tap
Model Solutions in WISDM / DMU
4


3. DEVELOPMENT
Subdivision of schemes into individual asset units / elements
Focussed engineering assessment across seven discipline areas
Assessment of six core 'deliverability' areas
Prepare Viable Solutions from 'source to tap'
Raw water abstraction → Treatment → Deployment
Technical development and reporting of viability at element, scheme and solution level
Development and use of new cost estimation methodology specific to WRMP processes
Outputs
• 119 schemes subdivided into 331 asset elements.
• 331 engineering appraisals of elements.
• 55 Scheme technical reports.
• Costs estimated for £16.5Bn of schemes
• 111 Solutions developed and carried forwards into the next phase.
Investment
4 months
~45 people
Severn Trent Water
STW Supply Chain
RESOURCE CHART 5


4. SOLUTION APPRAISAL
Hydraulic modelling to determine DO benefit of Solutions
Consideration of supplementary benefits to customers
Water Quality assessment and WQMP Production
SEA / HRA / WFD Assessment of Solutions
Validate Solution benefits & further confirm viability
Further increased confidence of Solution viability and outcomes
Outputs
• Hydraulic modelling of individual and combined permutations of schemes to increase confidence in DO benefit.
• Water Quality Management Plan.
• SEA Assessment of the Solutions.
• Understanding of the additional benefits offered by the Solutions.
Investment
5 months
~15 people
Severn Trent Water
STW Supply Chain
RESOURCE CHART 6


5. OPTIMISATION
Use of multi-criteria analysis optimisation tools WiSDM & DMU
Validation of optimised decisions with input from technical experts, customers and stakeholders
Consideration of over 150 WRMP, Resilience and Asset Maintenance Enabling options
Hydraulic modelling assessment of impact of preferred programme to Resilience
Preferred programme of 22 Solutions
Robust and confident programme derived on robust decision making
Outputs
• 31 WiSDM Runs carried out.
• 4 DMU sensitivity runs carried out.
• Hydraulic modelling assessment of Resilience impacts.
• Over 150 Options compared across five different driver areas.
• Preferred programme of 22 Solutions to be delivered across three AMPs.
Investment
5 months
~15 people
Severn Trent Water
STW Supply Chain
RESOURCE CHART 7

Annex 2: Line of sight between customer insight and our approach

Strategic investment area		Consolidated theme emerging from research	Details underpinning the theme	Sources	Further details of the sources	Score	How our plan reflects customer research findings
Supply and demand	Customer priorities	**Customers don't have appetite to invest on improving the current level of drought resistance, but no desire to let it deteriorate**	(In the deliberative research) customers were not spontaneously concerned about drought and consider it to affect other countries outside of the UK. Because they perceive drought restrictions as unlikely to occur they appear to be happy with the current standard. There was no desire for a reduction in the standard "in exchange" for a small bill reduction.	Supply demand deliberative research (page 26)	This emerges in the supply demand deliberative research but is also consistent with PR19 WTP, budget game and PR14 hose pipe ban valuation		We are not seeking to make any material investment to improve drought resilience above the current standard (1 in 200)
		Customers think that we should have plans in place to ensure a continuous water supply both now and in the future	Customers expect us to be prepared to address long term challenges that could affect that water supply, such as climate change and population growth	Resilience deliberative research (page 17, 20)	Appreciation of these challenges appears in other research projects too when talking about the future		We are deploying both demand management and supply solutions to ensure we meet the supply demand challenge in the future.
		Customers expect us to meet our statutory obligations, including those related to restoring unsustainable abstraction and ensuring no environmental deterioration	Whilst customers are not aware of the obligations we face (RSA and WFD) a basic expectation is that we meet our statutory obligations	Environment deliberative research	This isn't an area we have talked to customers about significantly, since meeting the statutory obligations is a key Ofwat expectation		We will deliver our statutory obligations
		Tackling leakage remains a top priority for customers	Compared to other (prompted) options for improvements in service leakage typically emerges as a top priority for customers. Customers believe that fixing leaks demonstrates our commitment to use resources responsibly	Tracker, PR19 WTP, budget game, choices qual, supply demand deliberative research			A 15% leakage reduction across AMP7 (much more stretching that previous AMP reductions). This target is part of the best value long term WRMP, a more stretching leakage target would not be the best value plan. Maintaining a performance commitment related to speed of response as this is also an area of customer focus.
	Investment support	**Customers don't want the lowest cost option but the best value option considering effectiveness, cost over time, and environmental impact**		Supply demand deliberative research (page 37, 38)	Some of this emerges as a theme at PR14, when customers consider what represents best value for them (e.g. wanting to go beyond the ELL)		We are addressing customer expectations with the best value long term option, given the uncertainty and prevailing risks.
	Solutions	**Most customers are happy to pay for long term water security but they are clear this should be spread out over time so not to cause undue financial burden for customers**		Supply demand deliberative research (page 38)	This comes from the deliberative research so care should be taken in generalising the finding. We have not really indicated what element of the bill pays for this, and what additional part of the bill is needed, and what the choices are in terms of pace. The long term role of water companies also emerges in the choices research (page 20)		Our WRMP modelling looks at the short - medium term and takes into account uncertainty. We are taking a multi AMP approach to ensure the investment does not cause undue financial burden to customers.
		Customers tend to favour demand management solutions	Demand side solutions are supported because customers have a sense of personal responsibility when it comes to water	Supply demand deliberative, PR14 supply demand sliders, Choices research (page 20)	The choices research also finds a sense of responsibility in terms of customer and company behaviour emerges as a theme		Demand management is a key component of the solution and the "go to" place before considering demand solutions
		When considering options, respondents demonstrated strong support for metering, however there are also myths and concerns around metering that need to be taken into account.	Apprehension about metering and a general lack of understanding emerge in multiple research projects	Tracker, co-creation, best in class customer service, supply demand deliberative, PR14 supply demand, customer needs, TapChat (anecdotal)	This echoes findings from the PR14 supply demand research in which customers favoured metering and leakage		100% metering programme targeted over 3 AMPs means
		Customers expect us to provide advice on water efficiency		Supply demand deliberative research, customer needs, social media scraping, tracker			An increase in water efficiency programme and new education approach for schools.
		However, customers recognise that a blend of demand and supply options is needed and have some specific opinions about supply options	Reservoir expansion is recognised to be a long term and sustainable option	Supply demand deliberative (page 49-50)			Supply side options included in the WRMP are in line with customer preferences: Exploring options to work with neighbours to increase supply Exploring water trading due to the political pressure (recognising that communication with customers could be key to removing the barriers) Developing new sources of water, with appropriate environmental controls in place to ensure no detrimental impact
			Customers show concerns about water trading solutions due to dependence on external parties, and potential cost, disruption, and environmental impact	Supply demand deliberative (page 51-52)			
			Increasing surface water abstraction is considered relatively simple and certain, although customers show some concern about environmental impacts	Supply demand deliberative (page 53-54)			
			Effluent reuse was a divisive option - there are concerns over the energy requirements, longer term sustainability and high running costs	Supply demand deliberative (page 55-56)			

Scoring	Rationale
	Multiple sources of evidence converge on the same finding (repeat themes) Including both quantitative and qualitative evidence
	Some consistency in themes across multiple sources but also some contradictory views
	Qualitative evidence from a single study that we should be wary of generalising Single source of evidence or multiple contradictory evidence from different sources Evidence from a old research project or on a slightly different topic

Annex 3: Summary of trading options reviewed *(inc cost, benefit, timing, environmental, technical issues)*

[REDACTED]

8.7.3 Cost adjustment claim: resilient water service

Every day our customers trust and expect us to deliver a continuous supply of safe, clean drinking water to their taps. To be able to deliver these fundamental water service expectations, we need sufficient water resource, treatment capacity and distribution capability as and when it is called for. This requires; (a) long term water resources planning, and (b), a resilient set of assets, systems and networks that can deliver core service irrespective of the shocks or stresses placed upon them. This business case considers the latter of these two fundamental requirements – the resilience of our asset base.

Changes since May 2018 Submission

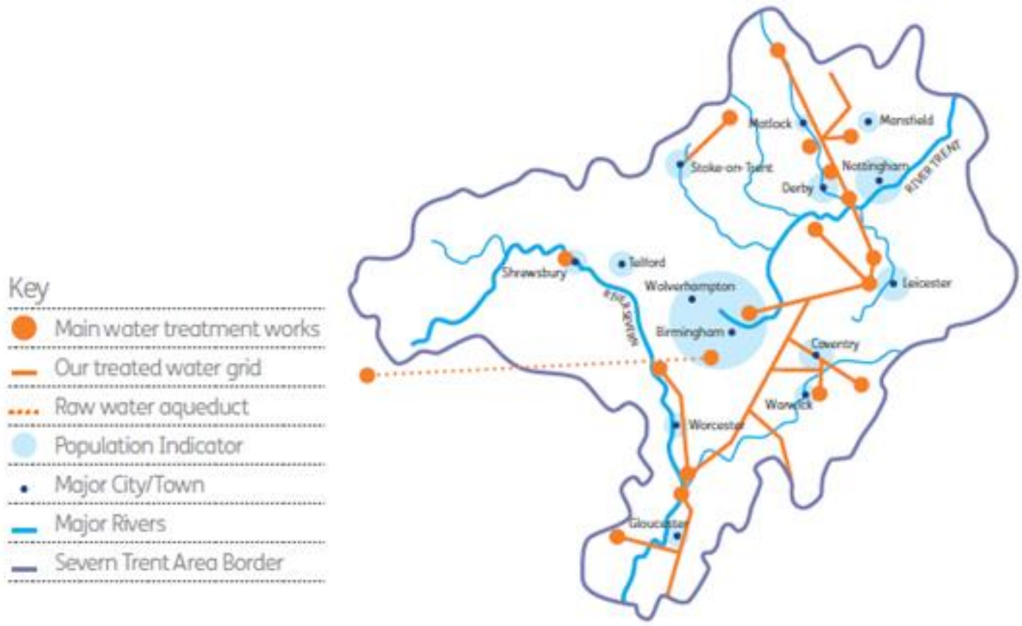
We submitted our case to Ofwat in May 2018 to outline the key need for the cost adjustment. The main change has been the inclusion of additional cost benchmarking to evidence cost efficiency, using benchmarks against comparable projects both within and outside of the water industry.

8.7.3.1 Need for investment

A continuous supply of water is one of our customers' most fundamental need from us. The investment in this case is driven by a clearer understanding of those needs, and a more robust assessment of the risks (both the likelihood and consequence of failure) across our Strategic Grid.

The Strategic Grid

The Strategic Grid is the principal treated water transfer system in the Severn Trent region which spans from Derbyshire in the north of our region, down the eastern side of our patch and across into Gloucestershire in the south of our region. In the last 40 years our Strategic Grid has evolved from a series on standalone assets to a system of interconnected aqueducts, pipelines, reservoirs, resources, water treatment works and control system through a series of investments to deliver extensions and connections. Figure 1 below provides a simple illustration of the key components of the Strategic Grid. The Strategic Grid supplies approximately 5 million of the c.8 million people we serve in our region. It is an integrated system of aqueducts, pipelines, reservoirs, resources, water treatment works and control systems. It enables us to move water within a large geographical area in a flexible and sustainable way, allowing us to effectively manage changes in the supply/demand balance. Over the last 30 years our customers have benefited significantly from this interconnectivity.



Mythe was a catalyst for risk reduction

Following the catastrophic failure of Mythe water treatment works in July 2007, and experiencing first-hand the devastating impact that it had on our customers, we have been systematically reducing the risk associated with the loss of supply from our critical assets, including aqueducts and our surface water treatment works. We have also been improving our understanding of the shocks and stresses that could prevent us from providing services.

This event had a major impact on our organisation and communities that we serve – it was the catalyst for a rapid cultural change and action to significantly improve the resilience of our vulnerable assets. This change continues today with our evolving understanding of risk and customer expectations.

Capital investment projects carried out in AMP5 and those ongoing in AMP6 have enabled us to manage and improve our resilience in the event of a temporary loss of service at a single major water treatment works. These investments include flood defence works and 'dual streaming' of water treatment works to remove critical single points of failure across our network including carrying out essential maintenance works and enhancements to the Strategic Grid. This is an ongoing process and will continue into AMP7 and beyond as part of our overall resilience programme.

