ST Classification: UNMARKED

SVE4.24

Raw water deterioration

Draft Determination representations

28 August 2024

WONDERFUL ON TAP

SEVERN TRENT

Contents

1. Executive Summary

Background

Severn Trent's business plan proposed a total of £336m to make improvements at water treatment works and across the catchments to ensure we can continue to treat the incoming water, which is deteriorating in quality across five water quality parameters. The investment is supported by the Drinking Water Inspectorate, who has served notices and/or issued letters of support for 99.4% of the investment covered by this business case. They 'commend for support' the remaining 0.6%.

The challenge: Insufficient evidence

Section 3.6 of the Draft Determination Expenditure Allowances document sets out the decisions related to raw water deterioration. Draft determination model "PR24-DD-W-Raw-water-quality-deterioration" sets out the allowance calculations and business case assessments.

The draft determination allows £202m, 39% less than the total in our business plan. The basis for the efficient challenge was largely due to two issues:

- Issue 1 – We did not provide sufficient evidence of optioneering and cost-benefit analysis – this is not to suggest we had chosen the wrong solution, but rather we did not provide Ofwat with the evidence to show why our preferred solutions were the right ones (resulting in a 20% cost adjustment on average).
- Issue 2 - Lack of evidence of efficient costs, benchmarking or independent assurance (resulting in a 20% cost adjustment on average) – Ofwat have been unable to create effective cost models and therefore requested additional evidence on benchmarking and assurance.

Separately, for the investment (£13m / 3.5%) that did not pass the "need" test, Ofwat rejected the schemes through the shallow dive process due to potential overlap with base and AMP7 funding. One scheme related to our proposal to develop our own PFAS sampling facility (£2m), the other related to catchment management schemes (£1m) and £10m relates to operating costs associated with assets that are not yet operational and therefore not accounted for in the base allowance. We provide evidence associated with the operating costs in representation SVE4.36 Operating costs for new capital schemes.

In its assessment of our Water WINEP Drinking Water Protected Areas (DWPA) proposals, Ofwat disallowed £7.4m of investment associated with catchment management schemes for managing cryptosporidium risk on the grounds that they were not named obligations in WINEP. That is true, but they are statutory obligations either instructed by the DWI or NRW and so we have moved these obligations onto the raw water deterioration drivers in the data tables and provide further evidence for the need and to demonstrate efficient costs in this representation.

Why it matters

The Drinking Water Inspectorate (DWI) sets clear parameters for the water quality solutions that are acceptable. Before support is formally issued, the DWI scrutinise the evidence to verify that there is an observed deterioration in the raw water quality. This evidence involves investigations, sampling and months of analysis and discussion and then, if satisfied with the evidence, concludes with a letter of support. This acts as independent confirmation that there is a demonstrable change in the quality of the source water which must be addressed to maintain the high drinking water standards.

The costs submitted in our PR24 business plan reflect these parameters, and it is not possible to value-engineer 39% of these costs out of the plan whilst also ensuring delivery in line with the DWI expectations. This reduction is over and above the c£20m cost reduction we applied before submitting our plan which was made to challenge ourselves to submit competitive costs. That means the current allowance would not allow us to deliver on our statutory obligations.

Our response

We have taken on board the challenges made by Ofwat to inform its top-down cuts and recognise that (i) we could have shared additional detail of the work we undertook to develop our preferred solutions; and (ii) we have since undertaken further analysis to develop the scope, costings and have engaged the supply chain to establish clear delivery plans. We summarise the key points below and provide detailed points in the remainder of this document.

Optioneering and CBA

- We have reviewed a total of 97 solutions, including the one option specified by Ofwat in the DD that it thought might be useful to review to assure ourselves and the DWI that we have identified the right solutions for AMP8.
- 43 options were then selected for detailed cost-benefit analysis, and taking on board the feedback in the DD, we have included the full results of each assessment in this response. Importantly, the analysis demonstrates that the solutions we have selected all have the best cost-benefit ratios.
- We have provided the DWI and an independent assurer with our approach and the results to confirm that not only have we followed a rigorous process, but that we have chosen the right solution for our customers.
    - For example, in response to the question "Does the document demonstrate that methods and evidence gathering are based on best practice" Jacobs scored us with an "A" and noted: *"Yes, multiple references to published literature in addition to evidence showing support from consultants and companies operating across the industry e.g. costings based on quotations, benchmarking exercises, exploration of alternative options to determine best solution."*
    - *Optioneering has taken place across a broad range of alternative solutions. A lot of the tables show costings associated with alternative options*
- Overall, we strongly believe (as does the DWI) that we have identified the right 12 solutions to deliver safe drinking water to our customers. We do not have any outstanding actions from the DD on this topic nor is there any evidence to suggest that we have chosen the wrong solution. In fact, as we note in the next section, the evidence is unequivocal that these solutions benchmark as being highly efficient. We therefore do not consider that the top-down adjustment of 20% should be retained.

Efficiency

In the absence of draft determination enhancement cost models, we appreciate the need to provide Ofwat with additional evidence on why our costs are efficient. We therefore sought to provide Ofwat with this assurance through four different methods.

- Bottom-up benchmarking – we have benchmarked our component costs against other companies using an independent cost consultant for each of the drivers of raw water deterioration. Across all drivers we perform better than average and typically in the upper quartile range. **Outcome: Between Median-UQ efficiency**

- Utilising PR24 cost models - Similar to how Ofwat assessed water resilience interconnector costs, using cost models from other areas, we have assessed our raw water deterioration costs using supply enhancement models given they support the same outcome, water available for use through new treatment processes. For each cost driver our costs are identified as being super-efficient, with capping being the likely intervention if these were submitted under a different driver. **Outcome: Highly efficient and better than the capping threshold**
- Independent assurance - We have also engaged three independent assurers to assess the efficiency of our costs Aqua Consultants and Gardiner and Theobold and Jacobs. For example, Jacobs noted:
    - The proposal contains a lot of information on costs in section 5 including benchmarking, cost curves, internal/ external reviews of costs and how efficiency has been considered through the stages of the case development. (scoring an A)
- Development of new cost models. We appreciate that Ofwat started the PR24 process with the intention of developing raw water deterioration models. Working with independent consultants (Reckon) we have proposed models across 4 drivers that could be used to assess raw water deterioration costs ahead of the FD. Under these models we generate efficiency scores in the region of 80%. Whilst this would not lead to our costs being capped, it does underscore the stretching nature of our proposals. **Outcome: Highly efficient**
- Irrespective of how our costs are assessed, they come out as efficient. This is consistent with other parts of our plan, from base costs, to water resources and CSOs, whereby our costs are deemed to be very efficient. For this driver we also took the added precaution of applying a to-down £20m challenge to ensure that we were comfortably below any efficiency benchmark. In this document we have closed down all specific actions from the DD and therefore do not believe there is any outstanding justification for applying a 40% cost challenge on schemes that address an agreed need by the DWI.

Table 1 below outlines the raw water deterioration representations in this document.

Table 1: Severn Trent raw water deterioration representations

Representation	Challenge type	Our response	Additional allowance above DD
Chapter 3: Use of Ofwat models to demonstrate efficient costs	Insufficient evidence	Utilise DD models, plus further model improvements	Covered in specific cases below
Chapter 4: Nitrate	Insufficient evidence	CBA on waste disposal provided. Use cost models to assess cost efficiency	£18.7m
Chapter 4: PFAS*	Insufficient evidence	More optioneering presented	£18.0m
Chapter 5: Whitacre WTW	Insufficient evidence	More detail on CBA provided. Use cost models to assess efficient costs	£19.8m
Chapter 6: UV - Cresswell WTW	Insufficient evidence	More detail on CBA provided. Use cost models to assess efficient costs	£3.8m
Chapter 7: PFAS Labs	Insufficient evidence	Detail behind commercial sector limitations.	£2.4m

Chapter 8: Crypto – Far Baulker/Rufford membrane	Insufficient evidence	More detail on CBA provided. Use cost models to assess efficient costs	£19.5m
Chapter 9: Lead – Homesford WTW	Insufficient evidence	More detail on solution and CBA provided. Use cost models to assess efficient costs	£29.1m
Chapter 10: AMP7 continued catchment management	Failed need	Evidence that this represents cost effective enhancements not previously funded	£1.2m
Chapter 11: River Severn Crypto schemes (previously in WINEP)	Failed need	Evidence to demonstrate statutory and the best option has been found	£6.3m
Chapter 12: River Dee Crypto schemes (previously in WINEP)	Failed need	Evidence to demonstrate statutory and the best option has been found	£1.1m
Chapter 13: UV model and transition spend	Insufficient evidence	The resulting model application remove the need for this adjustment	£12.4m
Representation SVE4.36 Operating costs for new capital schemes	Overlap with base	See separate representation	Covered elsewhere
Total			**£133**

*In representation SVE4.28 we have set out a business case for new undertakings relating to PFAS regulations. This incorporates changes to our obligations since submitting the business plan including the impact of the guidance note setting out a change to the tier system for risk categorisation received on 21 August 24 from DWI.

The table below provides a reminder of our schemes and Ofwat's allowance.

Table 2: Summary of the plan we put forward and Ofwat's DD allowance.

DD assessment method	Driver/ Number of schemes	Our plan	DD allowance
Deep dive	Lead at 1 scheme	72.65	43.59
	Algae at 1 scheme	66.03	46.22
	PFAS at 3 schemes	47.55	27.06
	Nitrate at 2 schemes	36.35	18.17
	Crypto at 2 schemes	61.5	38.17
Shallow dive	Catchment management and AMP7 scheme OPEX	10.9	0.28
Model	UV at 4 schemes	11.1	10.0
Transitional/Accelerated	Across 12 of above schemes	30.2	18.875
Total		**336.28**	**202.365**

2. Best Option for customers

2.1 Overview of the challenge

The specific concerns raised for sub-programme differ, but the broad concerns were threefold:

- Insufficient evidence that a broad range of alternative options have been considered at either a scheme or at subcomponent level. Or in cases where alternative options have been considered, the company did not demonstrate they are the most appropriate options to compare.
- Insufficient evidence of the optioneering process or screening criteria.
- The absence of singular and categoric evidence that the chosen option is the most cost beneficial. In the case of UV concerns were raised because the calculations of the financial costs and risks and underpinning assumptions were not provided.

Table 3 provides a summary of the assessment and resulting adjustment.

Table3: Deep dive assessment results for "best option for customers"

Water Quality driver	Criteria decision	% adjustment	£m reduction
Nitrate	Significant concerns	30%	£10.9m
PFAS - GAC	Some concerns	20%	£9.0m
Crypto – Ceramic membranes	Some concerns	20%	£9.7m
PFAS labs	Some concerns	100% - failed need	£2.44
Algae (Whitacre)	Minor concerns	10%	£6.6m
UV	Some concerns	20%	£2.6m
Lead	Some concerns	20%	£14.5m
Catchment management	Shallow dive - n/a	100% - failed need	£10.6
			£66.3m

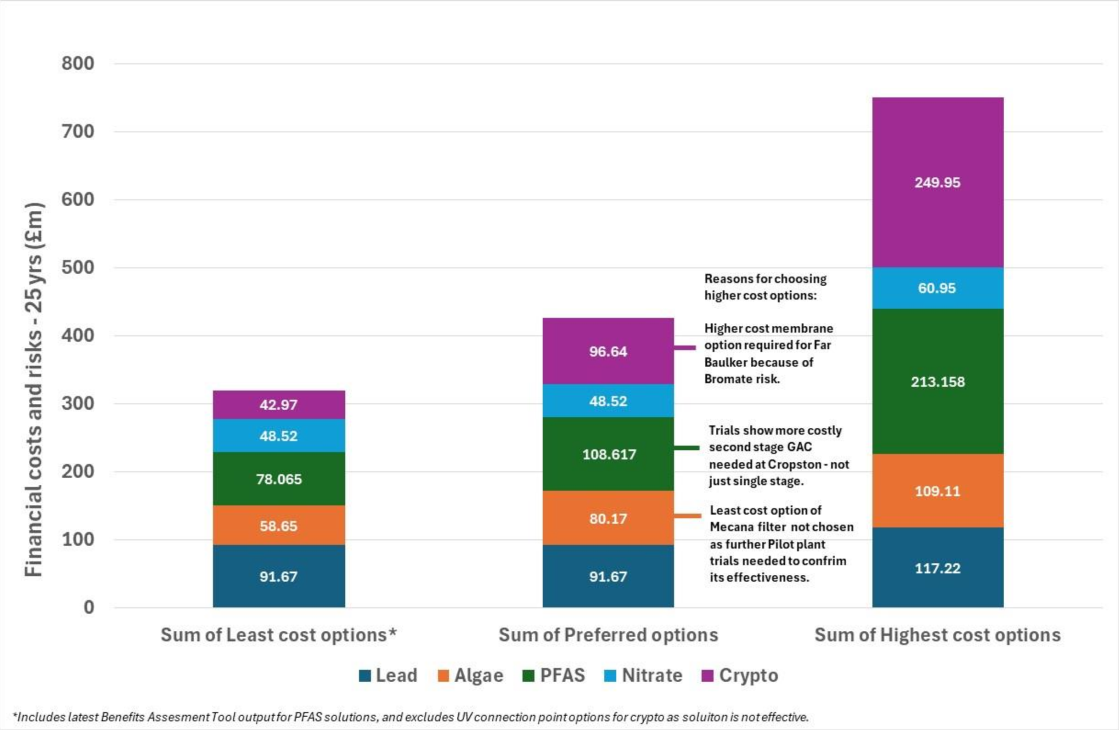
This assessment resulted in £66.3m reduction which would need to be met whilst still delivering the solutions set out in our plan which are specified by the DWI in the statutory instruments.