The Birmingham resilience scheme was a step change in our understanding of resilience and risk reduction

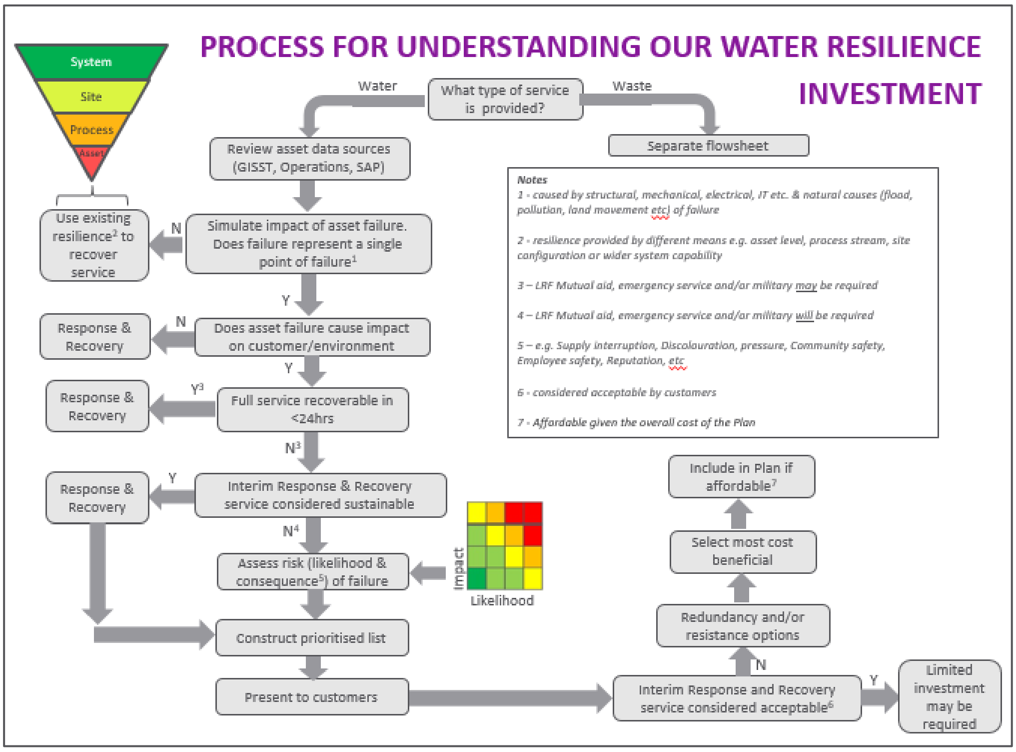
The Birmingham resilience scheme included in our AMP6 plan as a cost adjustment has parallels to this business case. In developing the Birmingham resilience scheme, we exposed risks that had historically been managed - and implicitly accepted by customers. When discussed with customers, these risks – both the likelihood and consequence were not acceptable.

Once completed the scheme will deliver a step change in resilience for 1.2 million customers in the Birmingham region. Our investment in this case will offer a similar level of protection for customers served by other areas of our Strategic Grid.

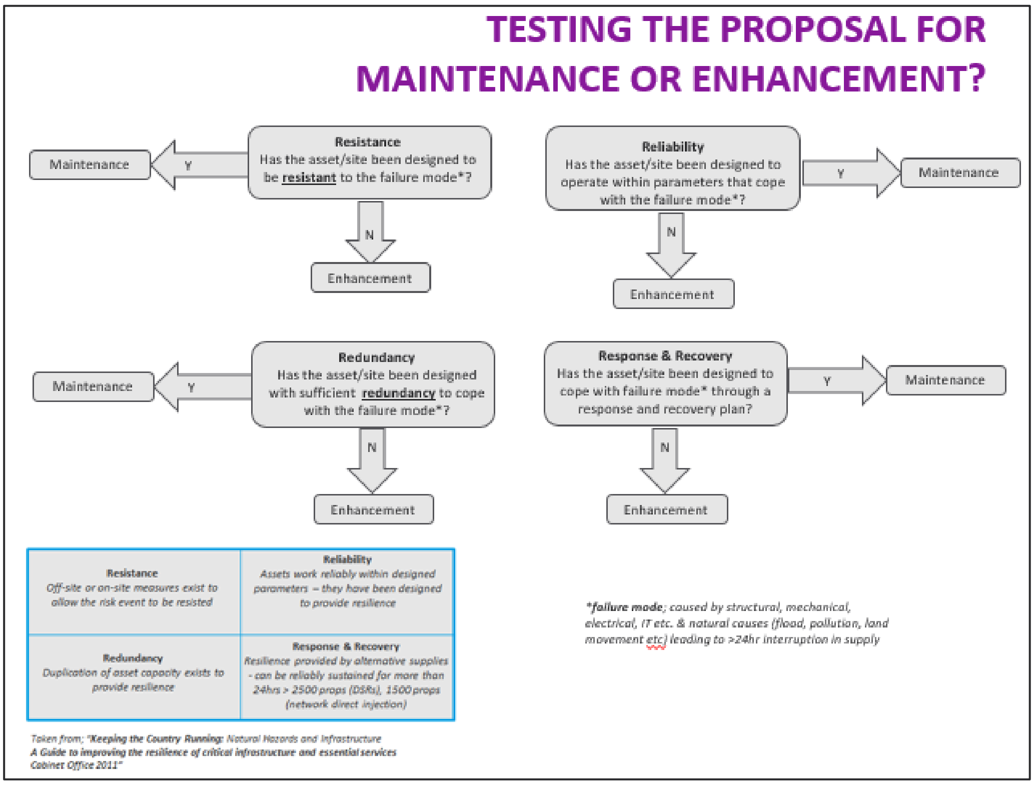
Our experience of developing the Birmingham resilience scheme, where we worked closely with Ofwat, has also shaped our approach to this case in two key ways:

- It gave us further insight about customers, their understanding of likelihood and the consequences of failure.
- We made significant improvements in our assessment of risk. In our second Birmingham resilience submission to we used a single system approach to assess probability of failure across a complex network of assets – to ensure we did not duplicate or overstate risk. We have adopted and further developed this approach for our proposals in this case.

We use the high level processes shown in the following figures to help us understand all resilience capability and resilience investment needs across our assets;



Key questions to understand if investment is maintenance or enhancement



We have a clearer understanding of our customers' expectations

Our experience of Mythe exposed, directly, the consequences of the failure of a critical asset on our customers, the logistical challenges of managing long duration/large impact events using a response and recovery approach, and customers' expectations for risk mitigation in the future.

And as noted above, for PR14 we undertook extensive qualitative and quantitative research over three stages. Our customer challenge group, the Water Forum, agrees it is valid to draw from that insight in relation to this case.

Our extensive research catalogues, compiled using many data sources and over many years tell us customers take their water supply for granted until something goes wrong - they are not aware of, and therefore do not readily think about, issues such as our responsibilities, supply interruptions and the causes of such. Most customers we spoke to had had limited experiences of disruptions to their water and waste water service. However, the thought of not having water at all times was very concerning for our customers - a selection of spontaneous quotes from the deliberative workshop (see below) on resilience were; "I've never been without water for any length of time at all", "I don't quite understand what it [resilience] means, actually"

Given this background, we re-designed our approach to customer engagement in PR19 so that we could ensure our customers could contribute in a meaningful, informed way on these matters. We have supplemented our more traditional research methods (tracker analysis and valuation studies) with revealed insight (social media 'scraping' and customer contacts) with a programme of deliberative research with a representative cross section of customers. This took two forms; a workshop (for those who felt comfortable contributing in an open environment) and for those we considered vulnerable (i.e. those with special requirements - financial or health) we conducted 1-2-1 home interviews (duration 1 hr) to ensure their opinions could be factored in to our work. The deliberative workshop was focussed but extensive in its content. Our independent experts who specialise in seeking accurate, informed customer views, led the workshops and with our input (only on the technical challenges), designed the agenda. We spent over 6hrs with our customers so we could explain exactly the challenges we are facing. We elicited both a spontaneous view and a much more informed view. The agenda covered company core service, challenges we are facing from disruptive events and options we have to respond to these in order to allow customers to provide informed responses to our proposals.

In order to ensure the event was as objective as possible customers had no prior sight on whether they were seeking to change our work done at that point in time or whether they would be endorsing what we were already planning. Additionally we did not share the detailed content of our proposed plan at the workshop nor did we express preferences on what we should do unless specifically asked. Instead we presented the challenges and options we have to respond to these. The outputs from the deliberative research demonstrate that customers are able to engage in, and understand, complex issues and comment in a meaningful and informed way, specifically;

- (a) what may cause a risk a resilience service
- (b) what risks are more acceptable than others,
- (c) what options we should consider (but leave the detailed technical appraisal to us) and,
- (d) what preferences they have.

We believe the deliberative workshops fulfilled our objectives and helped significantly customers understand what issues we are facing. Typical customer views expressed at the end of the sessions included; "My opinion of Severn Trent has improved. I now understand the challenges they face and how their operation works." "I now have increased trust that works will be carried out without increased/inflated costs."

Views that customers formed as a result of the deliberative workshops are that;

i. Customers were able to articulate the cause of a resilience risk (from failing infrastructure through to terrorism) and were able to plot these in terms of likelihood and impact,
ii. Having expressed views on cause and risk, Customers commented on the acceptability of any interruption to service - anything beyond medium term service (water supply) interruptions (greater than 24hrs) were considered unacceptable for them as was any (water) discolouration that may extend beyond 1 hour. Short term (water supply) interruptions were considered inconvenient but tolerable,
iii. Customers told us that interruptions to service caused by failure to maintain our assets was unacceptable,
iv. When presented with the scenario of assets that can't be proactively, fully maintained because it would require working beyond design standards, or assets that would cause discolouration for prolonged periods when used beyond their design standard, Customers told us they expected us to have plans in place to resolve them,
v. Customers told us that they expect us to anticipate the resilience challenge and therefore generally have resistance or redundancy solutions in place but for what they considered to be low probability events we should be prepared to respond for when things go wrong through a response and recovery approach and,
vi. Customers were in favour of the resistance/redundancy approach over response and recovery where bill impact was c.£2. Our Choices research continued to verify our findings where 78% of household customers and 76% of non-household customers supported the proposal to improve resilience.

Given these explicit findings we have responded by;

a. confirming which risks we should be seeking to protect our customers from,
b. looking for solutions that will remove the risk of a long duration supply interruption (>24hrs) and a discolouration event that would extend beyond 1 hour,
c. excluding risks caused by failures in maintenance programmes,
d. confirming that our plans cover only those assets that operate beyond design standards,
e. (e) identifying appropriate resistance or redundancy options or response and recovery options within the cost profile. (Reliability was not considered feasible because if risks to resilience were to crystalise our assets would be operating outside their design standards). Our redundancy, resistance and recovery options which offer the best value on a site-by-site basis and have been harmonised with our water 'supply demand' options to maximise the opportunity to secure multiple benefits from minimum investment. They comprise improved interconnectivity of treatment works, dual streaming of works and enhancements to the current pipe network to ensure 'resilience mode' is no different to 'business as usual' mode so we avoid discolouration.

Annex 2 provides a further line of sight between the outcome of our research and the investment we are proposing.

The Water Forum has challenged our need case

In addition to undertaking customer research to understand the views of our customers and shape our plan accordingly, we also worked closely with the Water Forum (WF) over the last 18 months. The WF has organised itself to focus on key issues associated with PR19 and as a result we have a number of separate sub-groups established to better understand and challenge in particular areas. These sub-groups bring together a diverse range of expert skill sets. The Water Forum Investment Sub-Group (ISG) comprises members from: the Environment Agency; Engineering Consultancy; Natural England; Consumer Council for Water (two members; one Chair of CCWater's Central and Eastern Region); Confederation of British Industry; West Midlands Combined Authority; and two from industry leading engineering consultancies (one of which started his role on the Water Forum as Head of Scientific Consultancy at the Met Office).

A key challenge from the WF was in design of our research approach and deployment of the various techniques. Furthermore the WF attended our deliberative research and witness for themselves the engagement levels and interest in the room. A significant amount of work and challenge took place in the 18 month period. The WF wanted to understand; the challenge we are facing, the options we have considered, the benefits we are seeking to deliver, the preferences of our customers and how we are accommodating them and the areas of support we had for our proposed plan.