2.2 Results of our optioneering assessments

We maintain our view that the overall approach to assessing costs and benefits is appropriate for this programme. We do accept that not all of the evidence and supporting calculations were included in our business case which would have limited Ofwat's ability to verify and scrutinise the details. In sections 4-13 below we have now provided this level of detail for each water quality driver.

Figure 1 provides a summary of the results of the assessment and shows that in most cases we selected the least whole life cost solution on NPV grounds, and if not, why not.

Figure 1: Results of our best value assessments



2.3 Consideration of CBA/assessment methods

As described in our PR24 submission we followed a three-step process. It shows that we considered over 90 options, further developed 43 of those and then carried out carried out the cost benefit (using the factors listed in table 3) on those 43 options before selecting the final 12 solutions through a combination of CBA results and broader technical assessment.

We understand Ofwat's desire to see a wide range set of cost benefit ratios but we firmly believe it is not in customers best interest to progress options which would not meet the statutory requirement even if they could be delivered at a lower cost.

We carried out the options assessment collaboratively to gather a wide range of views - from detailed site-specific knowledge to broader third party input. Table 4 is reproduced from our PR24 business case to set out the breadth of activity against each driver.

Table 4: Activities and engagement undertaken during options assessment stage

Need	Site visits & activity	Teams involved	Engagement with Stakeholders and Regulators
Groundwater nitrate	Catchment visits and investigations at Beckbury and Cosford	Catchment, Hydrogeology, Customer Operations (site team), Engineering Design and Delivery	EA confirmation through WINEP plus EA local teams, DWI PR24 meetings, farmers in the catchment, National Farmers Union (NFU), Industry/consultants – for best practice for NEP nitrate investigations and treatment solutions.

Groundwater cryptosporidium	Site level Catchment Risk Assessment visits. Engineering desk-based reviews of our groundwater site surveys carried out our Integrated Programme Team for AMP7 delivery, e.g. borehole surveys, previous scheme reviews, MCCs etc	Catchment, Hydrogeology, Customer Operations (site team), Hydraulic engineers, Engineering Design and Delivery	EA confirmation through WINEP plus EA local teams, DWI PR24 meetings, farmers in the catchment, NFU Industry/consultants – for best practice for cryptosporidium investigations and treatment solutions.
Algae – Whitacre WTW	10 detailed site visits specifically about scheme solutions.	Severn Trent: Catchment, Customer Operations (site team), Treatment Process Engineering design team, Engineering Design and Delivery, Innovation team, Asset Strategy and Planning External suppliers: LG sonics (ultrasonics), Doosan (DAF), Elique Hydro (Mecana filter), and Mott MacDonald (floating wetlands)	EA confirmation through WINEP, plus local EA teams, DWI PR24 meetings, Natural England, Warwickshire Wildlife Trust, NFU, farmers in catchment, large estates in the catchment (e.g. Packington), Arden Farmer Facilitation Fund Network, Warwickshire Rural Hub, Harworth Group (Large commercial landowner) Shustoke Sailing Club, and Shustoke Fly Fishers (fishing club).
Lead – Homesford WTW	Four detailed site visits specifically about scheme solutions.	Severn Trent: Customer Operations (site team), Engineering Design and Delivery, Treatment Process Engineering design team, Innovation team, Asset Strategy and Planning. External supplier: Nanostone (ceramic membrane)	DWI PR24 meetings. Historically we have engaged with the EA on the structural integrity of the Meerbrook Sough, which is the source of Homesford WTW.
PFAS – Witches Oak WTW, Cropston WTW	We currently have a pilot plant and live project delivery team on site for our Green Recovery scheme at Witches Oak – the same team has been working on PFAS solution options for AMP8	Severn Trent: Catchment team, Customer Operations (site team) – water/wastewater/biosolids/trade effluent, Engineering Design and Delivery, Treatment Process Engineering design team, Innovation team, External supplier: Veolia	EA local teams – water and wastewater, Fire Service, East Midlands Airport, landfill operators, local authorities, UKHSA.
Emerging risks – monitoring and laboratory	Visits to Bridgend chemistry laboratories to confirm equipment and costs required.	Laboratory: Labs Manager and Principal Scientist, Strategy and Planning, Water Quality Regulations team,	Labs Liaison Forum, as well as other groups such as "Laboratory Mutual Aid – chaired by DWQR (Scotland) and with DWI in attendance", and the Standing Committee of Analysts (SCA).

The process resulted in a short list of schemes which progressed to cost and benefit assessment stage.

The details behind the cost benefit assessment approach can be found in Section 4.3.3 of our Long Term Delivery Strategy (LTDS)[1] which includes a description of the Benefits Assessment Tool (BAT) and how it meets Ofwat and EA requirements for CBA. We used the BAT to calculate the 25-year financial cost-benefit for each raw water deterioration scheme option in Section 2 of our PR24 enhancement case, UME13 Raw Water Deterioration[2]. The factors it includes are: capex, 25 year NPV operating costs, carbon. None of the natural capital metrics or customer willingness to pay were used for this assessment. We took this approach because:

- The investment need is statutory, and therefore we do not require a positive CBA ratio to justify that the investment is worthwhile for customers.

[1] sve06-long-term-delivery-strategy.pdf (stwater.co.uk)
[2] https://www.stwater.co.uk/content/dam/stw/about_us/pr24/sve29-13-raw-water-deterioration.pdf

- All the options evaluated in the BAT have the same benefit for customers in three ways: delivering the statutory obligation, the certainty of delivering the outcome (as a result of the phase 1 technical feasibility assessment), and the future DWI compliance risk index (CRI) risk they are offsetting. Monetising the benefit does not, therefore, provide a useful way of evaluating the best option for customers because it does not identify the distinction between options.
- Even if options did have differing certainties of outcome, and we wanted to use customer preference to rank the options it would not be possible because the drivers of our schemes (unlike other water companies' water quality plans, e.g. Welsh Water's Cefn Dryscoed WTW[3]) are offsetting the increased risk of water quality failures and have no other taste and odour (T&O)/customer acceptability drivers that can be monetised by willingness to pay (WTP) research. Table 5 below demonstrates this.

Table 5: Assessing relevance of monetisation of benefits for raw water deterioration schemes

SVE13 Statutory Scheme/driver	Relevance of monetisation through willingness-to-pay
Nitrate	Customers cannot see or taste nitrate. This is purely a health-based Prescribed Concentration or Value (PCV) set by the DWI. 'Boil water' notices will not prevent the problem.
Crypto/Bacti	Customers cannot see or taste crypto/bacti. The driver is drinking water safety plan (DWSP) risk reduction to prevent future events of illness, as seen in South West Water's incident in May 2024.
Lead (Homesford)	Customers cannot see or taste lead. This is purely a health-based PCV limit set by the DWI. 'Boil water' notices will not prevent the problem.
Algae (Whitacre)	At some WTWs in the UK, algal blooms can lead to the production of Geosmin and Methyl-Isoborneol (MIB) that can cause T&O/acceptability issues. We do not have that problem at Whitacre WTW; instead, the statutory scheme is to prevent algae blocking up our water treatment processes, which could cause crypto to enter supply and physically stop the supply of water. 'Boil water' notices will not prevent the problem.
PFAS	Customers cannot see or taste PFAS. This is purely a risk-based limit set by the DWI. 'Boil water' notices will not prevent the problem.

The primary benefit of this investment is securing future water quality for customers (a statutory obligation), with a secondary benefit of offsetting future CRI risk. Our PR24 case included an estimate of the CRI benefit associated with this investment.

In conclusion, we are confident that the best option has been evaluated using our BAT, a financial CBA approach that combines EA and Ofwat requirements, supplemented by expert review and in collaboration with the DWI.

[3] https://corporate.dwrcymru.com/-/media/project/files/page-documents/corporate/library/pr24-reports/september-2023/asset-planning-documents/wsh55-10-improved-water-quality-by-reducing-risks-on-water-treatment-works.ashx

3. Evidence to demonstrate efficient costs

3.1 Overview of the challenge

The specific concerns raised across each sub-programme differ, but the broad concern was due to the lack of evidence to explain the cost derivation at a granular enough level and insufficient evidence to demonstrate costs are efficient. The assessment and corresponding reductions are shown in table 6 and table 7 provides the specific challenges.

Table 6: Deep dive assessment results for "cost efficiency"

Water Quality driver	Criteria decision	% adjustment	£m reduction
Nitrates	Significant concerns	30%	£10.9m
PFAS - GAC	Some concerns	20%	£9.0m
Crypto – Ceramic membranes	Some concerns	20%	£9.7m
PFAS labs	Some concerns	100% - failed need	£2.44
Algae (Whitacre)	Minor concerns	10%	£6.6m
UV	Minor concerns	20%	£2.6m
Lead	Some concerns	20%	£14.5m
Catchment management	Shallow dive - n/a	100% - failed need	£10.6
			£66.3m

Table 7: Scheme specific challenges and sign post to response

Water Quality driver	Feedback	Sign post
Nitrates	Insufficient evidence about the cost of disposal of waste streams from the proposed locations.	Section 4
PFAS - GAC	Insufficient evidence that the proposed costs are efficient. Third party benchmarking was not able to cover Witches Oak because they had no comparable cost data for this PFAS technology.	Section 5
Algae (Whitacre)	limited historic cost data to draw upon to demonstrate cost efficiency" and that "where bottom-up benchmarking/market testing is used the cost component evidence presented is limited." Ofwat also noted that we had not provided third party assurance statements specifically for this scheme.	Section 6
UV	sufficiently demonstrate the how the additional iron and manganese removal is efficient". On the third-party benchmarking evidence that we had provided, Ofwat noted that "the evidence provided does not qualify or quantify the benchmark comparison dataset".	Section 7
PFAS labs	The company states visits to other chemistry laboratories to confirm equipment and costs required were undertaken but does not present these or provide evidence regarding liaison with other related forums. The company does not provide evidence to show that it has considered the efficiency of costs for the specialist laboratory equipment and specialist supporting items for PFAS and emerging contaminants.	Section 8
Crypto – Ceramic membranes	The company provides evidence of obtaining one supplier quotation for ceramic membranes that can provide the ultrafiltration required for DWI-approved cryptosporidium removal. The company does not provide any evidence that the costs are efficient .	Section 9
Lead	Insufficient evidence to demonstrate that the higher costs associated with "more stringent planning requirements for new buildings within the Derwent Valley Mills world heritage locality"	Section 10
Catchment management	Implied concern that investment was funded in AMP7 through base	Section 11

This assessment resulted in £66.3m reduction which would need to be met whilst still delivering the solutions set out in our plan which are specified by the DWI in the statutory instruments. The adjustment does not represent Ofwat's view of efficient cost, but an arbitrary penalty for failing to meet the evidence bar. It was clearly Ofwat's intention to create an enhancement model (s) to enable an independent view of costs to be set. Three of the four queries issued on raw water deterioration asked for cost and cost driver information to facilitate the production of a model, but only one model covering £10m (3%) of our costs was produced.

3.2 Summary of our response

In this section, we set out additional evidence to demonstrate that our costs are efficient. This has consisted of:

- bottom up benchmarking of our costs at a component level (review of our costs by independent cost consultants to benchmark against 5 other water companies);
- use of other draft determination cost models where we consider that the interventions proposed here are analogous (for this we have used Ofwat water supply unit cost models given that RWD schemes are also delivering similar water treatment works upgrades); and
- a development of these models that attempts to better reflect the specific cost drivers (this is to better reflect differences between different types of water treatment works upgrades across both raw water deterioration and supply demand drivers).