We explained the two levels of optioneering we have done to respond to the challenge, namely; optimising the programme and optimising solution choice given the extent of project development. The WF tested how we had arrived at the size of proposed programme. They wanted to see evidence of the optioneering we have applied at a project level once they were satisfied the programme wasn't over-scaled.

We used a number of examples ([two locations REDACTED]) to show how we are optioneering at a project level to secure the best value option for our customers. One area the WF pushed particularly hard at was in making sure we articulated the line of sight from customer research to investment proposal. This has resulted in a line-of-sight document (Appendix 2) which not only links customer views gathered through research to proposal, but also references the research data sets and weights the strength of feedback.

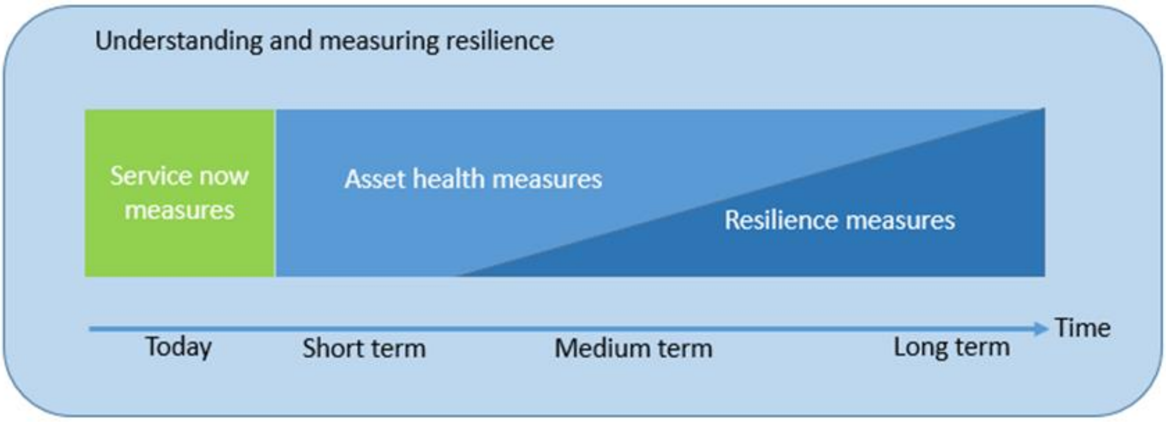
The WF also requested specific project level research be carried out if any individual project was considered significant (agreed to be >c£1 annual bill increase). No project exceeds that value so we have relied on our other sources of research. They also challenged us to ensure we were selecting scheme solutions on multiple criteria and not just cost. We addressed this by explaining our thinking in terms of residual risk associated with delivering resilience at [location REDACTED].

Read more: The Water Forum has produced an independent report outlining the challenges they've made to ensure our proposals are in line with customer views and needs.

We have a maturing understanding of resilience

One key element of analysis we undertake is to ensure that assets and systems that have been designed to provide resilience maintain their resilience over time particularly since external and internal environments can change over time. We continuously improve our understanding of the wide range of shocks and stresses that could prevent us from providing the services our customers expect now and in the future. We do this by gathering and analysing data about our assets and the external environment, reviewing our processes and, when failure does occur, interrogating the reasons and impact it has had on our customers. This deep understanding also improves our ability to predict how these shocks and stresses may change over time and therefore enable us to identify the most cost beneficial way of responding to over the long term. We consider performance across different timescales and then consider them collectively to understand our overall level of resilience as described in the figure below.

Tracking resilience reliability through different metrics

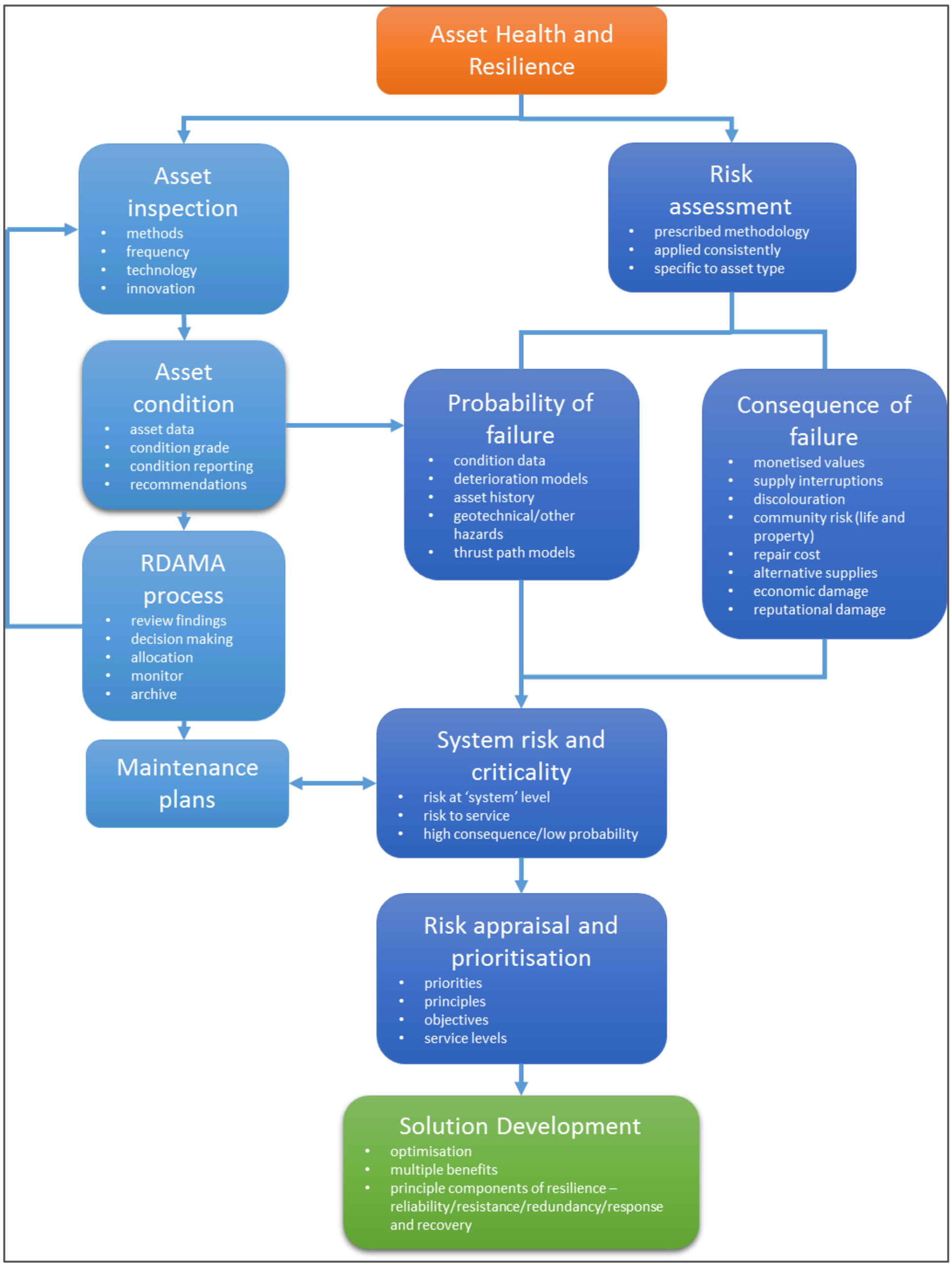


- Service now metrics. These provide important information on the resilience of services that are currently being delivered, but do not reveal how resilient services are to risks that have not yet materialised.
- Asset health metrics. These capture resilience issues that occur frequently (that is many times per year, e.g. bursts or collapses).
- Resilience measures. These focus on resilience issues that occur far less frequently (e.g. drought), or evolve on a long timescale (e.g. flood risk).

We are continuously improving our understanding across all of these timescales. Over the last 10 years, our understanding and ability to quantify the risks across our assets has increased considerably. Lessons learned from our Birmingham resilience scheme at PR14, and a subsequent Strategic Grid risk assessment have helped drive a more reliable and data led view of risks across our infrastructure.

Given the long life nature of the assets across our strategic grid, a major component of our risk assessment is asset health. We use this term to describe the overall understanding of the performance and condition of our assets and systems. It is not defined by a single indicator, but is a basket of measures that span the timescales shown above. Asset health is not a new concept and we have mature systems that enable us to combine asset health with other information such as failure history and age to assess the likelihood of an asset failing. We combine it with consequence of failure to give us an understanding of risk. This is illustrated in the figure below.

Our approach to asset health and resilience



All assets are appraised in a consistent and standardised way using the framework in order to reduce subjectivity. We then rank the assets to create a risk assessment hierarchy. This methodology allows us to develop interventions that target high risk assets to deliver the largest benefit for customers. Note this process covers assets and systems that have been designed (or subsequently modified) to be resilient as well as those which were designed (or subsequently modified) without our current resilient standard.

Through the systematic quantification of risk, across our Strategic Grid and strategic treatment works, we have identified three areas requiring investment.

- **Strategic sections of assets**. To address risks associated with the tunnel and conduit sections of the Strategic Grid, [location REDACTED] . 98,176 customers will benefit from the reduced risk of long duration interruptions. This asset was designed (over 100 years ago) without today's resilience standard in mind.

- **Large surface water treatment works**. To improve the resilience of four of the larger surface treatment works to reduce the risk of 386,898 customers experiencing supply interruptions as a direct result of an outage. These assets were designed many decades ago without today's resilience standard in mind. The interconnectivity of our treatment works that we now have as a result of connection to our Strategic Grid has brought many benefits although in the event of major works failure not all service can be maintained to today's resilience standard.
- **Network response to a treatment work failure**. To improve the capability of the distribution infrastructure to move water around and maintain supply in the event of one of our larger treatment works failing. Around 2.7m customers would benefit from an improved level of service from preventing such failures, of which 1.3m would benefit from reduced risk of discoloured supplies. These assets were designed many decades ago without today's resilience standard in mind.

We consider the outcome of our detailed risk assessment for each of the three in turn. We have tailored our approach to these detailed risk assessments depending on the nature of the asset. It is important to note that any resilience proposals we are making involve providing first time resilience either through redundancy or resistance or response and recovery. We have not included any proposals where assets and systems already have, or should have, resilience capability through either redundancy, resistance, reliability or response and recovery

Strategic sections of assets

Action is needed to address risks to tunnel and conduit sections of the Grid, [Location REDACTED] . . reduce the risk of a long duration supply interruption for 98,176 customers. The link was not designed at the time to provide the resilience standards required today

We have assessed the network assets in the Strategic Grid applying the two conventional measures of likelihood of failure; and consequence of asset failure – i.e. its impact on customers.

[REDACTED]

Large surface water treatment works

Action is needed to reduce the risk of a supply interruption in excess of 24 hours for 386,898 customers resulting from an outage of four of the larger surface water treatment works that serve our customers. Our works were not designed at the time to provide the resilience standards required today.

We have assessed the risk of failure

During AMP5, a study by Tynemarch in 2009 initially highlighted the level of risk associated with our surface water treatment works. We undertook a programme of interventions during AMP5 which has continued through AMP6 where we have addressed our biggest risks, e.g. with the Birmingham resilience project.

Notwithstanding these improvements, we still retain the risk of a supply interruption resulting from a supply deficit at a number of our water treatment works.

To help us understand the impact of a failure of our strategic surface water treatment works, we completed a further study in June 2016 to improve of understanding of the capability, capacity and constraints of the Strategic Grid and other assets both today and at the end of AMP6. This involved stress testing our water treatment works' production capability under a range of scenarios.

Our resilience modelling incorporated more granular asset data including raw water sources, water treatment works, boreholes and distribution links in our model. This entailed isolating each water treatment works to understand how the rest of the Grid would operate to try and make up for the deficit. In these scenarios, we put the Grid and water treatment works under pressure to operate differently to normal conditions – i.e. at higher flow rates and outputs. We were able to identify which scenarios resulted in more pressure on the Grid and the water treatment works we would expect an outage leading to a supply deficits for customers.

The outputs from our model identified [Four locations REDACTED] water treatment works as carrying the greatest risk in terms of consequence of failure and the number of customers impacted. The impacts are summarised in the table below.

Customers impacted and supply deficits resulting from treatment works outage exceeding 24 hours

[Figure REDACTED]

We have focused our solutions on the four water treatment works which present the greatest risk of a supply deficit to customers. We have also excluded works where the impact on customers can be managed to a level of service they expect using a response and recovery approach – for example, [location REDACTED].

The table above demonstrates very clearly that our customers benefit from having an interconnected system of assets constructed over the last 40years – the resilience we have within our system means that most of our works can be isolated (and turned off) without impacting customers. Only a few remain and whilst significant flows can be generated to provide significant resilience, not all flow can be recovered and thus some weaknesses still exist in our system. Our proposal will address this lack of resilience

Our analysis considered the maximum capacity of the water treatment works at the end of AMP6 and therefore included the benefits of AMP6 investment undertaken. We also considered the deployment of contingency plans to provide alternative piped supplies where possible.

[REDACTED]

Scenario analysis has helped us understand risk better

Building on our initial modelling, we have analysed two additional scenarios to help us gauge the level of risk better, as demand will vary seasonally and throughout the day - and supply may also vary because the Grid may not be at full capacity due to maintenance or operational issues. We have analysed the following scenarios.

- Average demand – 50th percentile and average water treatment work’s outage – 50th percentile.
- High demand – 95th percentile and higher than average water treatment work’s outage – 95th percentile

The ability of the alternative supplies and network to respond to these scenarios has improved our understanding of differing levels of supply deficit and therefore differing levels of risk.

SWIFT analysis has enabled us to prioritise options

We have carried out a *structured what if technique* (SWIFT) analysis on our major water treatment works which are at risk of causing a supply deficit. The technique analyses process type operations and gives us a greater understanding of the level of risk in the event of a catastrophic failure. This analysis has:

- confirmed the plausible failure modes – i.e. the events that could result in a water treatment works outage;
- confirmed the operational mitigation that is available to limit the consequence and impact of a failure event;
- confirmed the duration of an outage for each failure event; and
- estimated the likelihood / probability of each failure event.

The analysis has considered the entire end-to-end treatment process from river intake/raw water reservoir storage through to treatment and final water treatment works' output. This is illustrated in the figure below. It produces a large number of probabilities depending on which event is being assessed. We are currently using the analysis to develop a probability for single supply risk akin to that developed for the Strategic Grid network assets.

End-to-end assessment of potential single points of failure at [REDACTED] water treatment works

[Figure REDACTED]

The outputs of the study have helped us to prioritise investment options and informed the type and scale of resilience solutions recommended for a given level of risk. In section 3 below we explain how we have identified potential solutions for the risk presented by our highest risk works – [four locations REDACTED] . . .

Existing network response to a treatment work failure

Enhancements to the capability of the network distribution infrastructure so that - in the event of a failure in one of our larger treatments works - water can be moved to customers to maintain supply, would mean that 2,693,979 customers would benefit from an improved level of service in the event of a failure, of which 1,346,990 would benefit from reduced risk of discoloured supplies. Our network assets were not designed at the time to provide the resilience standards required today.

We have assessed impact and the likelihood of failure

We have undertaken a review of our existing networks assets to understand the impact and the likelihood of failure including detailed mass flow balance analysis using Aquator modelling. Our investigation has assessed the condition and status of all assets that would need to be operated in a way that delivers the 'resilience' our customers are seeking. We have concluded that many of our existing assets can be utilised to provide resilience but they are being used in a way that they weren't designed for. The study outputs show that significant flow direction and flow rate changes would be required across our network in order to deploy our existing second source capability. Multiple water treatment works would also need to increase production to replace the deficit in the event of failure of a customer's primary source of treated water. The table below shows the surface water treatment works we have investigated.

Major water treatment works we have investigated

[Figure REDACTED]

Maximising the use of existing network assets to provide the resilience our customers require

We have sought to utilise as many existing assets as possible to provide the resilience standard our customers require today. This will require many network assets to operate in a way that they were not designed to operate and thus many require modification. We have categorised the ability of our existing assets to perform to the new standard without modification by taking into consideration; ability to be utilised (if at all), likelihood of causing discolouration and time to deploy resilient service. Note however that none of the assets we are assessing have been designed specifically with the intent to provide resilience under the circumstances our customers require, notwithstanding that approximately 30% of existing assets are capable of doing so (e.g. R4 as shown below).

Resilience categories - standardised resilience definitions

Resilience category	Description of existing asset
R1	Existing network asset not able to provide any resilience service
R2	Existing network asset operating beyond intended design parameters (1) i.e. likely to cause both discolouration and / or long term (>24 hrs) supply interruption due to time to deploy.
R3	Existing network asset operating beyond design parameters (2) i.e. deployable without discolouration but will create long term (>24hr) supply interruption due to time to deploy.
R4	Asset capable of delivering resilience to new standard.

In order to meet the needs of our customers we will ensure all existing network assets achieve level R4 categorisation.

The table below summarises the baseline findings of our investigations. In the event of an individual water treatment works failure, a number of existing network assets will need to be operated differently to how they have been designed to compensate for the Works failure.[REDACTED] . . . . . . We have identified that 11 out of 30 asset are categorised as R4 – can be operated within existing design parameters (i.e. without modification) to provide the level of resilience our customers expect today, .The majority of our network assets will be required to work beyond their design parameters and thus will fail our customer expectations. We have therefore prioritised assets categorised as R1, R2 and R3 for investment.

[Table REDACTED]

Once we understood the baseline position of our existing assets, we identified solutions setting out the extent of works and investment required to improve the performance of the network assets to category R4 – without discolouration or a long term interruption – consistent with our customer expectations. . We undertook mass flow balance modelling using Aquator and hydraulic modelling using Synergi to support the development of these solutions. This modelling embeds the innovation we have captured to minimise discolouration through our longstanding relationship with Sheffield University to improve our understanding of discolouration in distribution systems.

As a consequence, we have identified network monitoring and control improvements, and connectivity enhancements that we could make to our existing assets. This will improve their operation in the event of a failure at a water treatment works and deliver the resilient service our customers require. These enhancements would allow for an improved and more flexible operation of the water supply network, thereby enabling normal service standards to be restored to our customers following a failure event.

8.7.3.2 Need for a cost adjustment

This cost adjustment is driven by a step change in the resilience provision that customers will receive. It will address prior known (and therefore, implicitly tolerated) risks which have now been considered by our customers as unacceptable and justified for increasing investment. This is distinct from our ongoing resilience programmes, which actively seek to manage new risks and therefore protect the service of customers to the level to which they are accustomed.

Ofwat's cost models are unlikely to adequately allow for all expenditure allocated to a resilience cost driver

Our analysis shows that Ofwat's cost models, which are based on historic expenditure, are unlikely to adequately allow for all expenditure allocated to a resilience cost driver - both our ongoing resilience programmes and the specific step change investment set out in this business case. Given resilience activity and expenditure is difficult to predict using independent econometric models, we have explored how non typical enhancement expenditure of this nature could be calculated, in line Ofwat's PR19 methodology statement.

Our starting point has been to follow the approach used by Ofwat at PR14 to assess how much resilience expenditure that may be allowed for in the PR19 basic cost threshold. At PR14, water service resilience expenditure was allowed for as part of the 'un-modelled allowance'. This uplifted 'modelled' base and enhancement expenditure by a percentage based on the historic proportion of expenditure that could not be viably modelled by econometric or unit cost model approaches. We have followed the same approach, indexation and future efficiency challenges to estimate how much could be included for resilience. We have derived possible implicit allowances with assumptions surrounding:

- the price control to which the PR14 allowance related;
- likely changes to the un-modelled allowance approach as a result of to the generation of additional models; and
- changes to industry wide resilience expenditure incurred since PR14.

Given the size of the potential resilience allowance, we have assumed that it will account for all of our wider resilience programmes but make no allowance for the expenditure set out in this cost adjustment claim. The table below shows interaction between enhancement and cost adjustment.

Resilience

Resilience **Central estimate: £135m (excludes £12m relating to the operation of the Birmingham resilience scheme which we consider will also be fully allowed for in Ofwat's modelling))**	
Resilience Central estimate: £135m	
Resilience Cost Adjustment Central estimate: £74m	Resilience implicit allowance Central estimate: £61m (excluding £12m for operation of Birmingham resilience scheme)

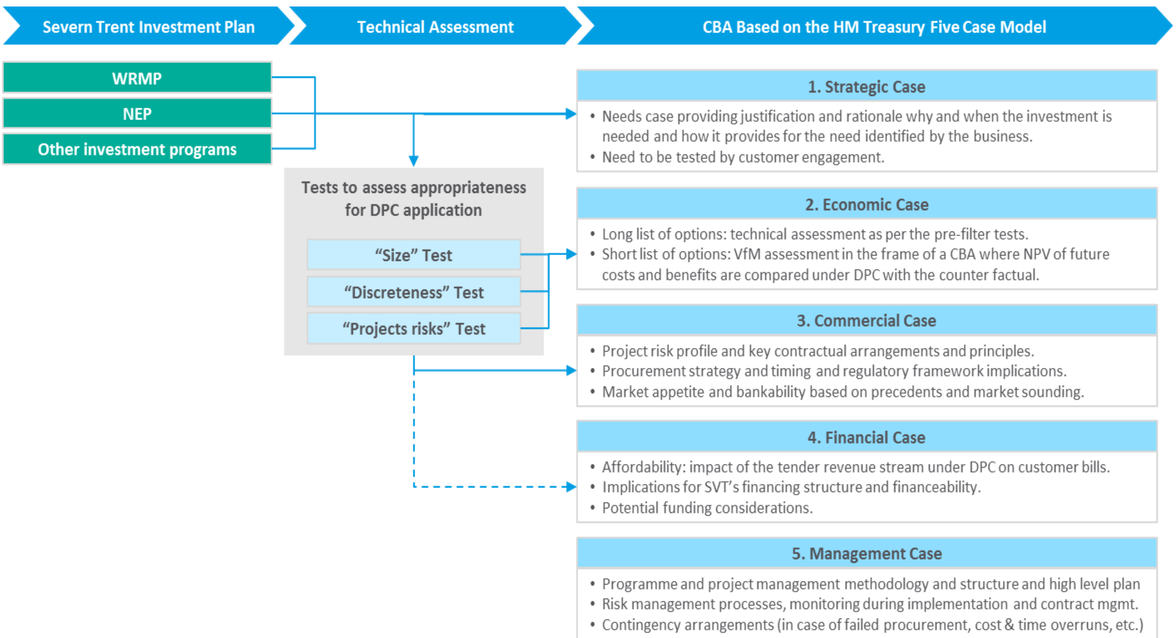
We have considered the potential for direct procurement for customers

We are supportive of DPC and recognise the potential to embrace markets in this way to deliver more benefits for customers.

DPC is new to Severn Trent and so we sought specialist advice on understanding the concept and how to apply Ofwat guidelines with appropriate fairness, transparency and repeatability. This was to ensure that any scheme progressing via this route would provide genuine value for customers.

We have worked with KPMG to develop a DPC assessment framework (illustrated below) and for assessing potential discrete, large-scale enhancement projects expected to cost over £100 million whole-life totex.

Assessment process flow diagram for DPC



We have passed all projects and programmes of work with a totex of greater than c.£80 million through this process.

The conclusions of our work confirm that Direct Procurement for Customers does not apply to this investment proposal for the following reasons:

- Size - the totex of any given project was less than £100 million; and
- Discreteness - the work is both disaggregated across many sites and very often highly integrated within existing processes

A detailed description of our methodology, criteria and assumptions used is available in a separate report on request.