The outputs of these analyses are summarised in the table below (green highlight depicts areas where there is evidence of efficient costs):

Table 8: Summary of our efficiency analyses, showing costs are efficient

Raw Water Deterioration Component	Bottom up benchmarking of our costs	Use of analogous DD cost models	Econometric models developed to better reflect cost drivers
Nitrates 2 schemes @ Cosford and Beckbury	Bottom up benchmarking of costs show schemes to perform better than upper quartile	• Treatment components benchmark very efficiently against treatment (base activity scheme) unit cost model <0.15 efficiency score. • Schemes still outperform Ofwat smaller 'other' unit cost. • Waste disposal pipelines not analogous to interconnector modelling due to very low flows	• No better model identified than Ofwat DD approach
PFAS 4 schemes	N.a. Not assessed due to no comparable information being available	• Benchmark very efficiently against treatment (base activity scheme) unit cost models <0.1 efficiency score. • Schemes still outperform Ofwat smaller 'other' unit cost.	• Models accounting for supply, Lead, Algae and PFAS interventions. • Modelling shows programme to be efficient with an efficiency score of 0.87

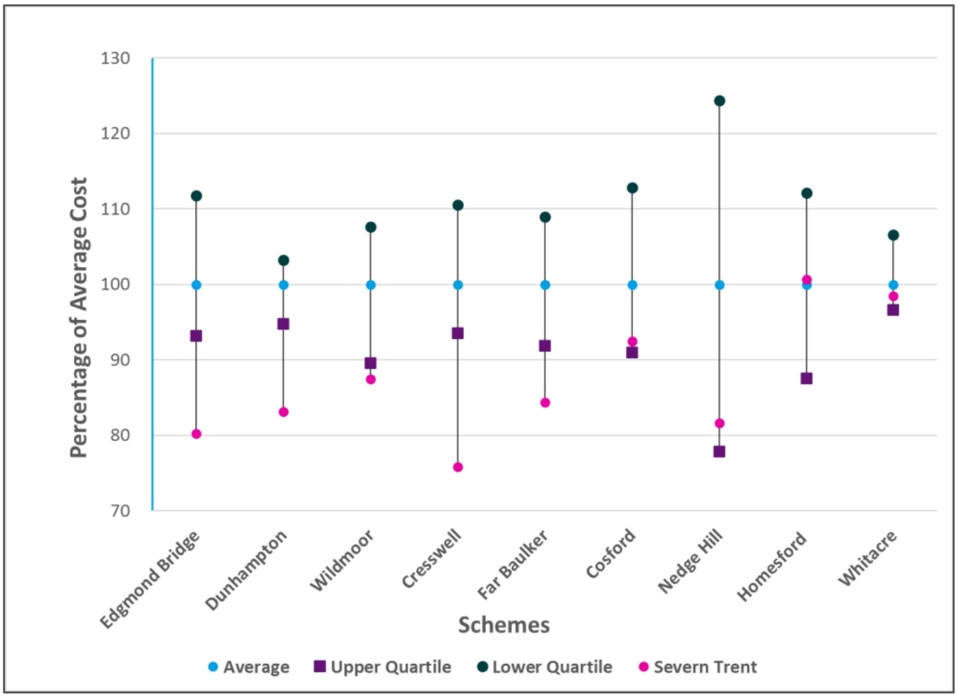
Algae 1 scheme @ Whitacre	Bottom up benchmarking of costs show schemes to perform between average and upper quartile	Benchmark very efficiently against treatment (base activity scheme) unit cost model 0.34 efficiency score	• Models accounting for supply, Lead, Algae and PFAS interventions; and Models accounting for supply, Lead and Algae interventions. • Modelling shows programme to be efficient with an efficiency score of 0.82 to 0.87)
Crypto (UV) 1 scheme @ Creswell	Bottom up benchmarking of costs show schemes to perform between average and upper quartile	Benchmark very efficiently against treatment (base activity scheme) unit cost model 0.17 efficiency score	• N.a. No better model identified than Ofwat DD approach
Crypto (Membrane) 1 scheme @ Far Bulker / Rufford	Bottom up benchmarking of costs show schemes to perform between average and upper quartile	Benchmark very efficiently against treatment (base activity scheme) unit cost model 0.45 efficiency score	
Lead 1 scheme @ Holmesford	Bottom up benchmarking of costs show schemes to perform at the average of the distribution	Benchmark very efficiently against treatment (base activity scheme) unit cost model 0.29 efficiency score	• Models accounting for supply, Lead, Algae and PFAS interventions; and Models accounting for supply, Lead and Algae interventions. • Modelling shows programme to be efficient with an efficiency score of 0.82 to 0.87)

This gives us confidence that our business plan costs can be considered as efficient across raw water deterioration driver lines, and particularly so at a programme level. Consequently, our DD representation values set out in the RP2 proforma reflect our original submission numbers. Including a reallocation from WINEP driver DWPA to raw water deterioration for £7.4m of catchment management schemes.

3.3 Bottom-up benchmarking of our costs

We note that in all assessments of our enhancement schemes for Raw Water Deterioration, there is a common adjustment (reduction) made due to needing to see more details of our cost benchmarking and 3rd party assurance, which we described in our business case in section 5.1.2. A summary of this business plan benchmarking is set out in figure 2 below. This covers over 80% of our investment. The pink dots represent our costs which show in all but one case (Homesford lead) that we were either beyond or very close to an upper quartile efficiency benchmark. The feedback questioned the details behind this analysis.

Figure 2 independent benchmarking by Aqua consulting



The following provides more detail behind our original submission and the work that Aqua consultants carried out for us. In sections 4 and onwards we provide evidence of the efficiency of our costs on a scheme-by-scheme basis where relevant.

Aqua Consultants were selected to support us at PR24 due to their knowledge of our costing systems and the veracity of the data they use to benchmark costs. They have extensive datasets for five water companies within the UK which includes companies of a similar scale to us. All data points are from relevant schemes and converted to a common price base using CPIH.

Allied to their datasets, Aqua Consultants also employ a number of experienced water sector estimators that know how to challenge scope and ensure that costs are reviewed on a like for like basis. This knowledge and expertise has also allowed us to gain insight into more novel and unusual items of scope where estimators have used their networks to compare to similar quotations. This technique has been used where applicable and similarly gives us reason to either challenge current costs or put them forward with confidence that they are robust and efficient.

Our efficiency assessments helped us to demonstrate that we were providing costs that were robust and efficient whilst demonstrating that we had challenged ourselves to reduce cost where practical and where there was sufficient evidence to do this.

We have since commissioned Gardiner and Theobald to carry out a subsequent review of the analysis and we include their independent report in our representations. They conclude that the benchmarking method we have used is robust and provide reassurance that the data supporting the analysis is reliable and appropriate.

3.4 Using sector wide benchmarking to demonstrate efficiency

At PR19, Ofwat was unable to identify a suitable cost driver associated with raw water deterioration schemes, preventing the creation of an econometric or unit cost model to establish an appropriate allowance. Ofwat set out its intention, through the cost assessment working group, that they intended to try again to create cost models for this investment area. To support the development of our PR24 business plan, we commissioned research into the potential for using econometric modelling to demonstrate the efficiency of our costs. We set out the results from these models in our business plan which suggested modelling could be viable.

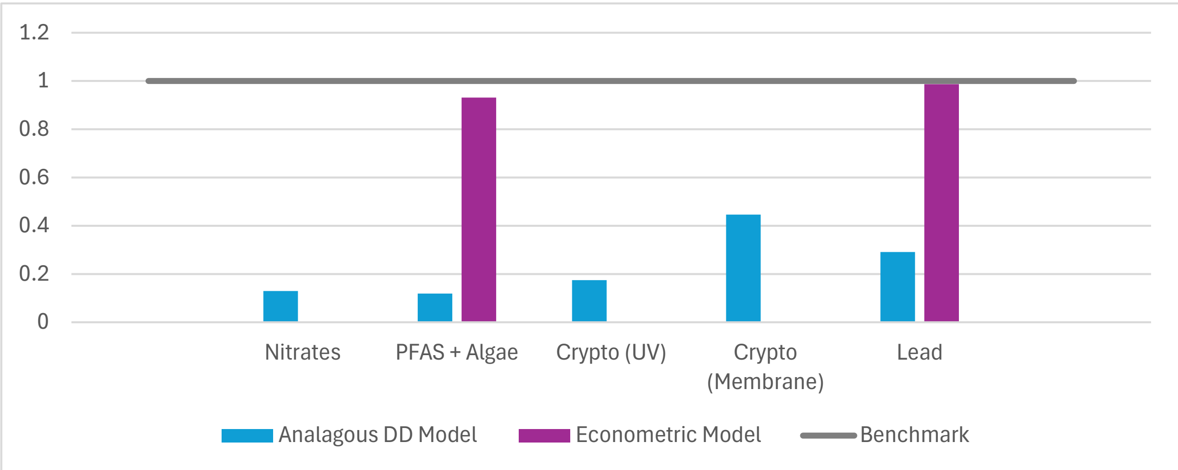
It is clear from draft determinations that when assessing cost efficiency, Ofwat has given significant weight to sector-wide and scheme-level benchmarking modelling. Given this, we have broadened the scope of our cost benchmarking exercise to include the use of benchmarking models in two main ways:

- section 3.4.1 compares our costs to benchmarks for similar activities derived from other enhancement cost models used by Ofwat in its draft determinations[4]; and
- section 3.4.2 sets out our view of how the business plan data could be used to develop simple econometric models which better reflect different cost signatures within treatment upgrade interventions.

As illustrated in figure 3 below, the results from both sets of benchmarking models clearly show that our scheme costs are efficient across the range of RWD schemes. In particular:

- When comparable costs are benchmarked through inputting the schemes into Ofwat's Draft Determination supply enhancement model, all of our RWD schemes have costs that are below the relevant cost benchmarks[5].
- Our newly developed scheme-level econometric models suggest that our water treatment works schemes across the range of RWD drivers are efficient.

Figure 3: Chart showing our raw water deterioration efficiency against both Ofwat's draft determination supply scheme benchmark, and our proposed econometric model



Based on model spec 2, scope 3

We acknowledge that the Nitrates and PFAS + Algae schemes look very efficient in the chart above, however we note that they remain efficient even when Ofwat's smaller 'other' supply scheme unit cost of £0.71/Mld is used.

[5] We note that we have not benchmarked the waste disposal pipeline component of our Nitrates schemes. This is because they are not analogous to typical Nitrates activities. Attempts to benchmark using interconnector models were not successful due to the very low intermittent flows that are assumed relative to a water interconnector.

We also show the outputs of our efficiency analyses against each of the RWD drivers in sections 4-13 of this document.

3.4.1 Expanding the use of the existing enhancement models

In relation to raw water quality deterioration schemes, Ofwat's draft determinations say "although companies propose a range of schemes, there are common activities across several companies, which allows opportunities for some areas to be unit cost benchmarked."

We believe that there are opportunities to expand the use of existing enhancement cost benchmarking models to inform the assessment of the efficiency of our RWD schemes. Our proposed RWD schemes share similarities with schemes in other enhancement categories, particularly those schemes in categories where Ofwat has used benchmarking models to assess cost efficiency at draft determinations. We believe that comparisons with benchmarks derived from those models can provide useful evidence on the efficiency of our schemes. In summary, where interventions are analogous, we consider that benchmarking of schemes that have been allocated to different enhancement cost drivers should not be discounted. This is because the underlying drivers of cost will be the same.

Indeed, Ofwat has relied on this approach of benchmarking costs across enhancement categories when considering the efficiency of enhancement schemes where a suitable focused model cannot be found. For instance, Ofwat used the supply interconnector enhancement cost model to assess the efficiency of interconnector schemes within both our proposed WINEP WFD enhancement programme, and our resilience interconnector schemes. This was on the basis that the underlying activities are comparable. In this case, the models found that our proposed schemes were efficient.

We think this is a pragmatic approach and we have investigated the potential for using other enhancement models where the proposed activity is comparable.

We identified and investigated additional enhancement cost models that could potentially be used to benchmark our RWD schemes that Ofwat assessed through deep dives.

We found the water supply enhancement model to be most suitable for RWD schemes[6]. It is a unit cost model that calculates cost benchmarks for supply-side schemes aimed at providing a WAFU benefit to the supply demand balance. We highlight the following reasons:

- This is a highly versatile model that covers a wide variety of schemes from across the sector aimed at providing supply-side WAFU benefits. It includes activities covering treatment works, reservoirs, transfers (excluding interconnectors), reuse, ground and surface water and licence trading.
- The supply model calculates benchmark unit costs for different types of schemes, grouped into five complexity categories (high, base activity scheme, medium, low and very low) depending on the scale and scope of activities involved. This means that the model does not take a one-size-fits-all approach to scheme costs.

[6] Ofwat's DD Supply enhancement model: https://www.ofwat.gov.uk/wp-content/uploads/2024/07/PR24-DD-W-Supply-1.xlsm

- All of our RWD schemes involve the installation of one or more new treatment processes, which is analogous to the supply side schemes that involve treatment work upgrades. This makes the benchmarks from that model particularly relevant.

Distribution of scheme-level efficiency scores

The distribution of scheme-level implied efficiency scores for our RWD schemes are significantly tighter and more favourable than the efficiency scores for the sector-wide schemes that Ofwat modelled using its supply model.

Table 9: Application and results of scheme level costs

	Number of schemes	Range of scheme-level efficiency scores
Schemes modelled by Ofwat in the supply enhancement model	34	0.15 – 6.24
Our RWD schemes assessed against the unit cost benchmarks from the supply enhancement model	10	0.06 – 1.02

3.4.2 Developing a scheme-level econometric approach

The case for making better specified econometric models

We agree with Ofwat that a simple unit cost benchmarking model may have limitations in the context of schemes with significant variation in costs and activities. We therefore considered the potential for using scheme-level econometric benchmarking models using data from other companies' business plans. We also agree with Ofwat that scheme-level econometric models can potentially be useful in addressing some of the drawbacks with company-level benchmarking models that were used in PR19.

Our approach to modelling the efficient costs of water treatment works upgrades is based on our view that the activities involved in such schemes can be very similar irrespective of the underlying purpose for the schemes (e.g. whether they are for WINEP, raw water quality deterioration or for supply). We believe that most of the water treatment works listed in Business Plan table CW8 involve either upscaling existing treatment processes or adding additional processes and therefore are comparable.

In developing scheme-level econometric models, we considered:

- The appropriate model form to use, including logarithmic and linear specifications.
- The comparability of schemes and activities across companies and enhancement categories, and pre-modelling adjustments where necessary to support comparability.
- That all treatment upgrade interventions will not necessarily have the same cost signatures. This can be as a result of the number and type of treatment process interventions needed at a given site. We acknowledge that the use of the DD supply model to assess all treatment interventions is overly simplistic in this light as it fundamentally assumes that all treatment upgrades will be analogous. A key benefit of developing a multivariable econometric model is that better consideration can be given to these differences.

Results from our models

We set out the full results from our econometric modelling exercise in Appendix A of this document. Table 10 below presents the estimated company-level efficiency scores for Severn Trent for each combination of model specification and scope.

Table 10: Company-level efficiency scores: Efficiency scores <1 = company cost lower than modelled benchmark

	Model Spec 1	Model Spec 2	Model Spec 3
Model scope A (SDB CW8 schemes only)	1.39	0.82	0.82
Model scope B (above +Lead + Algae)	1.24	0.87	0.82
Model scope C (above + PFAS)	1.10	0.92	0.87
Spec summary	Control	Preferred specification	Most analogous to DD supply modelling approach

The results show that:

- Our scheme costs are efficient when using our preferred model spec 2 under model specifications B (modelling of Lead and Algae RWD schemes alongside SDB supply schemes) and C (modelling of Lead, Algae and PFAS RWD schemes alongside SDB supply schemes). This model includes a dummy variable to account for differences between schemes in terms of their underlying activity.
- There is little difference between our efficiency scores under model specification 2 and 3. This implies that the key differentiator for scheme costs is whether or not the scheme involves a treatment works upgrade. The other dummy variables, whilst supported by coherent engineering logic, carry less explanatory power or statistical significance.

4. Nitrate

4.1 Best option for customers

4.1.1 Significant concern 1

We have concerns whether the investment is the best option for customers. The company provides no evidence that alternative options have been considered for the disposal of waste and does not provide details of a cost benefit analysis to demonstrate that the chosen option is the right solution.

Our response: We present the waste disposal options that we described in our Ofwat query response 168 and also provide a breakdown table of those waste options along with financial cost benefit. In Table 11 below, we have provided more detail behind the costs and Benefits Assessment Tool (BAT assessment of these options. It shows that our chosen option for Cosford in our original case (Waste to sewer - open cut) gave the best value for customers, albeit with a higher carbon impact than other sewer options. For Beckbury, due to the longer sewer main involved, tankering comes out as a lower 25-year cost option, but due to the factors outlined in our Ofwat query response 168 (multiple tankers a day to a rural site, higher operational carbon, supply resilience, impact on neighbours, site limitations) we have chosen the lowest 25 year cost of the sewer options. For both schemes, we will review sewer construction methodologies during detailed feasibility and design to optimise cost vs. carbon impact. In summary, multiple alternative options were considered and costed, and we selected the least cost sewer option for both schemes, recognising that disposing direct to watercourse is unacceptable and that innovation is still in trial phase globally.

Table 11: Summary of outputs from Cost-Benefit Analysis for nitrate waste disposal options

Scheme	Waste Option Solution	AMP8 CAPEX (£m)	AMP8 OPEX (£k)	Financial costs and risks – 25yr Ofwat compliant (£m)	Total Carbon costs (£k)
Cosford IX	**Sewer (open cut) – PREFERRED**	**4.063**	**4.983**	**3.430**	**80.700**
	Sewer (directional drilling)	5.306	4.983	4.461	46.982
	Tankering options	2.021	144.532	3.917	216.675
Beckbury IX	**Sewer (open cut) – PREFERRED**	**10.781**	**2.907**	**8.974**	**211.164**
	Sewer (directional drilling)	13.828	2.907	11.501	117.028
	Tankering options (not preferred due to high carbon and disruption to customers 5 tankers a day)	1.939	130.496	3.682	255.035

Waste disposal to sewer options
Site level suitability and considerations
• Receiving sewage treatment works (STWs) were selected based upon their location and suitability to treat the waste and the available Dry Weather Flow (DWF) headroom to avoid breaches of permits at the STWs and associated pollution risk. • STWs with activated sludge processes needed to allow for biological removal of the nitrate.

- STWs had to be of a reasonable size to reduce the impact of chloride upon the works – as high levels of chloride cause corrosion of certain grades of steel, and high chloride concentrations would result in the need to change a significant element of the receiving sewage treatment works infrastructure to be able to cope with the incoming waste.
- The map below in Figure 4 shows the suitable candidate locations near Cosford WTW and Beckbury WTW (both are near Telford).
- Albrighton STW and Shifnal STW, are the two closest STWs to Cosford which could be considered.
- Our proposed option for Cosford sends flows to Albrighton STW, a medium sized ASP site which we assessed as having sufficient DWF headroom. Shifnal STW is also an alternative nearby but with insufficient headroom. If the project detailed feasibility confirms insufficient DWF headroom at these sites, then our choice will need to be one of Telford's larger STWs (Coalport STW, or Rushmoor STW which is to the West of Telford) which are further away requiring a longer pipe route.
- Coalport STW was proposed to take the waste flows from Beckbury IEX plant, as above, assessed to have sufficient DWF headroom which is being confirmed as part of more detailed project feasibility.
- We assume the mains will take the flows directly to the sewage treatment works, due to the scaling and corrosion risks with discharging into the existing network. Time intensive network modelling (12 months) is required to determine if existing sewer network can take the flows - if it is possible to discharge into the existing sewer network, it will be more than likely very close to the STW where the receiving sewers are larger. There is also the challenge that utilising the existing network risks overflows under storm conditions, therefore this would need to be accounted for in the transfer into the existing network.
- Our Waste main routes are constrained to the road network as we do not have a legal right to install process waste mains on private land.
- Our initial assessment was that we need pumped rising mains until more detailed site level investigation into topography could be assessed. The alternative gravity options have little impact on sewer CAPEX.

Figure 4: All sewage treatment works (STW) considered within the region around Nedgehill and Cosford WTW.

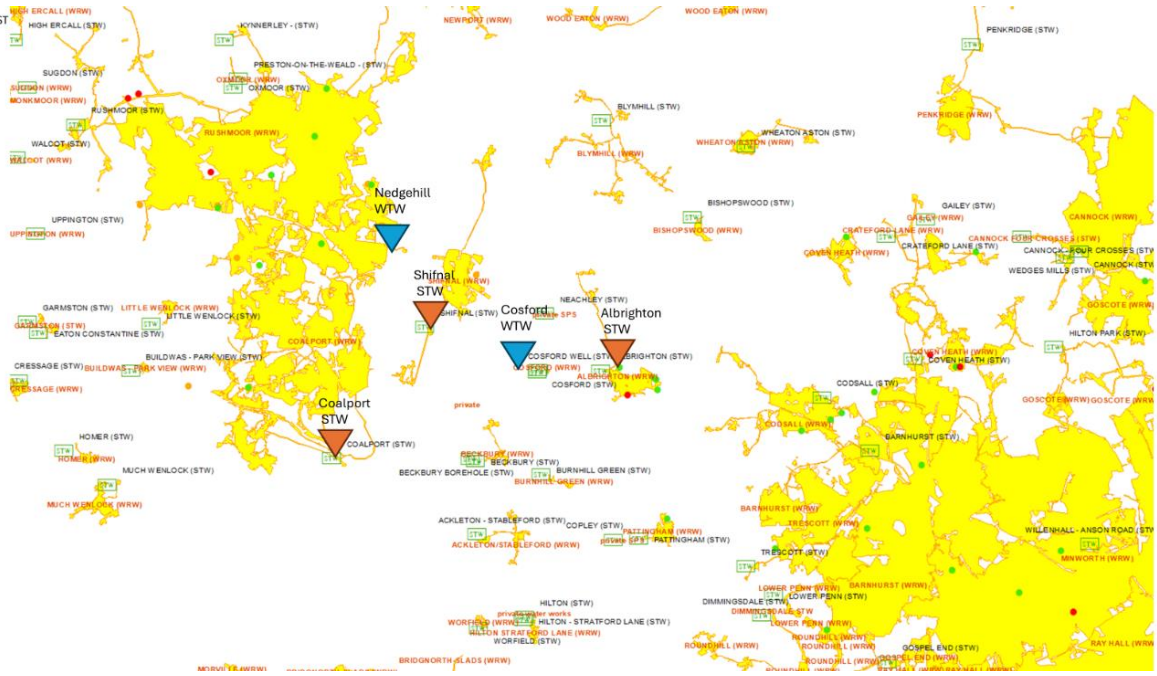
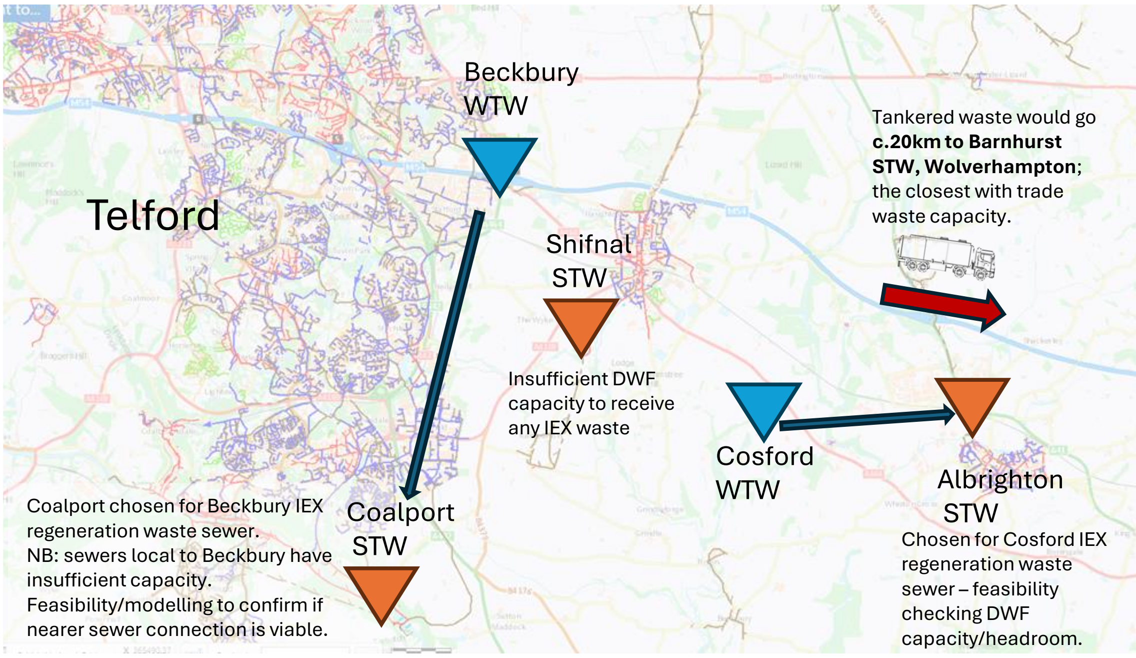


Figure 5: Most suitable candidate sewage treatment works for receiving Ion Exchange waste – showing proximity to the WTWs. Existing sewer network shown – red foul network and blue surface water. Road map also shown with indication of route for tankered waste to Barnhurst STW, Wolverhampton.



Tankering – site level suitability & cost consideration
• To enable tankering, our cost estimates for these options include for waste storage tanks and tanker hardstanding areas. • For Beckbury we have also included cost estimates for new access for tankers to the site – widening the road by 1m, new access gate and fence, gravel road on site. This adds c.£193k to the CAPEX for this site's tankered waste option.

Innovative option – biological treatment - site level suitability & cost consideration
Biological nitrate removal is not something that has been deployed on groundwater treatment in the UK. There is currently no Reg 31 approved process for this. We are in the process of assessing various technologies which are available that have been deployed in other countries. These offer the advantage of not having a brine waste stream, as we are getting with ion exchange. However, the technologies available for biological nitrate removal are complex, and may require nutrient dosing. Trialling will be required, along with the Reg 31 approval process, this will take a significant amount of time. This may mean the technology is not available for AMP8 but rather for AMP9, which would be too late for the statutory dates to mitigate Water Quality risks for these schemes.

4.1.2 Significant concern 2

The company provides some evidence that different options, including three treatment options, have been considered. This includes a high-level description of each nitrate reduction option, but the company does not provide sufficient and convincing evidence of its optioneering process or screening criteria and no site-level suitability assessment.

The company provides results of its cost-benefit analysis for shortlisted options considered to treat nitrates in the form of 25-year financial costs and separately carbon costs per option but does not *provide sufficient and convincing evidence to demonstrate that the proposed schemes are the most cost beneficial and best value for customers.*

Our response: Regarding optioneering process, Section Error! Reference source not found. above now provides more detail behind our CBA methodology and our Benefits Assessment Tool (BAT).

In our SVE 13 case we showed that our selected scheme option (ion exchange) gave the best financial cost benefit – note that the financial cost and risk column is based on our BAT tool (extract below).

Table 12: Summary of outputs from Cost-Benefit Analysis for shortlisted options considered to treat nitrates

Site	Solution option	Financial cost and risks – 25yr Ofwat compliant (£m)	Total carbon costs (£m)
Cosford	IX (preferred)	23.87	0.747
	EDR	33.85	1.21
	RO	29.09	0.82
Beckbury	IX (preferred)	24.65	0.36
	EDR	27.10	0.57
	RO	24.98	0.40

Our preferred option for nitrate has the lowest whole life cost and carbon cost of options assessed.

4.1.3 Significant concern 3

The company does not provide sufficient and convincing evidence to support the decision for the preferred solution. There is no evidence provided of cost-benefit or best value analyses. The company has not provided any evidence of the quantified benefit waste removal solutions selected at each site.

Our response: Regarding cost benefit or best value analysis, we describe this in Section 2 above. With regard to waste removal solutions specifically, the table above presents the outputs from our Benefits Assessment Tool which shows we have chosen the best value and most practicable option for customers. Regarding site-level suitability, we refer to this in our Ofwat query response 168 and provide more detail on waste options per site, above.

4.2 Evidence to demonstrate cost efficiency

***Some concerns 1**: We have some concerns whether the investment is efficient. The company does not provide sufficient and convincing evidence that the proposed costs are efficient, especially regarding the disposal of waste streams from the proposed locations.*

Our response: full details of the waste disposal options have been provided in 4.1.