8.7.3.3 Management control

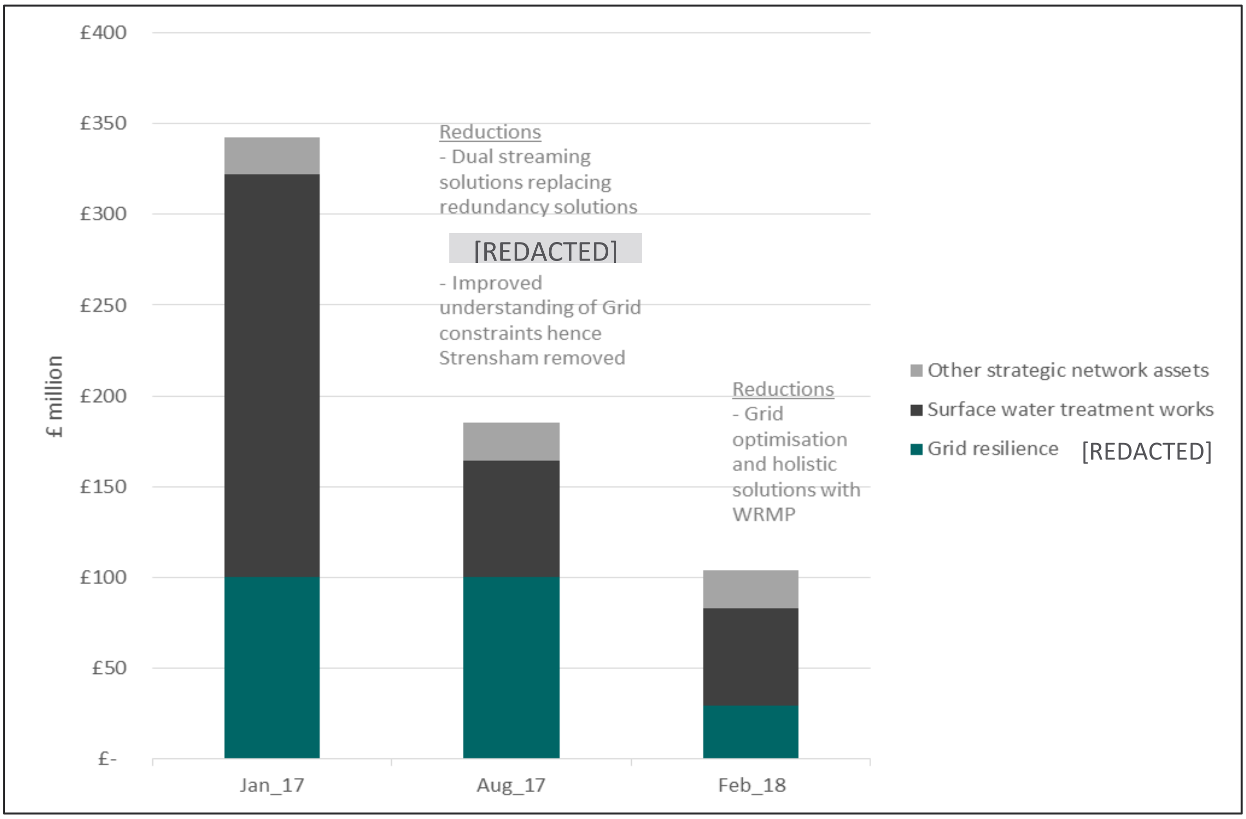
We understand both the affordability constraints our customers face, and the value they attach to having a resilient water supply that is always there when they need it. We have taken a risk based approach to identify need, and successive rounds of modelling in order to drive down scope and costs.

We have scrutinised the need and costs of our proposed solutions

We have worked with and developed solutions within the parameters set out by our customers. We have challenged ourselves to scrutinise the basis for every need and cost of our proposed solutions.

The iterative approach we have taken has allowed us to make successive reductions in the costs proposed in this business case as set out below. Each bar represents our estimated cost for resilience investment throughout stages of our planning process and shows how we have made significant cost reductions at each stage.

Successive cost reductions



To achieve these reductions, we have undertaken an iterative approach to cost and solution optimisation, remodelling more granular scenarios to gauge the level of risk better. The outputs have shaped our proposed solutions.

We have also responded to our customer and stakeholder feedback that we should exploit the potential for multiple benefits in the communities we serve.

For example, our proposed solution at [two locations REDACTED] water treatment works set out in section 4 has been combined into a single solution delivering multiple benefits and represents the lowest cost solution overall.

And while simultaneously developing our water resources management plan, we have considered the wider resilience benefits of this programme. . An interim conclusion during our investigations suggested our resilience challenge between [Location REDACTED] could be resolved by an expansion proposal (to address supply-demand) [Location REDACTED] which at the time removed c£70M from the proposal. We have however since demonstrated that the resilience challenge can be addressed by other means which offer almost the same level of saving independent of the 'supply demand' scheme.

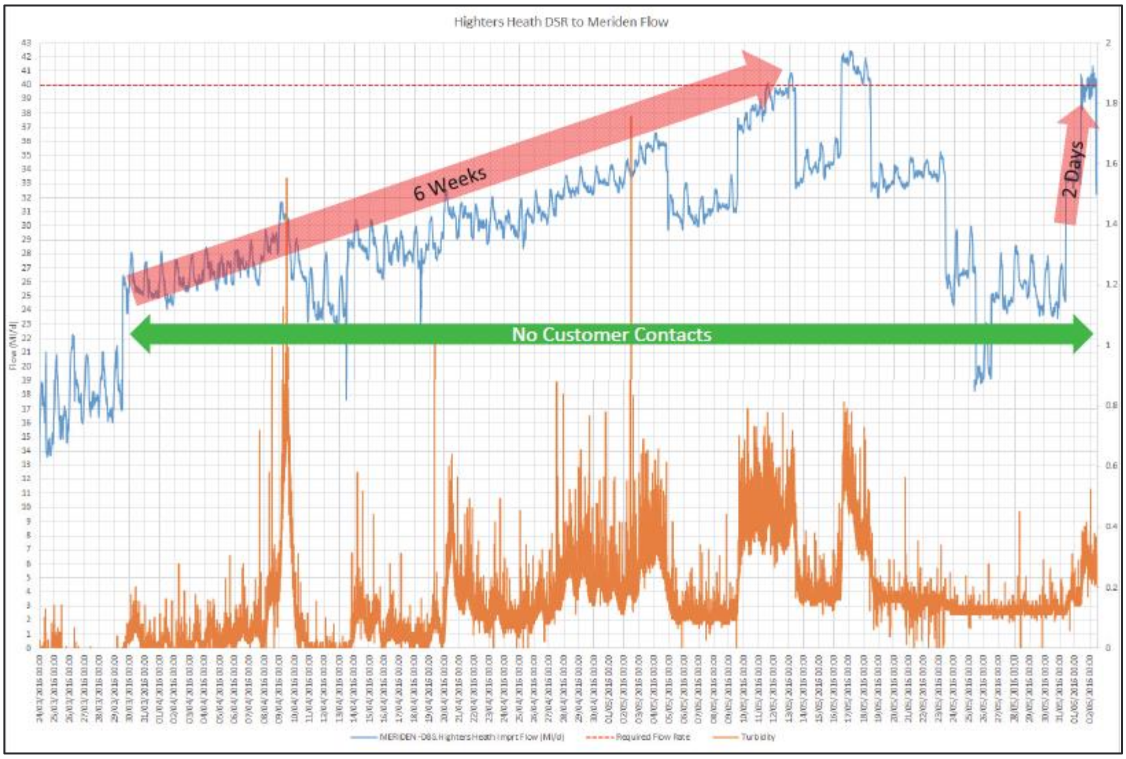
We have applied innovation to our hydraulic modelling to meet customer expectations

We have been working with Sheffield University for 14 years to better understand the impact of discolouration causes on our network as a key member of their PODDS (Prediction of Discolouration in Distribution Systems) Project. The research has led to a much improved ability to understand the potential discolouration consequences as a result of sudden flow changes on the distribution systems as well as improve ability to implement flow conditioning of the system to accept enhanced operation. This learning is key to how we implement flow changes after installation of our network enhancements.

We now have the ability to improve and simulate the impacts of flow changes across multiple criteria anywhere on our network such that customer impact is minimised to a level that is acceptable. In AMP6 we are trialling our latest learning on our trunk main which links [Location REDACTED] . The graph below shows how our controlled and phased increases in flow, have conditioned the main to accept significantly higher flows but with no customer contacts for discolouration.

Previously our orthodox thinking was to keep the main conditioned using a (low) 'sweetening flow' which we now know will not deliver the performance our customers expect. The graphic shows how we have conditioned the main over a six week period (flow shown in blue increases over time) with measured impacts on turbidity (shown in orange). We have been able to control the turbidity increases within acceptable parameters. Once the main is condition to the correct level (red line) we can then increase the flows over much shorter timescales (2 days as opposed to 6 weeks in this example) after implementing a periodic conditioning cycle.

Conditioning mains using the knowledge from PODDS



8.7.3.4 Best option for customers

Our proposals have been built iteratively – allowing for successive rounds of internal and external engagement and challenge. Our proposed solutions are driven by the facets of service that customers told us were important to us, and underpinned by cost benefit analysis which uses the value they attach to improvements.

We have worked with customers to design our response to the resilience challenge

From our deliberative research we know that customers can;

i. articulate the cause of a resilience risk and can plot these in terms of likelihood and impact;
ii. articulate views on tolerability of supply interruptions and discolouration - anything beyond medium term service interruptions (greater than 24hrs) were considered unacceptable and any discolouration that may extend beyond 1 hour;
iii. expect us to address interruptions to service caused by failure to maintain our assets;
iv. expect us to address resilience issues caused by assets working beyond their design parameters;
v. expect us to generally have resistance or redundancy solutions in place but for what they considered to be low probability events they expect us to be prepared to respond and; and
vi. expect us to implement resistance/redundancy solutions over response and recovery where bill impact was c.£2.

These findings have helped shape our plan in a number of respects.

- establishing solutions that will remove the risk of a long duration supply interruption (>24hrs) and a discolouration event that would extend beyond 1 hour. We have adopted this as one of the criteria underpinning our new resilience performance commitment for AMP7 (see section 6). While we have not specifically assessed the cost of providing resilience for a shorter duration, we do not believe that solutions would not be cost beneficial based on customers' current willingness to pay and the significant network changes that would be required.
- confirming that our plans cover only those assets that operate beyond design standards.
- identifying appropriate resistance or redundancy options or response and recovery options within the cost profile and deploying most suitably e.g. response and recover are more likely to be adopted in rural areas. (Reliability was not considered feasible because if risks to resilience were to crystalise our assets would be operating outside their design standards).

The Water Forum has challenged our approach

The Water Forum and the Investment Sub-Group have challenged us to demonstrate that our proposed approach is the best option for customers – on the basis that it reflects customers' priorities and their views on approach. Our response to the challenges laid out by the ISG are set out above and in the Water Forum's independent report.

We have considered resistance, reliability, redundancy, and response and recovery

The figure above shows that we have considered resilience using the four principal strategic components of resilience (Cabinet Office guide - Keeping the country running: natural hazards and infrastructure, 2011). We have appraised our solutions using the four principal options of resistance, reliability, redundancy, and response and recovery outlined in the document and adopted a number of solutions using these strategic components to minimise investment whilst maximising resilience benefit. The hierarchy of options range from:

- Do nothing.
- Increase interconnectivity to provide a supply from an alternative source, removing single source dependency.
- Dual streaming of water treatment works, removing single points of failure.
- Relocation of critical or vulnerable equipment/assets to a safer location.
- Provide alternative supplies through contingency plans (tankers, bottles, bowsers, etc.)

The extent of our work in formulating this business case includes many thousands of hours of engineering and customer research time. Our optioneering has been extensive. A summary of the scale of activity is shown in Appendix 3 which includes a high level review of optioneering, and a simplified process to explain key stages and activities.

We have ensured all proposed resilience enhancements are cost beneficial

We have undertaken detailed cost benefit analysis to support our decision making, using it to identify best value for money for our customers and to select our preferred solutions. We have scoped, designed and costed over 60 different schemes.

Our cost benefit analysis includes:

- a range of benefits associated with each solution (while it is appropriate to include avoided private costs of failure and avoided wider economic damage, the cases remain cost beneficial even when considering the willingness to pay benefit alone);
- the different residual risks associated with each intervention; and
- our system risk assessment to arrive at robust estimates of likelihood of failure on complex interconnected network systems.

We have not double counted the benefits from the various strands of the business case. Benefits have been allocated where they are largest, and where customers would also receive second order protection from another component this additional benefit has been removed from the calculation.

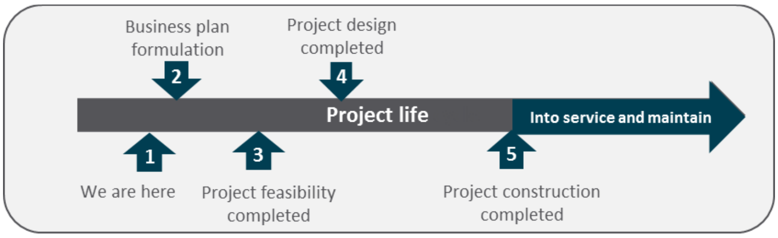
The cost benefit has been calculated in terms of net present value (NPV) and the cost benefit ratio. For each of our three proposals (set out in more detail in sections 3.5 to 3.7), we have considered the following in our calculations.

- Annualised whole life present value costs of intervention options
- Annualised pre intervention risk (probability **x** impact of each identified benefit currently faced)
- Annualised post intervention risk (probability **x** impact of each identified benefit post intervention)
- Probability of failure (quantification of system risk to account for multiple failure modes on a network of interacting assets)
- Impact of failure (extent and duration to which benefits will be felt)
- Quantified and monetised customer benefit (annualised avoided risk of service interruptions of various lengths)
- Quantified and monetised economic damage benefit (annualised avoided damage to the local and regional economy during major service interruptions)
- Quantified and monetised private cost of failure benefit (avoided cost incurred in the event of a failure such as repair costs, provision of contingency supplies and compensation)

To take into account this potential uncertainty, we have undertaken sensitivity analysis. The investments remain cost beneficial and this analysis does not alter the preferred option.

Our process for exploiting more benefits in the future

We recognise there may be more benefits we can exploit as we progress further through the project lifecycle of our preferred schemes. We are currently at stage 1 of the project lifecycle, indicated in the figure below.



As we progress the detailed feasibility we may uncover other benefits, for example those associated with the wider environment or wider societal benefits (natural and social capital). However, as these additional benefits remain optional under the principal driver for this investment, we will only do this subject to alignment with our customer research. Where we can, we seek to monetise these and bring them into the financial option analysis. The example above illustrates this approach.

We will have the opportunity to find further benefits as we progress through the project lifecycle

- Option 1 & 2 do not achieve the minimum requirement so are rejected.
- Options 3, 4 and 5 achieve minimum requirements and option 3 is considered most beneficial at this time. (Following stage 1 assessment).
- Further assessment of options (stage 2 onwards) has identified additional benefits for an increase in cost resulting in an improved cost benefit analysis (CBA) ratio.

We therefore have options 3, 4 and 5 to pursue. Beyond stage 1 we will consider the value our customers place on the additional benefits. We will only pursue an option if it continues to be cost beneficial and does not become disproportionately expensive (and unaffordable) – to ensure that bill impacts are kept to a minimum for customers.

In the following sections we set out the specific options considered, and cost benefit assessment for each of the three investment needs for:

- strategic sections of assets;
- large surface water treatment works; and
- Network response to a treatment work failure.

Strategic sections of assets

[REDACTED]

Summary of our total investment for Strategic Grid sections of assets

Central estimate	Capex	Opex	Population benefitting	Probability of failure
Strategic sections of assets- [REDACTED]	£29.5 million	£59,000 p.a.	98,176	0.05

Our preferred option is cost beneficial

We have undertaken cost benefit analysis (see table below) which supports our decision to promote our preferred solution detailed above. Cost benefit has been calculated in terms of net present value (NPV) and cost benefit ratio.

Cost benefit assessment and sensitivity analysis

		Best estimate on key assumptions (probability of failure and interruption length) Low benefits (WTP only)	Sensitivity on assumptions (25% reduction on probability of failure and interruption length) Low benefits (WTP only)
[REDACTED] option 1	NPV (benefits-costs)	£ 23,276,588	£3,037,091
	CBA ratio	1.83	1.11
[REDACTED] option 2	NPV (benefits-costs)	-£35,072,385	-£46,738,872
	CBA ratio	0.45	0.26

[REDACTED] option 3	NPV (benefits-costs)	-£3,271,544	-£9,227,796
	CBA ratio	0.81	0.47

Our preferred option ([REDACTED] option 1 including synergies from our proposed supply/demand driven investment) is cost beneficial and has a CBA ratio of 1.83. Alternative options [REDACTED] . . were found to be not cost beneficial having CBA ratios of 0.45 and 0.81 respectively.

We have also carried out sensitivity analysis to test our assumptions. This analysis reduced the probability and supply interruption length by 25% which has reduced the CBA ratio of our preferred solution to 1.11. However, this option remains cost beneficial which gives confidence that our assumptions would need to be incorrect by a considerable margin for option 1 to not be cost beneficial. .

Large surface water treatment works

We have set out the need to reduce the risk of a supply interruption in excess of 24 hours for 386,898 customers resulting from the outage of four of the larger surface water treatment works that serve customers.

Our option assessments have focused on solutions to provide resilience for four of the larger surface water treatment works that serve our customers and are at greatest risk –[REDACTED] . . . Our assessment identified a total of 23 options to resolve the supply deficits that would be created in the event of a failure of these works.

These are summarised in the table below.

[REDACTED]

Our preferred solutions are cost beneficial

We have undertaken cost benefit analysis (as shown in the table below) which supports our decision to promote our preferred solutions for [four locations REDACTED] .water treatment works. Cost benefit for each solution has been calculated in terms of net present value (NPV) and cost benefit ratio. Where there is a dual benefit with this solution and other solutions included in this business case, we have not double counted these within the analysis. Durations of outages within these calculations can vary depending on the mode of failure. We have taken a cautious approach and selected a 10 day outage.

Summary of our total investment for surface water treatment works

Central estimate	Capex	Opex	Population benefitting	Probability of failure
Surface water treatment works	53.5 million	-	386,898	0.03*

*This probability is taken from our SWIFT analysis

Cost benefit assessment and sensitivity analysis

[REDACTED]

Sensitivity analysis of our preferred solutions has reduced the CBA ratio as expected. However, the Bamford solution remains marginally cost beneficial while the Melbourne and Trimpley/Hampton Loade solutions remain strongly cost beneficial. This gives confidence that our assumptions would need to be incorrect by a considerable margin for the preferred options to be not cost beneficial.

Network response to a treatment work failure

Enhancements to the capability of other water treatment works and the distribution infrastructure so that - in the event of a failure in a significant treatments works - water can be moved to customers to maintain supply, would mean that 2,693,979 customers would benefit from an improved level of service in the event of a failure, of which 1,346,990 would benefit from reduced risk of discoloured supplies.

We set out in the table below the assets that we would seek to prioritise to increase resilience capability. The number of interventions required, and the cost increases with resilience category as assets are improved to a higher resilience category. The type of interventions required are wide ranging, but primarily enable us to fully automate critical sections of the Strategic Grid. To achieve this, we will need to implement an integrated control system by installing actuated valves, pressure control equipment, improved flow measurement, pipeline reinforcements, additional cross connections to improve interconnectivity and the upgrading of existing pumps. Once installed, we will then make operational changes to run the network regularly at resilience mode to ensure that we are ready to operate without risk when we need to under a failure scenario.

The full cost of solutions needed to meet the required resilience category for each water treatment works are summarised in the table below. The ongoing operation of these solutions will result in an annual opex increase of £1.8 million (based on current estimates).

Summary of costs to meet each resilience category

[Figure REDACTED]

Our proposed solution is to undertake interventions that will improve the capability of these existing assets to an R4 category standard so as to meet the needs of our customers. We estimate this will cost a total of £20.6 million and includes a total of 19 interventions on nine water treatment works.

We consider the R4 category to be the appropriate standard having listened to our customers. They can be deployed when required without the risk of failure – e.g. a supply discolouration or supply interruption. The table below sets out the overall costs of our proposed solution.

Overall cost and benefit of solution to R4 category standard

Central estimate	Capex	Opex	Population benefitting	Probability
Strategic network capability improving from R1/R2 to R4	£20.6 million	£1.8 million p.a.	2,693,979	0.03*

* We have assumed the probability of other strategic network assets being deployed in a resilience scenario is dependent on the probability of a surface water treatment works failing. This probability is being updated to give a single system risk.

Our preferred solution is cost beneficial

We have undertaken cost benefit analysis which supports our decision to promote our preferred solution detailed in the table above. Cost benefit has been calculated in terms of net present value (NPV) and cost benefit ratio. Where there is a dual benefit with this solution and other solutions included in this business case, we have not double counted these within the analysis.

Cost benefit assessment and sensitivity analysis

		Best estimate on key assumptions (probability of failure and interruption length) Low benefits (WTP only)	Sensitivity on assumptions (25% reduction on probability of failure and interruption length) Low benefits (WTP only)
Network option 1	NPV (benefits-costs)	£ 23,514,719	-£10,003,668
	CBA ratio	1.35	0.85

Our preferred option is cost beneficial and has a CBA ratio of 1.35. We have also carried out sensitivity analysis to test our assumptions. This analysis reduced the probability and supply interruption length by 25% which has reduced the CBA ratio of our preferred solution to 0.85 which is not cost beneficial. However, this demonstrates that our assumptions would need to be incorrect by a considerable margin for the option to not be cost beneficial. We will continue to refine our analysis as we move closer to AMP7 to improve even further the CBA ratio.

8.7.3.5 Robustness and efficiency of costs

As outlined in appendix A8.1 and A8.2, we have set ourselves stretching efficiency targets across our plan.

You can read about this in Chapter 20 – Securing cost efficiency, where we've explained how we are planning to build on our strong AMP6 efficiency performance to deliver 13% efficiency on wholesale costs. We also conducted a number of external benchmarking studies to build and test the efficiency of our costs including construction contract costs, construction on-costs and support costs. The range of studies helped to ensure we avoided potential bias from not comparing costs on a like-for-like basis and, as we also repeated some PR14 benchmarking, provided a consistent analysis. The analysis proved to be an eye opener, helping us to find and prioritize specific areas of opportunity to build into our PR19 efficiency plans. We've summarised the results of our benchmarking analysis in Chapter 20, and have included the studies in this appendix.

Delivering cost efficiency in Severn Trent Water

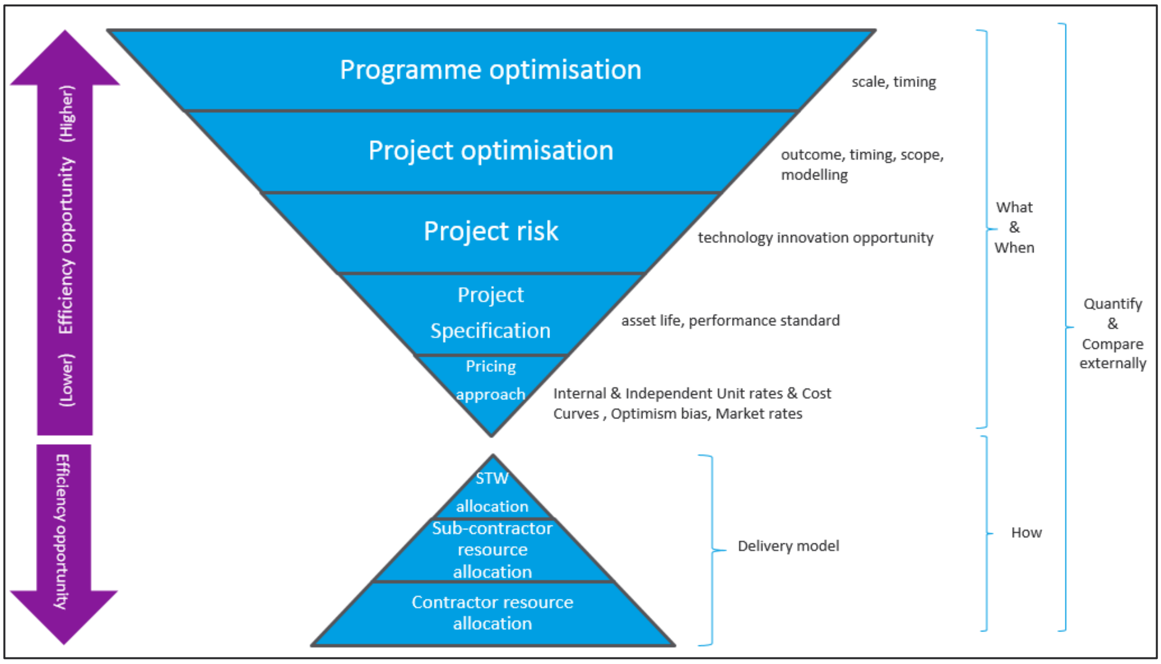
For this business case we have adopted a proportionate approach to risk and cost having regard to our customers' needs. They have told us that they think of value [of investments] in terms of 'effectiveness and spreading the cost over time and not the lowest cost option', so it is clear they have sophisticated expectations in this area. The linking of solution effectiveness, time and low cost, suggests to us that our customers expect;

- our work to be phased in such a way to avoid large changes in bills (wherever we can);
- solutions that do not deliver short term cost savings at the expense of long term cost increases;
- our solutions need to be reliable over time; and
- have an associated benefit stream that addresses the challenge sufficiently.