***Some concerns 2:** The company provides a high-level explanation of its costing approach, which is based on historical cost data applied to the expected investment scope. The company does not provide cost breakdown comparisons of multiple options as supporting evidence.*

Our response: We provide cost breakdowns of the options taken forward for CBA below.

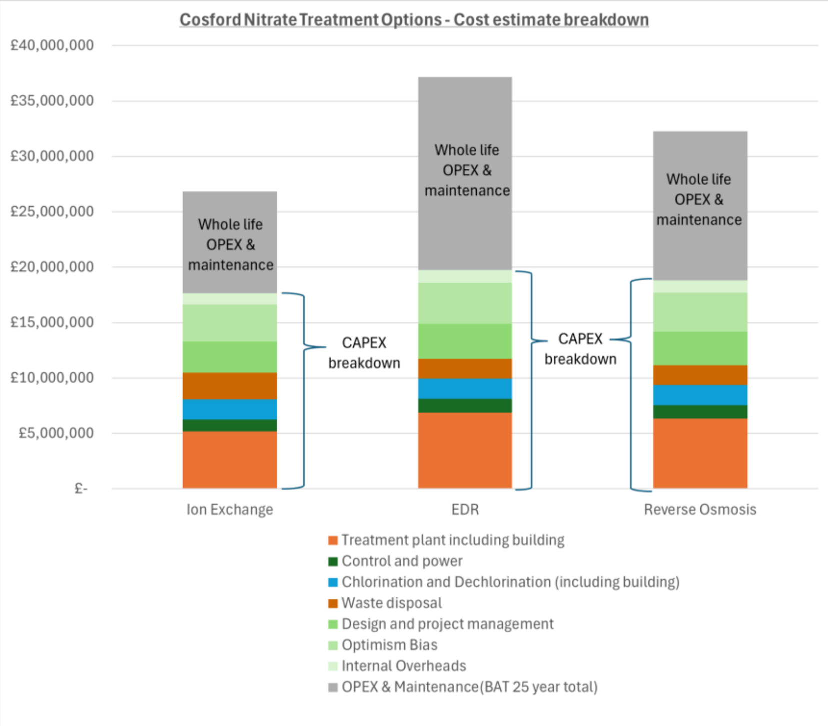
There are many common scope items between Ion Exchange, EDR and Reverse Osmosis treatment options, in summary the differences are:

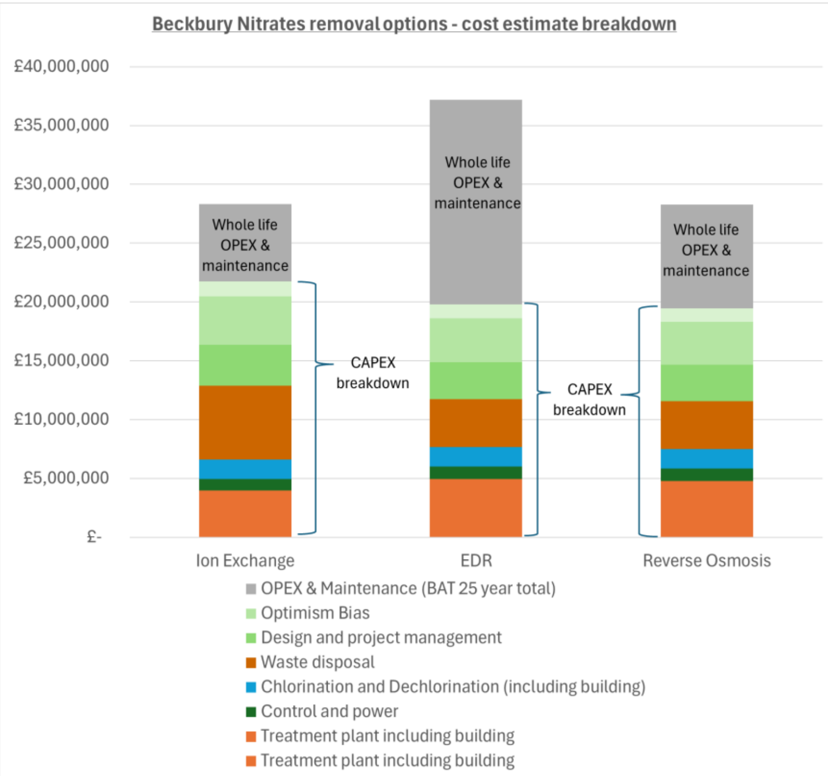
- The treatment plants themselves. Based on supplier quotations – the IEX plant is the lowest cost.
- Waste disposal (pumping station and sewer) – Ion Exchange is higher cost due to the requirement for dual waste mains given the scaling of the mains and associated cleaning required.
- Control and power (Control panel, site power upgrades, telemetry) – the higher energy usage of EDR and RO mean the power supply and control infrastructure are higher cost.
- OPEX – higher energy consumption in EDR and RO drive higher OPEX costs.

Our chosen option (IEX) has the lowest whole life cost in both cases, and is the lowest CAPEX for Cosford, but highest CAPEX for Beckbury due to the waste disposal costs (longer sewer length).

The water losses in the IEX process are far lower (c.1-2%) than for EDR (5%) and RO (c.10%) which further adds to the process choice rationale of IEX.

Figure 6: Graphical representation of costs associated with shortlisted nitrate treatment options at Cosford BPS (Nurton Group) and Beckbury BPS (Nedge Hill Group).





4.2.1 Cost modelling approach

Our business plan includes two nitrate schemes: Cosford (Nurton) and Beckbury (Nedge Hill), both of which were assessed by Ofwat through a deep dive assessment.

37% of the costs for our two schemes relate to ancillary waste disposal pipelines. These do not relate to the fundamental treatment of the pollutant, instead they are a function of the atypically long distance to an appropriate waste disposal source. Consequently, we do not think that these costs should be included when benchmarking against analogous schemes.

Ofwat made an adjustment of 50% to our scheme costs following this assessment. Ofwat said that we had not provided sufficient and convincing evidence that our costs are efficient, especially the costs of waste disposal pipelines. We believe that our proposed scheme costs are efficient, and Ofwat's proposed adjustment of 50% to our costs is unnecessary.

To evidence our efficiency, we first split our schemes into two elements: a treatment process element and a waste disposal pipeline element as set out in the table below.

Table 12: Cost breakdown for Nitrate schemes

	Totex for treatment process (ion exchange) element	Totex for waste disposal pipeline element	Total
Cosford (Nurton)	£13.97m	£4.06m	£18.03m
Beckbury (Nedge Hill)	£11.32m	£10.59m	£21.91m
Total (Nitrates)	£25.29m	£14.65m	£39.94m

The activities of installing a new ion exchange treatment process at Cosford and Beckbury are very similar to the activities covered by treatment upgrade schemes included within the supply enhancement cost model. This means that a comparison of our costs against the unit cost benchmarks derived from that model can provide useful evidence on the cost efficiency of our new treatment processes. The results from this comparison are set out in the table below.

Table 13: Efficiency comparisons of Nitrate schemes

Treatment process elements of Nitrate schemes	Totex	Category for Ofwat's supply scheme model	Applicable unit cost benchmark	Modelled cost	Implied efficiency score
Cosford (Nurton)	£13.97m	Base activity scheme	£5.71m per Ml/d	£117.1m	0.12
Beckbury (Nedge Hill)	£11.32m	Base activity scheme	£5.71m per Ml/d	£77.91	0.15
Total (treatment process element)	£25.29m			£195.01m	

These results suggest that our treatment process costs are efficient compared to the costs of similar treatment work upgrades included within Ofwat's draft determinations model. We considered the potential of benchmarking the waste pipeline costs using the draft determination interconnector model. However, this was not successful due to the very low intermittent flows (the major scale driver in the model) that will be seen in the waste pipelines relative to a water interconnector. Consequently, we concluded that deep dive assessment is the most appropriate way to assess these costs.

5. PFAS schemes

5.1 Best options for customers

***Some concerns**: We have some concerns whether the investment is the best option for customers. The company does not provide sufficient and convincing evidence that alternative options have been considered and states that it is not able to carry out a cost benefit analysis on multiple options at this stage, given that the per-and poly fluoroalkyl substances (PFAS) is such a new parameter of concern.*

Our response: At the time of our PR24 submission, there was significant scheme solution uncertainty given that PFAS was such a new and rapidly evolving requirement. As such we could only provide a high level capex estimate for our two schemes and no financial cost benefit analysis.

Since our submission, we have had a pilot plant up and running at Witches Oak, trials carried out with WRc for Cropston and promoted both projects as part of transitional spend. Much of this is described in our new PFAS Tier 2 business case (SVE4.28) that we have submitted alongside our DD representations. This has provided us with more certainty about potential options which we are now able carry out financial CBA on. Selected solution costs are showing that we need more than our original plan submission. However, we will honour our original cost submission but the evidence below should negate the need for the 40% adjustment (reduction) allowance that was made as part of the DD.

Table 14 below provides the outputs from our latest financial CBA on PFAS options, taking the learning since PR24 as described in our new PFAS Tier 2 business case.

Table 11: Summary of outputs from Cost-Benefit Analysis for shortlisted PFAS treatment options at Cropston and Witches Oak

PFAS Scheme	Scheme option	AMP8 Capex (£m)	AMP8 Opex (£m)	Financial costs and risks – 25yr Ofwat compliant (£m)	Total carbon costs (£m)	Solution selection
Cropston	*Original PR24 solution* – PAC dosing	17.9	1.030	Not calculated	Not calculated	**Discounted** – cannot deal with PFAS laden waste
	Updated solution - PAC dosing on Thornton Feed	6.077	3.174	24.575	12.134	
	Single Stage GAC – Replacement of Existing media	0.797	1.038	6.679	7.177	**Discounted** – trials show PFAS breakthrough
	Roughing GAC on Thornton raw water Feed	6.997	0.527	10.745	3.049	**Discounted** – trials show PFAS breakthrough, clogging of filters.
	Two Stage GAC	**28.035**	**1.365**	**37.231**	**12.271**	**Selected**
Witches Oak	*Original PR24 solution* – Actiflo Carb (PAC dosing)	31.3	3.650	Not calculated	Not calculated	**Discounted** – trials unsuccessful and cannot deal with PFAS laden waste
	Updated solution - Actiflo Carb (PAC dosing)	48.153	5.962	143.607	91.248	
	Single stage (new media) GAC	6.997	41.915	140.563	76.651	**Discounted** – trials show PFAS breakthrough
	Single stage (regen media) GAC	6.997	25.595	88.586	15.406	

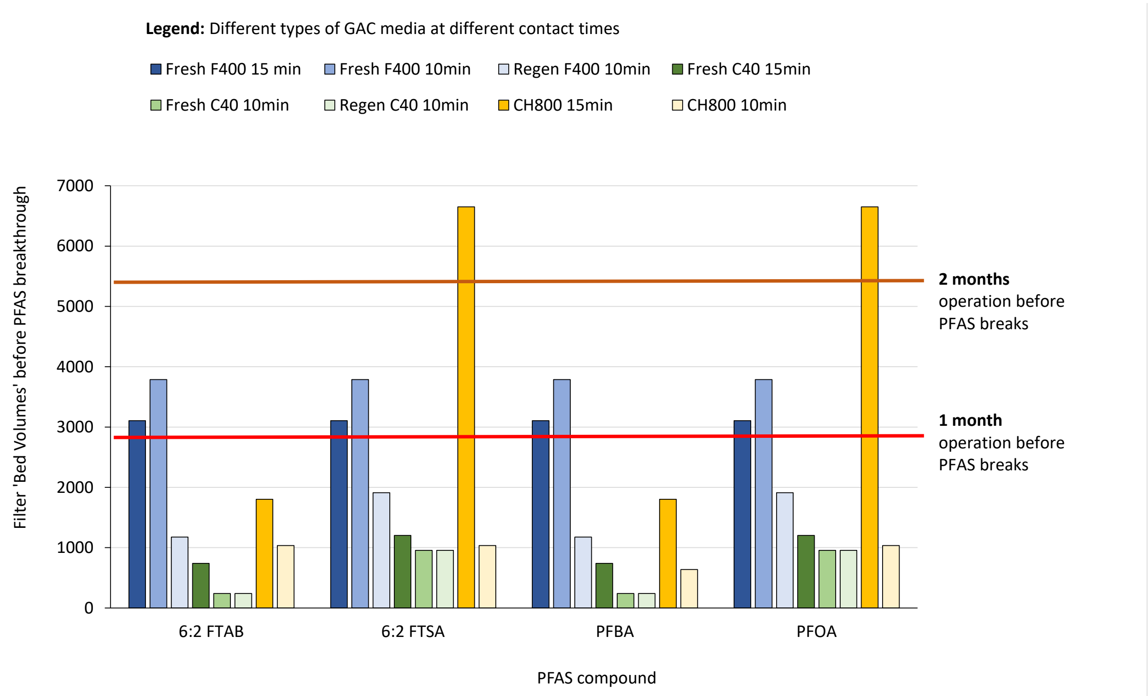
	Two stage GAC (new media)	40.022	42.540	175.927	19.410	**Not preferred** – higher 25yr cost vs. IEX; organics risks GAC performance
	Two stage GAC (with regen)	40.022	26.220	123.951	6.013	
	Ion Exchange and GAC	**42.555**	**1.782**	**71.386**	**1.140**	**Selected**

An additional, second stage GAC is now our preferred option for Cropston, in place of our original PAC dosing solution. Firstly, PAC is not viable as it creates a PFAS-laden waste stream which we currently have no viable means of dealing with as it we have confirmed that it cannot be disposed of to sewer, as PFAS will pass through sewage treatment works and back into the environment.