Our cost efficiency strategy seeks to deliver on all these expectations.

There are multiple strands to delivering cost efficiency as shown in the figure below.

Our model for delivering cost efficiency



The most significant savings exist when looking scaling the proposal at a programme level; scaling the investment proposal offers the most significant level of savings to our customers. In order to establish the appropriate scale of investment we assessed our resilience opportunities and removed all assets (and thus sites) that do not fulfil our resilience selection criteria – this ensures we do not invest where our process streams, sites or systems already have resilience embedded within them. If we establish resilience pre-exists we will not invest. Our review identified a number of proposals where this was the case.

Programme scaling was also impacted by a thorough understanding of the complex interactions between all the existing and emerging capacities being created. As we developed our understanding of the impact and benefits of our Birmingham Resilience Project we have been able to demonstrate resilience investment is not now required at Strensham WTW. This has negated the need for c£50M of investment. Scaling was also impacted by reviewing synergies between our 'supply-demand' programme and our resilience programme. [REDACTED . . . .We have however since demonstrated that the resilience challenge can be addressed by other means which offer almost the same level of saving independent of the 'supply demand' scheme.

Project scope is selected according to the most optimal way of delivering the benefit in the particular project circumstance. At [REDACTED] we reviewed varies levels of scope to cover off the deficit in supply in the event of failure of the works. This ranged from standalone new supply schemes, increasing capacities across the Grid and duplicating process streams on site. Each carries a different risk post-investment. At [REDACTED] our option costs ranged from c£14M – c£160M with post-investment risk assessments of low, medium and high. The elements of work within projects have been costed using our cost tools. We have followed a structured approach to building cost estimates – this is contained in our 125page Cost Methodology Report.

The costs of the projects which have been selected and included in our Plan have been established through the use of the following estimating tools;

- STW cost curves established, updated and refined over the last 15yrs for similar activity;

- STW unit rates established, updated and refined over the last 15 years;
- Cost data provided by an independent engineering consultant with specialist cost data sets; and
- Best practice guidance on understanding and applying an appropriate level of optimism bias within our projects

We have then tested the efficiency of these using an independent expert (Turner & Townsend) by;

- Benchmark testing a selection of representative projects; and
- Benchmark testing a number of programme level costs e.g. feasibility fee, design fee, project support costs.

Cost efficiency benchmarking is set against the background of having secured programme optimisation and project optimisation savings such that they accrue in their entirety to Customers. On this programme of work we estimate that these costs are in excess of £100m capex.

The results of the benchmarking exercise are set out below.

Industry standard guidance on Optimism bias for typical projects contained in the Resilience programme are 44%. We have reduced this by 36% following a review of component weighting following a review of what elements of uncertainty are not captured elsewhere – this has avoided double counting of risk and uncertainty.

A project containing elements of work that are replicated across the whole proposed programme has been tested for cost efficiency by our independent third party specialist cost expert (Turner & Townsend). This project contained; river intake enhancements, treatment works extension, pumping station and cross country trunk main.

The project at [REDACTED] has elements of work that are replicated across the whole proposed programme has been tested for cost efficiency by our independent third party specialist cost expert (Turner & Townsend [T&T]). The project contains; river intake enhancements, treatment works extension, pumping station and cross country trunk main. The costs against which T&T tested our estimates came from projects that have been constructed or are under construction – this means their reference prices are comprised of suppliers who have been successful in securing work and therefore are de-facto the most competitive. T&T priced the work according to our bill of quantities and then provided a P20, P50 and P80 reference point. Our aim was to be at P50 or below to demonstrate competitiveness as T&T deem this to be competitive. The representative scheme is considered competitive by T&T; "The estimation which Severn Trent Water submitted for the scheme was [REDACTED]. This is close to our P50 estimate [REDACTED] therefore in our view Severn Trent Water's estimate is deemed competitive''.

We recognise that driving savings at a programme level and testing the cost efficiency of a representative project (using a standard methodology and standard tools) may leave minor risks elsewhere on our programme. In order to address this risk we also engaged our independent cost expert to assess the cost efficiency of general recurring project costs such as upfront feasibility, investigative contracts and project management (defined as Owner team costs by T&T), design costs and Company overhead costs.. Our cost expert used other water companies and other sectors (Rail, Highways, Environment, Telecoms, Aviation and Power) against which to compare us. The results of this analysis is shown below;

Sector	% addition for capital overhead
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]

**this model is mainly outsourced and therefore may not be representative*

Sector	Design costs as a % of total project
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]

Sector	Owner costs as a % of total project
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]

Overall we believe this shows that our general costs are competitive across various sectors and in some cases at frontier or very close to.

8.7.3.6 Customer protection

The investment proposed in this business case is the principal means by which we will ensure we meet our performance commitment for increasing the percentage of our customers who receive a resilient supply.

We are proposing a performance commitment to protect customers which focuses on delivery of the service level that they have told us they want – percentage of customers whose service to the tap can be restored within 24 hours of a single failure event in their normal supply route.

This proposed performance commitment builds on our AMP6 equivalent (which covered only the failure of customers' sources of treated water) by combining the two elements of a resilient water service: source of treated water resilience; and network resilience. We believe the innovation applied to this measure sets us apart from others in the sector as we are not aware that others are seeking to measure resilience in this way. Our performance commitment now includes those customers who can be served sustainably by tankering as opposed to the more traditional approach of [permanent] 'second source'.

The investment set out in this business case will contribute to a 9% improvement in AMP7 from a baseline of 87% at the end of AMP6.

The full definition and AMP7 target is set out in Appointee table 1, as well as appendix A3 – Designing performance commitments.

8.7.3.7 Affordability

We have carefully considered the affordability implications of our resilience proposals, and sought to drive down scope and cost wherever possible.

When we tested our proposals with customers with indicative bill impacts in our *choices* research – which allowed customers to prioritise investment in the context of other priorities in our plan, and potential bill impacts – we found that 78% of household customers and 76% of non-household customers support our investment proposals in relation to resilience.

As our plan has developed, we have engaged with the Water Forum about the balance of priorities, the extent of the efficiency challenge and the overall implications to the bill. We have tested the overall plan with customers in our acceptability research. The results of this are presented in Chapter 7 – Addressing affordability and vulnerability, and appendix A2.

8.7.3.8 Board assurance

Working with Pricewaterhouse Coopers, we designed a bespoke assurance framework to support the development of our plan to the highest quality. This Board-led framework builds upon our well-established and robust annual assurance processes. Each 'building block' within our plan was assessed for 'bottom up' risk to include the individual components (e.g. data/source, methodology, judgements and assumptions) against our likelihood factors (level of change, complexity, roles and responsibilities and subjectivity) and our impact factors (financial value, customer impact, competition, statutory/regulatory requirement).

The level of risk determined the type and level of assurance required with significant or high risk building blocks allocated to an independent third line assurance provider depending on the particular expertise required (technical/regulatory, financial, specialist model expertise etc.). This framework was applied to our cost adjustment claims which were assessed as high risk and therefore were assured through all three lines of assurance. Assurance was undertaken in stages and took account of costs, the need for the claim and testing of solutions. For more information on how we developed and applied our framework to our cost adjustment claims and the findings of the assurance, please read our 'securing trust, assurance and confidence' chapter and supporting appendix.

Annex 2: Line of sight between customer insight and action

Strategic investment area		Consolidated theme emerging from research	Details underpinning the theme	Sources	Further details of the sources	Score	How our plan reflects customer research findings
Supply resilience	Customer priorities	**A continuous supply of tap water is considered to be a basic customer need, alongside ensuring the safety of drinking water, and having a reliable service is something that our customers take for granted**		Customer needs research, Birmingham resilience research, Choices research (qual), Resilience deliberative			We are investing to ensure customers can continue to take their water supply for granted
		Customers want us to make the water supply more resilient	Customers are willing to pay for us to invest in supply resilience 78% of HH and small NHH customers support the investment to increase supply resilience, and 74% of medium and large NHH customers (Choices research, in the context of the bill impact, but single improvement choice) Investment in supply resilience is cost beneficial (based on WTP, in the context of other service improvements)	Choices research (qual and quant) Willingness to pay research (PR19) Birmingham resilience research			We are investing in enhancing supply resilience for our customers
		Customers don't accept long term interruptions to supply (over 24 hours)	Long term interruptions (longer than a day) are considered unacceptable due to the potential impact on customer's life.	Resilience deliberative research (page 30), Best in class customer service (page 37)	This is backed up by the WTP research - short term interruptions don't emerge as a priority for improvement and WTP for improvements is small, and also by the Choices research. In the best in class qual research customers expected resolution of an interruption within 24 hours (although timings in the quant were more stringent). Other sources (budget game, tracker) potentially contradict this for 6-12 hour interruption emerging as a higher priority. In the resilience research setting customers were potentially more "understanding" and we were discussing major disruptive events (for example in the choices qual participants tended to think about more routine planned maintenance)		The proposed investment addresses the risk of long term interruptions to supply (i.e. avoids interruptions over 24 hours), and brings these customers up to the same resilience level as the majority of our customer base
			Customers are willing to pay to avoid interruptions, and their valuation increases with the duration of the interruption	Birmingham resilience research			
			Short / medium term interruptions to supply (a few hours to half a day) are seen as inconvenient but acceptable	Resilience deliberative research (page 29, 30)			
		Customers want us to reduce supply with a reasonable chance of discoloration	Appealing taste, smell and appearance of tap water are a basic expectation of the water supply. Many customers are unaware that discolored water is safe to drink.	Resilience deliberative research (page 32) and choices research			Investment in operational readiness to avoid supply with a chance of discoloration
			Fleeting duration (i.e. less than an hour) is seen as relatively minor, however longer discoloration (e.g. lasting more than an hour) starts to become unacceptable	Resilience deliberative research (page 32)			
	Investment support	**Customers made it clear that we should have plans in place to ensure a continuous water supply**	Customers are more understanding of an interruption to water supply if the cause is natural or out of Severn Trent's control. Most think that Severn Trent should prepare for any threats to water supply	Resilience deliberative research (page 42), Birmingham resilience research			We are investing in enhancing supply resilience for our customers. Our optioneering considers the most suitable way of providing customers will continuous supplies
			Customers consider interruptions due to single points of failure unacceptable.				
	Solutions	**Customers think that we should have a combined approach to resilience (i.e. both anticipating the challenge and preparing to respond when things go wrong)**	While customers accepted that weather conditions are unpredictable and out of Severn Trent's hands, they also expected Severn Trent to have preventative plans in place (to avoid interrupting customer supply)	Resilience deliberative research (page 24)	This is in the context of discussing high impact, low probability events		We have operational response plans (hot weather action plans, response to flooding) in order to prevent customer impact of extreme weather situations
			Customers think we need to provide a back up option to ensure a constant supply of water	Birmingham resilience research	This is from specific research in which we were asking about a back up supply for Birmingham		Optioneering will consider back up options as well other ways of mitigating the threat
			Customers don't prioritise supplying rural areas with contingency supplies as highly as urban areas - It seems intuitive that urban areas would be prioritised due to population differences and economic impacts	Resilience deliberative research (page 56)			Rural communities would be protected through operational response solutions (e.g. tankered supplies), rather than back up supplies or dual streaming.

Scoring	Rationale
	Multiple sources of evidence converge on the same finding (repeat themes) Including both quantitative and qualitative evidence
	Some consistency in themes across multiple sources but also some contradictory views
	Qualitative evidence from a single study that we should be wary of generalising Single source of evidence or multiple contradictory evidence from different sources Evidence from a old research project or on a slightly different topic

Annex 3: Scale of activity undertaken to develop this business case and simplified process and activities

	1. Understanding our Strategic Assets and their Constraints								2. Approach/Analysis																								3. Risk Appraisal, Prioritisation and Solution Development											
Option	Define Grid	Categorise by Asset Type	SG Hydraulic model build	Grid Capacity	Grid Constraints	Existing Opex Costs	MISER base model	Existing Asset performance assessment in Resilience mode	Network Component Failure Mode (geotechnical, other)	Consequence of failure - Fatalaties	Consequence of failure - Injury	Consequence of failure - Community Risk	Consequence of failure - Reputational damage	Consequence of failure - Supply Interruption	Consequence of failure - Discolouration risk	Consequence of failure - Repair Cost	Consequence of failure - Alternative supplies	Probability of failure - by asset type	Annualised Risk	MISER modelling - deficit analysis	Flow Restoration Plans	System Resilience Study - WTW's	System Resilience Study - Existing assets (R1 to R4 baseline category)	SWIFT analysis	Solution development - SLBA	Solution development - WTW's deficit	Solution development - Existing network assets	Cost estimates - initial	Solution type - Resistance	Solution type - Reliability	Solution Type - Redundancy	Solution type - Response and Recovery	System Risk analysis	Benefits assessment	Aquator modelling	Scenario Testing	Prioritisation	Cost Estimate - using WRMP/Resilience cost model	Residual Risk analysis	Cost Benefit Analysis	Optimisation with WRMP solutions	Aquator modelling with combined WRMP and Resilience solutions	Appraisal of cross workstream benefits	Prioritised programme of investment
Strategic Network Asset Options																																												
NDNE reinforcements - option 1	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
NDNE reinforcements - option 2	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NDNE - additional	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SLBA pipeline 90Ml/d	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
SLBA pipeline 25Ml/d	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Expand Little Eaton plus pipe refurb	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Expand Little Eaton plus new pipe	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Carsington WTW to Ambergate	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Expand Ogston WTW	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
River Idle to Sunnyside SR	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Church Wilne WTW plus pump to Strelley SR	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Homesford to Ambergate	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Strategic Grid transfer - option 1	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Strategic Grid transfer - option 2	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Water Treatment Works Options																																												
Bamford - dual Streaming	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bamford - Rivelin/Loxley WTW transfer	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bamford - Import from YW Grid	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bamford - AMP5 Rivelin resilience	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bamford - new main - Loxley	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bamford - Ch Wilne to Long Eaton and Higham	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bamford - new main Carsington to Bamford	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bamford - new main Ambergate to Bamford	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melbourne - Ch Wilne treatment-Hathern transfer	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melbourne - dual streaming	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Melbourne - Ch Wilne treatment Melbourne trans	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melbourne - Grid solution - Melbourne to Oldbury	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melbourne - ASL link main	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melbourne - Tuttle Hill DSR	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melbourne - Oldbury booster	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Hampton Loade - rebuild with dual streaming	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Hampton Loade - new main Tettenhall/Goldthorne	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Hampton Loade - new main Hampton Loade to Trir	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trimpley - dual streaming	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Trimpley - new WTW Hollywaste	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Trimpley - Grid solution Elbury Hill	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Trimpley - Grid solution - Strategic Link main	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Trimpley - new main Hampton Loade to Trimpley	✓	✓	✓	✓	✓	✓	✓	✓												✓		✓		✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Existing Network Intervention Options																																												
Bamford resilience - to R2 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R2 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R2 - intervention 3	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R2 - intervention 4	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R2 - intervention 5	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Trimpley resilience - to R2 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 3	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 4	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 5	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 6	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 7	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 8	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R3 - intervention 9	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Campion Hills resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Church Wilne resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Church Wilne resilience - to R3 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Melbourne resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Melbourne resilience - to R3 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Melbourne resilience - to R3 - intervention 3	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Melbourne resilience - to R3 - intervention 4	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Ogston resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Strensham resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Trimpley resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Whitacre resilience - to R3 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Whitacre resilience - to R3 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				
Bamford resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 3	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 4	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 5	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 6	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 7	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 8	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 9	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 10	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Bamford resilience - to R4 - intervention 11	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Campion Hills resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Church Wilne resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Church Wilne resilience - to R4 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Melbourne resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Melbourne resilience - to R4 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Melbourne resilience - to R4 - intervention 3	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Melbourne resilience - to R4 - intervention 4	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Melbourne resilience - to R4 - intervention 5	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Melbourne resilience - to R4 - intervention 6	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Ogston resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Shelton resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Shelton resilience - to R4 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Strensham resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Strensham resilience - to R4 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Strensham resilience - to R4 - intervention 3	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Trimpley resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Whitacre resilience - to R4 - intervention 1	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓
Whitacre resilience - to R4 - intervention 2	✓	✓	✓	✓	✓	✓	✓	✓															✓				✓	✓			✓			✓			✓			✓				✓

1. UNDERSTANDING OUR STRATEGIC ASSETS AND THEIR CONSTRAINTS

Our Strategic Assets

Our strategic water supply assets form an integrated system of aqueducts, pipelines, reservoirs, resources, water treatment works and control systems. This enables us to move water within a large geographical area in a flexible and sustainable way.

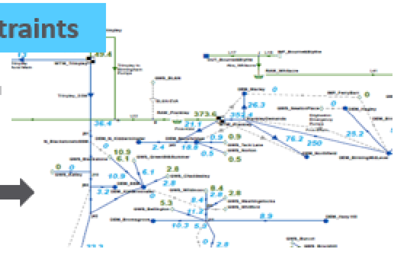
Pipeline and Siphon Length – 1,104 km
Tunnel, Conduit and Masonry Crossings Length – 92 km
Large Surface Water Treatment Works – 17 No.

Capability, Capacity and Constraints

Huge data gathering exercise

- WTW's constraints
- Borehole yields
- Outages
- Demands
- Licence constraints
- Operating costs
- Blending Rules
- Distribution constraints
- Imports/exports

Data incorporated into MISER model – to be used for further resilience analysis



Outputs

- Understanding the Capacity of the Strategic Grid - Report
- Strategic Grid SynerGee (Hydraulic) Model
- Updated MISER model

Investment

6 months

Approx 3,000 man hours

2

2. APPROACH/ANALYSIS

Asset Health/Assurance Risk Based Approach

- Prescribed Methodology
- Consistently Applied
- Specific to Asset Type

Probability of Failure

- Condition data
- Deterioration models
- Asset history
- Geotechnical/other hazards
- Thrust path models
- SWIFT analysis for WTW's

Consequence of Failure

- Monetised values
- Population affected by a supply interruption
- Population affected by discolouration
- Community risk (life and property)
- Repair costs
- Alternative supplies
- Economic damage
- Reputational damage
- MISER modelling
- Flow restoration plans

System Risk and Criticality

- Risk at 'System Level'
- Risk to Service
- Risk Hierarchy

Outputs

6 No. Methodology Documents
(defining approach for each asset type/hazard)

4 No Risk Models
(by asset type/hazard – tunnels, pipes, defects, geotechnical)

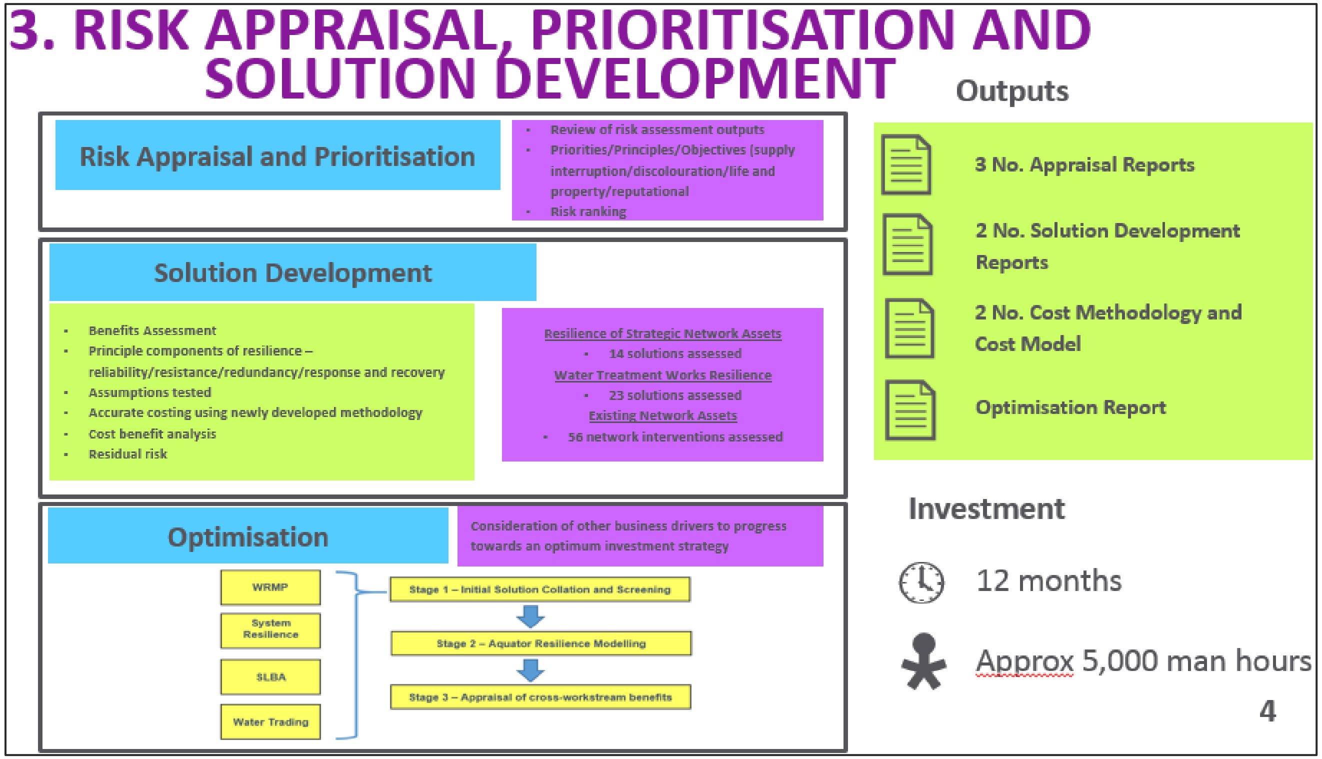
5 No. Other Technical Studies
(Flow restoration plans, system resilience WTW's & existing assets, MISER modelling, SWIFT analysis, system level risk)

Investment

12 months

Approx 5,200 man hours

3


3. RISK APPRAISAL, PRIORITISATION AND SOLUTION DEVELOPMENT
Risk Appraisal and Prioritisation
Review of risk assessment outputs
Priorities/Principles/Objectives (supply interruption/discolouration/life and property/reputational
Risk ranking
Solution Development
Benefits Assessment
Principle components of resilience – reliability/resistance/redundancy/response and recovery
Assumptions tested
Accurate costing using newly developed methodology
Cost benefit analysis
Residual risk
Resilience of Strategic Network Assets
14 solutions assessed
Water Treatment Works Resilience
23 solutions assessed
Existing Network Assets
56 network interventions assessed
Optimisation
Consideration of other business drivers to progress towards an optimum investment strategy
WRMP
System Resilience
SLBA
Water Trading
Stage 1 – Initial Solution Collation and Screening
Stage 2 – Aquator Resilience Modelling
Stage 3 – Appraisal of cross-workstream benefits
Outputs
3 No. Appraisal Reports
2 No. Solution Development Reports
2 No. Cost Methodology and Cost Model
Optimisation Report
Investment
12 months
Approx 5,000 man hours
4

8.7.4 Cost adjustment claim: security

While our customers accept that some risks will persist (even after investment), they expect us to have appropriate measures in place to protect against current and foreseeable future threats.

[REDACTED]

Pages 305-345 REDACTED

8.8 BENCHMARKING STUDIES AND MODELLING CLAIM SUPPORT

Benchmarking

Benchmarking can provide an external and independent perspective on how costs compare with others, both inside the water sector and from wider afield. But a wide range of studies is needed to avoid potential bias from not comparing costs on a like-for-like basis.

We've undertaken a series of benchmarking studies, including repeating analysis originally carried out at PR14 to provide a consistent and comparable dataset. The analysis we've undertaken has proven to be an eye opener, helping us to find and prioritize specific areas of opportunity to build into our PR19 efficiency plans.

The results of our benchmarking analysis is summarised in Chapter 20 securing cost efficiency, with the five external reports included as outlined below.

8.8.1 Arcadis benchmarking report
8.8.2 Turner & Townsend General benchmarking report
8.8.3 Turner & Townsend cost adjustment claims specific report
8.8.4 PwC benchmarking report (in line with the PwC terms of engagement we've not included this report)
8.8.5 Atkins Cyber Security Benchmarking report

Cost modelling claims

In May we submitted four documents in support of our claims. For ease of reference the same reports are included as set out below:

8.8.6 Severn Trent and Hafren Dyfrdwy supporting report (Arup)
8.8.7 Developer services supporting evidence
8.8.8 Cornwall energy price forecast report
8.8.9 ONS table 406 – housebuilding forecast