Secondly, our process investigations show that single stage GAC (existing plant) is not viable as PFAS breakthrough occurs in short timescales (1-2 months). This would require media changes in each filter every month. For context, our GAC media for pesticide removal is currently changed every 5 years. This high frequency is not feasible due to the time taken to empty, fill and recommission each filter and the associated down-time and lost treatment capacity.

It is likely that these shorter breakthrough times are due to competition between DOC (organics), pesticides and other PFAS compounds. It is therefore recommended that two stage GAC removal should be implemented as this will allow for more efficiency of PFAS removal as competition could be limited through removal of competing compounds on the first stage, and the operational life of the carbon can be safely extended as the downstream second stage would act as a safety net for compounds breaking through and will last significantly longer due to lower concentrations on this second stage.

Figure 7: Single stage GAC media - Breakthrough time of different PFAS based on Cropston trial results



For Witches Oak, pilot plant trials to date have shown that the PAC dose required for our original Actiflo Carb process solution is much higher than anticipated and the waste cannot be effectively collected for PFAS destruction (taking PFAS waste to sewer is no longer an option). Trials of GAC at

Witches Oak have also shown very high levels of organics in the River Trent which prevent adsorption of PFAS onto the GAC. Our current proposed solution is to provide a pre-treatment stage of Ion Exchange to remove organics from the water, and allow PFAS to be more effectively adsorbed by downstream GAC. We have trialled single stage GAC at Witches Oak (without Ion Exchange) and breakthrough times for the PFAS of concern are longer than at Cropston (around 4 months) and so with Ion exchange pre-treatment the GAC life could be extended sufficiently to make the media replacement requirements feasible for this site.

As stated previously, regardless of the new process choices that we believe are required for Cropston and Witches Oak and the additional cost of these, we will honour our original cost submission for these schemes, but request Ofwat consider removing the 40% reduction to these in their draft determination.

5.2 Cost efficiency

Some concerns: *We have some concerns whether the investment is efficient. The company does not provide sufficient and convincing evidence that the proposed costs are efficient.*

The company provides a description of its costing approach, which is based on both top-down and bottom-up benchmarking, however it does not provide sufficient and convincing evidence that the two PFAS schemes are cost efficient.

The company states that third-party consultants reviewed the schemes. however, were unable to benchmark the Witches Oak scheme because they had no comparable cost data for PFAS technology.

5.2.1 New benchmarking for PFAS sites

Gardiner and Theobald (G&T) were employed to support us with our representations following the Draft Determination. One of the areas that we sought advice from G&T was on our new Tier 2 PFAS schemes (see new PFAS business case in SVE4.28). In our previous submission we provided a slightly different scope which meant that it was difficult for us to gain insight into the relative efficiency of the costs put forward as it was based on a novel technology. With these new schemes we were able to ask G&T to provide a bottom-up benchmarking study to assess the relative efficiency of each site and the results showed that we were within less than 1% of the benchmark rates for two sites combined.

This has provided us with sufficient confidence that the costs we put forward in the Tier 2 schemes are robust and efficient and similarly that the PFAS costs within our original Raw Water Deterioration business case can be delivered for similar values and are robust, deliverable and efficient.

5.2.2 Cost modelling

Our business plan included two PFAS schemes: Witches Oak WTW and Cropston WTW, both of which were assessed by Ofwat through deep dives at draft determinations. Ofwat made an adjustment of 40% to our scheme costs following this assessment and said that we had not provided sufficient and convincing evidence that our costs are efficient. Since the submission of our business plan, two new PFAS schemes have been added to our plan: Whitacre WTW and Church Wilne WTW.

Our business plan also included one algae removal scheme at Whitacre WTW. Algae removal and PFAS are two separate treatment interventions (construction of a Granular activated carbon plant for PFAS, and the construction of a Dissolved Air Flotation (DAF) plan for Algae removal). However, we consider that it is appropriate to consider them together here given that we are benchmarking against a holistic water treatment works upgrade which would require interventions at multiple treatment stages[7].

These schemes are summarised below.

Table 15: Cost and benefit of PFAS schemes by site

PFAS scheme	Totex	Benefit	Treatment process
Witches Oak WTW	£34.9m	[✂] Ml/d	Granular activated carbon
Cropston WTW	£18.9m	[✂] Ml/d	Granular activated carbon
Whitacre WTW	£31.8m	[✂] Ml/d	Granular activated carbon
Church Wilne WTW	£53.8m	[✂] Ml/d	Granular activated carbon
Total	£139.4m		

Table 16: Cost and benefit of Algae scheme

Algae removal scheme	Totex	Benefit	Treatment process
Whitacre WTW	£67.31m	[✂] Ml/d	Dissolved air flotation (DAF)

We then compared the costs of our PFAS and algae removal schemes against the unit cost benchmarks from Ofwat's supply (excluding interconnectors) models. The results are set out in the table below.

Table 17: Model results for PFAS schemes using Supply models

PFAS and Algae scheme	Totex	Category for Ofwat's supply scheme model	Applicable unit cost benchmark	Modelled cost	Implied efficiency score
Witches Oak PFAS	£34.9m	Base activity scheme	£5.71m per Ml/d	£371.28m	0.09
Cropston PFAS	£18.9m	Base activity scheme	£5.71m per Ml/d	£148.51m	0.13
Whitacre PFAS + Algae	£99.11m	Base activity scheme	£5.71m per Ml/d	£289.60m	0.34
Church Wilne PFAS	£53.8m	Base activity scheme	£5.71m per Ml/d	£936.76m	0.06
Total	£206.71m			£1,746.14m	

These results suggest that our PFAS and Algae removal schemes are very efficient compared to other treatment work upgrade schemes included within Ofwat's supply enhancement models.

To provide a further layer of assurance, we also compared our single process PFAS scheme costs against the unit cost benchmark for the "other" schemes category that Ofwat used in its supply enhancement model covering minor works (other than treatment works upgrades). This comparison also shows that our scheme costs are relatively efficient.

Table 18: Model results using "other" supply category

PFAS and Algae scheme	Totex	Category for Ofwat's supply scheme model	Applicable unit cost benchmark	Modelled cost	Implied efficiency score
Witches Oak PFAS	£34.9m	Other	£0.71m per Ml/d	£46.15m	0.76
Cropston PFAS	£18.9m	Other	£0.71m per Ml/d	£18.46m	1.02
Church Wilne PFAS	£53.8m	Other	£0.71m per Ml/d	£116.44m	0.46

[7] A typical WTW flow will includes: Pre treatment processing, Clarification, Filtration, Chlorination, and additional processes as required to manage specific raw water risks (e.g. GAC, UV, Ion exchange)

6. Whitacre WTW Algae scheme

6.1 Best option for customers

***Minor concerns**: We have minor concerns whether the investment is the best option for customers. The company considers a range of alternative options but does not provide sufficient and convincing evidence to demonstrate that the chosen options are the most appropriate to compare.*

Our response: The range of alternative options we considered are set out in page 32 of our business case. On page 29 we explained: "For all options, we completed Process Options Reports, which is our standard approach for all our live capital projects. We self-funded these knowing that several options would not proceed but needed high calibre work for this business case. These technical reports considered feasible options and outlined advantages, disadvantages, risks, and certainty of outcome. They are summarised in Table 11 to 19, and highlight which ones we screened out, and those we put forward for preliminary design, costing and benefits assessment using our standard tools (our approach to costs is set out in Section 5). In most cases our preferred and most feasible option has the lowest whole life and carbon costs." The Process Options Reports are produced by our in-house Treatment Process Engineering team, who are highly skilled in identifying and evaluating appropriate comparative options to address all water quality hazards, including Algae. DAF, Mecana and Ceramic membrane are all stages of treatment that can remove Algae and are commonly used. We outline in our 'Further evidence for Whitacre' section below additional commentary from our process experts regarding the rationale for the shortlisted options being the most appropriate to compare. We considered full treatment and partial treatment side stream sub-options in our considerations.

Regarding Mecana filter being an appropriate option, a case study below is provided which we did not include in our business case. The DWI in our submission also acknowledged in their support and meetings that we were comparing appropriate solutions.

***Minor concerns:** The company shortlists three options from a total of eleven for cost/benefit analysis (CBA). However, it is not clear what criteria were used in screening apart from certainty of outcome. The company presents abridged CBA results showing financial costs, total carbon emissions and costs. However, that falls shorts of being sufficient and convincing that the preferred solution represents best value.*

Our response: We did base initial screening out of options, prior to CBA, on certainty of outcome, as assessed by our team of technical experts and process engineers and based on our trials and pilot plants at the time. (refer to page 32 of our business case, and also more information on the Whitacre trial case study that we did have at the time but didn't include (see figure 8 below).

Regarding the preferred solution representing best value, this is reflected in the 25-year financial cost benefit and risks that we explain more in Section 2 above.

6.1.1 Further options for Whitacre

We provide more evidence below to demonstrate why our chosen options were the most appropriate to compare.

Option for Algae	Why appropriate for comparison?
DAF	For any source waters at risk from algae, the conventional treatment approach would be DAF as opposed to hopper bottom clarifiers that are currently at Whitacre, which are more suited to lowland river fed WTWs. DAF air bubbles are particularly good at attaching and removing algal cells. At most of our works we have a mix of HBCs and DAFs to cope with algal periods as they arise – Whitacre has never had these; most likely as back in the 1980s/1990s, ferric dosing of the reservoirs took place as the main control (and this has since been banned by the EA). Innovation wise we have been working with Doosan, a supplier which is offering a new efficient, cheaper DAF technology that avoids the need for air saturators.
Ceramic Membrane	Ceramic membranes can cope with high total suspended solids (TSS) such as algal loads and are able to produce high quality effluent (very low TSS). This technology would need to be trialled during algal bloom periods to confirm impact upon membrane fouling and therefore viability.
Mecana (full treatment)	Figure 4 below is a summary of an innovation trial undertaken on a small scale at Whitacre in 2021-22 for a Mecana pile cloth filter. This has shown promising results on some species of algae – however there is uncertainty over its performance for different species of algae that emerge throughout any given year, which led to us discounting this as the main treatment option in our enhancement case. As part of our transitional work on this scheme we have recommissioned the Pilot Plant to inform if/how this technology could be used – we envisage this may be a suitable pre-treatment to complement other options and potentially reduce the size of other additional downstream treatment required.

Innovation trial at Whitacre WTW

Figure 8: Summary of outputs from Whitacre Innovation Trial used to inform option comparison in our business case.

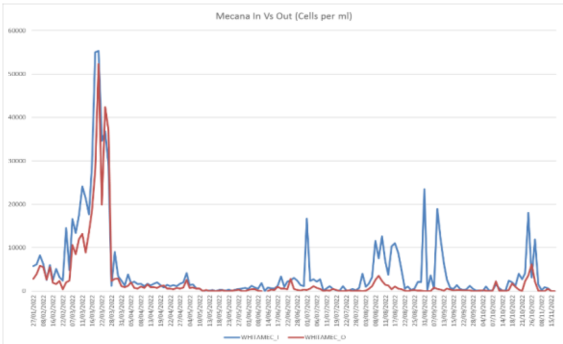
Pile cloth filtration Trial to remove algal from abstracted reservoir water and increase treatment resilience

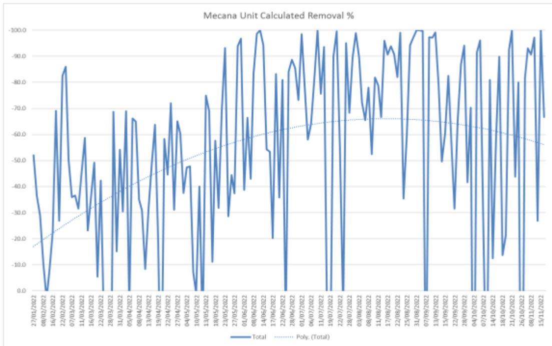
The reservoirs feeding Whitacre WTW are prone to significant algal blooms every year from March to late September. Whitacre WTW's output has been significantly restricted [by approx. 6Ml/d during the last 2 summers (2019 and 2020)] due to algal blooms in Lower Shustoke reservoir.

- The resultant algal loading on the WTW can be levels of up to 48,000 cells/ml; this can happen with little warning.
- These algae quickly block the RGFs which then need backwashing. The amount of water used for backwashing all the filters in quick succession means that the deployable output from the WTW starts to decrease.
- In extreme circumstances the WTW is not able to produce any water for a period until the bloom passes. These blooms can last for weeks.
- The timing of these blooms tend to be in peak summer when demand is at its highest and alternative abstraction from the river(s) is limited.

A 3 disc Mecana unit was trialled at Whitacre WTW from October 2021 to December 2022. The unit uses a cloth pile media to filter the water and has a maximum throughput of 60m^3 per hour. The unit took its feed from the Lower Shustoke inlet of Whitacre's onsite reservoir.

The unit was switched on at the end of October 2021 and the units inlet and outlet frequently sampled. Samples were enumerated and speciated at STW labs, allowing a direct measure of the algal removal performance.

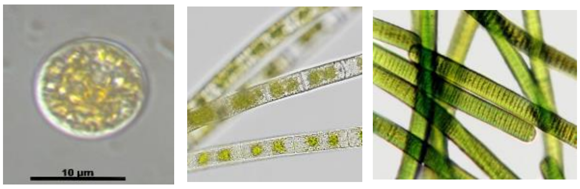




The Mecana unit arriving on site at Whitacre WTW

It was important for the trial to encompass an entire algal season, as the dominant species and overall loading change throughout the year.

Whilst 2022 turned out to be an unusual year for algae at Whitacre, the trial provided useful data. Initially the unit was removing 33% of Diatoms present in inlet. The dominant alga at this time was *Cyclotella sp,* which is a small (<10um) centric diatom. As the year progressed, removal rates improved significantly as the dominant algal species shifted to larger-celled Cyanobacteria. Algal removal reached 96.7% during the Summer against the filamentous Cyanobacteria *Aphanizomenon sp.* and *Oscillatoria sp.* These are the most frequently problematic algal species encountered at Whitacre WTW during the Summer months, when the water is most in demand.



The problematic algal species in Lower Shustoke reservoir:

From left to right; *Cyclotella, Aphanazemnion & Oscillatoria*

Mecana unit commissioning

7. Crypto – Cresswell WTW UV treatment

7.1 Best option for customers

Some concerns*: We have some concerns whether the investment is the best option for customers.*

The company provides evidence that alternative options have been considered. However, it does not provide sufficient and convincing evidence to demonstrate how the presented options financial cost and risks are calculated, and what uncertainties and assumptions have been considered in the 25-year assessments.

The company states that the ultraviolet (UV) preferred option has the lowest whole life cost for five sites, but there is no clear evidence on how the values were calculated. Supporting commentary narrative shows that the total carbon costs for six different capacity sites (one being a membrane solution) are all identical to two decimal places, but the company does not provide sufficient and convincing evidence to demonstrate how the values are evidenced convincingly.

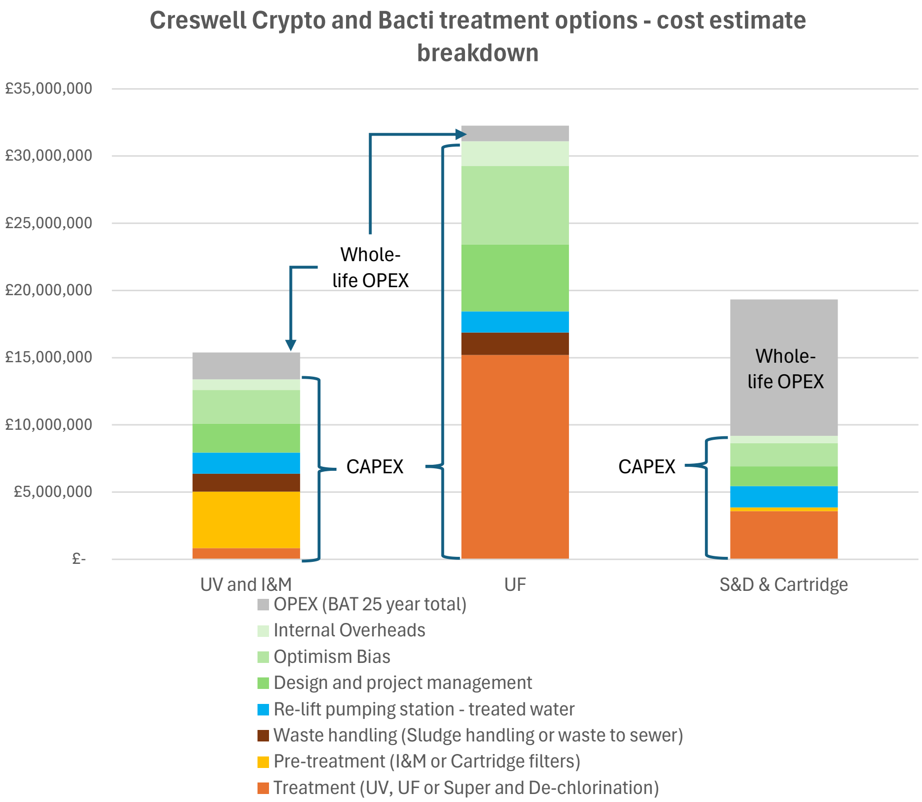
Our response: Financial costs and risks calculations using our BAT is summarised in Section 2 above. We acknowledge that our carbon cost assessment for the UV schemes contained errors, please see Table 19 below for the correct assessment of carbon cost, alongside financial cost and risks.

Table 19: Corrected BAT outputs for shortlisted cryptosporidium mitigation at Cresswell BPS.

Site	Solution option	Financial cost and Risks – 25yr (£m)	UPDATED Total carbon costs (£m)
Cresswell	UV and iron and manganese removal (preferred)	17.66	0.48
	UF	37.76	0.34
	Cartridge filters with S&D disinfection	21.31	0.96
	Emergency UV connection points (Discounted as does not mitigate risk)	1.18	0.33

The CAPEX (22-23 PBD) and the 25-year OPEX from our BAT tool is broken down in Figure 9 below.

Figure 9: Graphical representation of costs associated with shortlisted cryptosporidium mitigation options at Cresswell BPS



For each option considered for Cresswell, the assumptions are:

- Design flow is 13.62 ml/d
- All options have re-lift pumping required for the treated water
- OPEX breakdown/assumptions shown below in Table 6
- OPEX starts in year 5 of AMP8

Table 20: Breakdown of OPEX assumptions behind the 25 year cost at Cresswell BPS

	UV & I&M Operating costs			Ultrafiltration			Super and Dechlorination with Cartridge		
		Quantity	£/yr		Quantity	£/yr		Quantity	£/yr
Power (MWh/yr) 1	UV	39	£ 12,351	UF	268	£ 85,584			£ -
Power (MWh/yr) 2	I&M pumping	322	£ 102,775			£ -			£ -
Chemical usage (tonnes per year)	Chlorine	3	£ 5,951	Various chemicals for Chemical Backwash	4	£ 6,871	Hypo & Bisulphite	56	£ 19,075
Meterials (£)	UV lamps, annual service parts	10644	£ 10,644			£ -	Membrane cartridges, plus minor other parts	787350	£ 787,350
Hired and Contracted (£)	Lintott Maintenance contract	8516	£ 8,516			£ -	Cartridge changes - personnel	5152	£ 5,152

7.2 Cost efficiency

***Minor concerns**: We have minor concerns whether the investment is efficient. The company provides a description of the costing approach of using UV cost curves based on a significant number of previous recently completed projects, with the use of supplier quotes for non-standard solutions, but does not sufficiently demonstrate the how the additional iron and manganese removal is efficient.*

Our response: We accept that we didn't explain how we produced a cost estimate for the iron and manganese removal component of Cresswell. This was generated using our STUCA cost curves which are built up from historic project costs; these cost curves have 11 data points based on previously completed schemes.

To address this challenge, in addition to the benchmarking carried out by Aqua for our PR24 submission which showed this scheme to be upper quartile based on their dataset, we have compared our Iron and Manganese cost curve against the WRC's TR61 benchmark, and our curve gives a project cost 2% lower than the TR61 benchmark for the equivalent design flow treatment plant.

***Minor concerns**: The company provides evidence of third-party benchmarking and assurance which suggests that the company is beyond the upper quartile for this scheme, however the evidence provided does not qualify or quantify the benchmark comparison dataset.*

Our response: Section 3.3 above addresses this point by explaining our third-party bottom up benchmarking in more detail.

7.2.1 Cost modelling approach

Our business plan included a UV scheme at Creswell WTW for cryptosporidium inactivation, which was assessed by Ofwat through deep dives at draft determinations. Ofwat made an adjustment of 30% to our scheme costs following this assessment and said that we had not provided sufficient and convincing evidence that our costs are efficient.

We believe that the installation of new UV treatment process at Creswell is analogous to the treatment works upgrades included within Ofwat's supply enhancement model. We therefore compared the cost of this scheme against the unit cost benchmarks derived from the supply enhancement model.

Table 21: Costs and efficiency results for UV scheme

UV treatment scheme	Totex	Category for Ofwat's supply scheme model	Applicable unit cost benchmark	Modelled cost	Implied efficiency score
Creswell WTW	£13.54m	Base activity scheme	£5.71m per Ml/d	£77.8m	0.17

This comparison suggests that our UV treatment costs at Creswell WTW are relatively efficient.

8. PFAS laboratory analysis capacity

8.1 Need for investment

8.1.1 Fail to meet need

***Fail:** The investment fails to meet the criteria for enhancement investment and additional customer funding.*

The company does not provide clear and convincing evidence why a commercial laboratory cannot provide the expected service and why customers should provide funding to expand the company laboratory that could provide future commercial activity.

Our Response: This activity is critical for delivering our AMP8 PFAS Strategy that we submitted to DWI in June 2023, and which is now linked to:

- DWI Commend for Support Letter ref SVT-2023-00007
- Section 19 Undertaking ref SVT-2023-00014
- PCDW13 which now has PFAS Strategy as an output and the unit listed as a DWI legal instrument

There are three main reasons why a commercial laboratory cannot provide this activity:

- Legal obligation. With the new PFAS tier sampling requirements and the likely need to increase sample frequency, commercial lab capacity is not enough - there is only one company, ALS, who the whole water industry use for PFAS.
- Resilience – as we explained in our business case, the turnaround time from the commercial lab is too slow and we have experienced a number of samples submitted but tests not carried out (Figure 7 below) – customers would find this unacceptable for such a high profile public health risk, which is why we strive for in house analysis of all drinking water quality determinands.
- Cost comparison on our cost vs a commercial laboratory. This investment would be 40% less over its life than the commercial alternative; a better use of customer's money (see Table 7).

8.1.2 DWI support is not sufficient

The DWI has issued a support letter (SVT15-PFAS Strategy) for the company's PFAS strategy, which includes a scheme for laboratory expansion to increase PFAS and other emerging contaminants analysis, which the DWI 'commended for support'

Our Response: Other schemes which are "commend for support" from the DWI have been approved by Ofwat for AMP8, and will be tracked in the PCD as an "Acknowledged Action". The lab investment is in this same category, and is required for delivering our PFAS strategy for which we also have a Price Control Deliverable.

8.1.3 Why does this need to be insourced

***Fail**: The company does not provide sufficient and convincing evidence why the investment is needed now and why the commercial sector cannot cost effectively meet the company's demand. The company also does not quantify the potential income generation from running its own laboratory.*

Our Response: In pages 39-40 of our business case, we have set out that PFAS is an area where demand has outstripped capacity in the marketplace as there is only one commercial lab able to undertake analysis to the right standard for PFAS in drinking water ([✂]). This is even more of a problem with the increasing PFAS sampling requirements that we explain in our new PFAS business case (see Figure 6 below). Effectively, there is a risk for the water industry as companies that are not developing methods will all be reliant on a single commercial option. The only water company labs who are accredited at the moment for PFAS are ourselves, Anglian Water, Affinity and United Utilities.

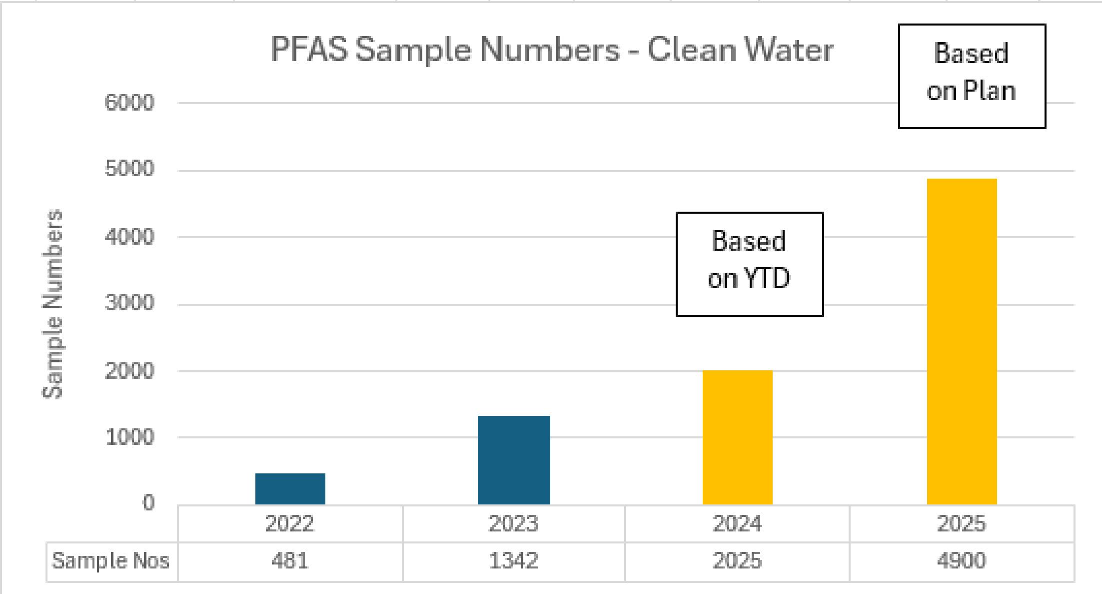
We have not sought any income generation from our labs since 2013 when we brought labs in-house. Prior to 2013, Severn Trent Water's Chemistry analysis for both clean and waste samples was sub-contracted to Severn Trent Laboratories (part of the Severn Trent Group). Following concerns raised during a DWI audit and also cross subsidy concerns in the early 2010s the decision was made to cease a commercial model within the laboratories and this resulted in the waste water analysis being split from clean water analysis to allow the Bridgend site to focus purely on core Severn Trent Water clean water analysis only. This was to achieve a number of key aims:

- Ensure no conflict of interests between commercial work and regulatory work
- Simplify workstreams to make them more efficient
- Reduce complexity of the quality system and parameters run to ensure quality to the right standard
- Simplify accounting for our analytical work

The new Bridgend clean water lab under Severn Trent Water was therefore established in 2013 and since this date has remained a commercial free laboratory that undertakes work solely for Severn Trent Water. The only work done for other water companies is on the basis of mutual aid – typically this is where other water company labs have been unable to cope with specific workloads due to instrument issues, staff problems, loss of site or IT etc.

Under a mutual aid agreement the Severn Trent Labs would look to offer mutual aid to other companies for this specific analysis should the commercial market be saturated, and subject to our internal demand being fully met before any excess being offered to other water companies – this is however not a commercial model for our method development. We explained this in our business case on pages 39-40.

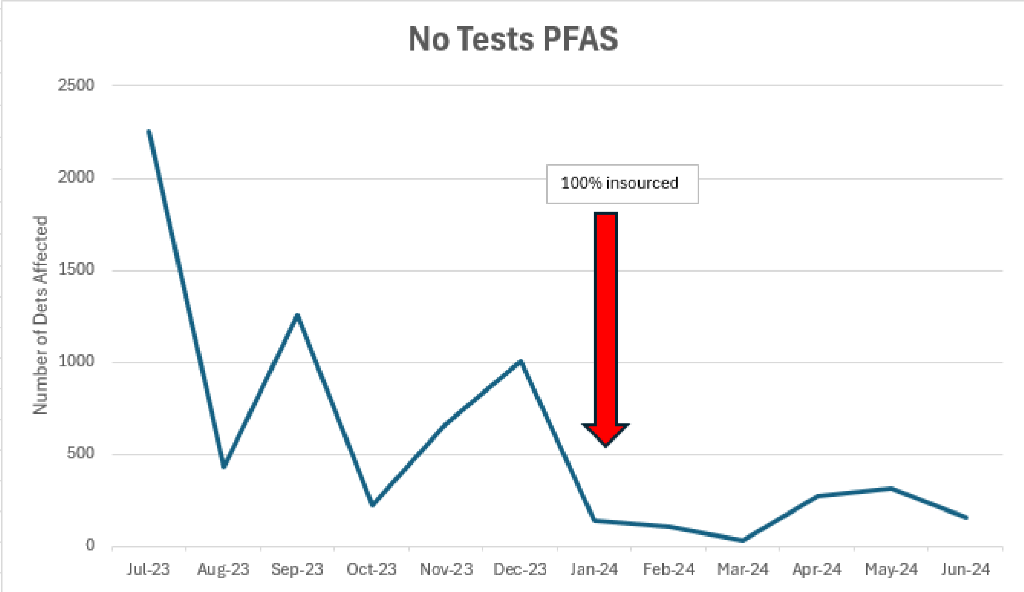
Figure 10: Graph showing the number of clean water PFAS samples taken annually since 2022 (including 2025 projection based on our new PFAS business case).



As well as commercial sector capacity being an issue, the service quality for PFAS labs analysis isn't there for AMP8 either. The commercial lab referred to above has not been able to analyse samples that we have provided – evidenced below in Figure 11 which shows the number of No Tests for PFAS across the preceding 12 months. At the turn of the year, we insourced 100% of the PFAS clean water testing and Figure 12 shows a step change in no-tests at this point - showing the improved customer service as a result of us analysing these samples within our own testing labs.

The impact on No Test is both delayed results, impacting on our ability to ensure we meet our public health obligations, and also rework as we will need to go back out and take the samples again and put back through the supply chain.

Figure 11: Number of No Test PFAS due to capacity issues at commercial lab.



We can also provide better value for our customers than the commercial option. Assuming that that the commercial lab could accommodate our and the industry's projected workload, the Cost model below, based on current costs/PFAS from commercial labs shows that we are more efficient (40% cheaper) – assuming that our PFAS labs enhancement expenditure is allowed.

Table 21: Projected efficiencies that can be achieved through having an in-house lab rather than relying on commercial lab

PFAS	Cost/sample*	Sample Numbers/annum	Costs/annum	Lifetime (7 years)
Commercial lab - sub-contract	235	4900	£1,151,500	£8,060,500
STW In-house labs	141	4900	£690,900	£4,836,300
Projected efficiency	*-£94*		*-£460,600*	*-£3,224,200*

**Insourced costs include depreciation and are a fully loaded cost model*

As part of our PFAS strategy we need this equipment to give us the capacity and capability to measure PFAS samples in water and catchment or effluent samples. We compared options that included "as is" manual sample preparation versus investing in automated sample preparation. Our analysis below shows that with our automated option we expect a 28% reduction in the costs per sample, and with maintenance and energy costs applied, that is a 14% reduction in overall analytical costs for both sample types. More importantly, our automated option will provide the capacity and resilience that we need to meet PFAS sampling requirements, which is not easily quantified as a benefit.

Table 22: Breakdown of laboratory costings and potential cost saving opportunity by investing in automated sample preparation

	Drinking Water samples		Effluent/Catchment sample	
Instrument Costings	Manual SPE	Automated SPE	Manual SPE	Automated SPE
Capital Cost	£0	£120,000	£0	£120,000
Depreciation p.a. (7 years)	£0	£17,143	£0	£17,143
Maintenance Contract p.a.	£0	£10,000	£0	£10,000
No. columns per year	0	0	0	0
Cost per column	£0	£0	£0	£0
Cost of columns p.a.	£0	£0	£0	£0
Electricity	£50	£250	£50	£250
Total annual cost	£50	£27,393	£50	£27,393
Cost per minute	£0.000	£0.052	£0.000	£0.052
Example				
Cycle time (mins)	6	6	6	6
Cooldown (mins)	0	0	0	0
Total inst cycle (mins)	6	6	6	6
Batch size	57	57	57	57
No. calibrations, AQCs	3	3	3	3
Injections per batch	60	60	60	60
Run time for (=b21) samples (min)	360	360	360	360
Time per sample	6.32	6.32	6.32	6.32
Cost per sample	£0.00	£0.33	£0.00	£0.33
Consumable Costings				
SPE/solvent	£4.00	£4.00	£4.00	£4.00
Adjusted cost SPE	£4.21	£4.21	£4.21	£4.21
Total Material Cost per Sample	**£4.21**	**£4.54**	**£4.21**	**£4.54**
No FTE time	1	0.5	1.5	0.75
FTE salary & overhead	£31,511	£31,511	£31,511	£31,511
Cost labour	£31,511	£15,756	£47,267	£23,633
No samples per week	96	96	134	134
Cost labour per sample	**£6.31**	**£3.16**	**£6.78**	**£3.39**
Total cost per sample	**£10.52**	**£7.70**	**£10.99**	**£7.93**
Cost of Analysis per annum	£52,533	£38,418	£76,610	£55,266
%Reduction		27%		28%
Analytical savings per annum		**£14,115**		**£21,344**
Maintenance Contract Savings		-£10,000		-£10,000
Energy Reduction		-£200		-£200
Total Saving		**£3,915**		**£11,144**
%Reduction		9%		17%

8.1.4 Overlap with other costs

The company does not explain if the specialist laboratory equipment is replacing any existing equipment or providing a replacement service that may reduce existing third-party costs.

Response: Replacement of laboratory/analytical equipment is carried out on a routine basis as part of our base expenditure. Our proposal is in addition to this.

8.1.5 Why now?

The company states that an 'in-house laboratory capability is required to confirm PFAS removal and to inform longer-term planning for emerging contaminants that may have legal standards to come over the next 10 to 20 years'. The company notes opportunities to explore concerns regarding the disposal/regeneration of GAC/resin media with PFAS but does not provide convincing evidence why now

Response: Please also refer to our SVE4.28 PFAS Updated Regulations – evolving regulatory requirements as well as increasing public interest require us to act now to ensure we are the best informed we can be for the future of dealing with PFAS.

8.2 Best Option for customers

The company does not provide sufficient and convincing evidence that it has considered and evaluated alternative options.

The company does not explain why the existing third-party commercial arrangement is not adequate, cost effective for the future and why customers should provide funding to expand the company laboratory that could provide future commercial activities.

Response: Please see table 21 above for the assessment of the whole life cost comparison between in-house and commercially sources PFAS analytical services. In-house is c.40% less cost.

9. Crypto scheme- Far Baulker/ Rufford membrane

9.1 Best option for customers

***Some concerns**: We have some concerns whether the investment is the best option for customers. The company does not provide sufficient and convincing evidence to justify its selection of the preferred option.*

The company provides evidence that alternative options have been considered. However, it does not provide sufficient and convincing evidence to demonstrate the cost benefit analysis of the options compared to the preferred option. We also do not consider that all alternative treatment options have been considered.

We note that the company states that ultraviolet (UV) treatment has not been selected, as the raw water bromide is high and much greater than the levels experienced at existing sites with UV treatment. Noting that installing UV treatment would pose a risk of transforming bromide to bromate, which is a carcinogen and low permissible concentration value (PCV) of 10ug/l. The company does not provide evidence to qualify and quantify these risks and therefore justify ruling out UV as a viable alternative.

Our response: Regarding option selection, Section 2**Error! Reference source not found.** above now provides more detail behind our CBA methodology and our Benefits Assessment Tool (BAT).

In our SVE 13 case we showed that our selected scheme option (Ultrafiltration membrane) gave the highest 25 year financial cost (Table 22), but is our only robust and sustainable choice to address Cryptosporidium risks at the site given (i) the Bromide risks with using UV, and (ii) the unsustainable cartridge filter replacement requirements with the Super chlorination with cartridge filters option.

Table 22: Summary of outputs from Cost-Benefit Analysis for shortlisted cryptosporidium mitigation at Far Baulker BPS – including updated Carbon figures, as per Ofwat DD challenge

Site	Solution option	Financial cost and Risks – 25yr (£m)	UPDATED Total carbon costs (£m)
Far Baulker	UV (not suitable for this site)	9.17	1.61
	UF (preferred)	**62.84**	**0.94**
	Cartridge filters with S&D disinfection	28.41	2.29
	Emergency UV connection points	6.51	0.03

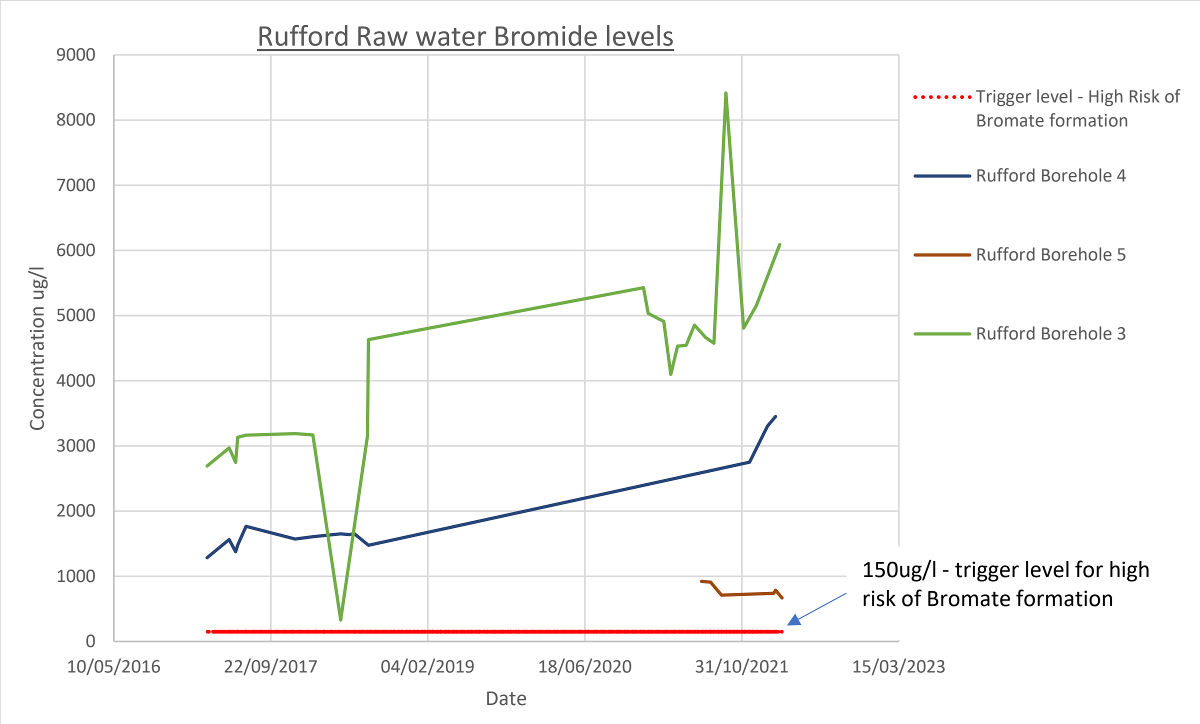
All processes for disinfection, as per the Severn Trent Disinfection policy (v1.2 01/01/22), have been considered. These being under the three categories of super chlorination (in combination with cartridge filters for crypto removal), UV and ultrafiltration.

Bromide (non-toxic) present in the water at Rufford and Far Baulker poses a risk of toxic Bromate formation when undergoing UV treatment. Our internal STW limit for high bromide is <150ug/l, above which investigations are undertaken to ensure there is no likely pathway for bromate formation to take place that breaches the PCV of 10ug/l. UV irradiation is one such pathway.

Figure 12 shows that Bromide levels in the raw water are significantly higher than the trigger limit of 150 ug/l. Whilst there is limited literature on the formation of Bromate from UV irradiation, this trigger level has been derived from our experience at sites where UV is used – at our Shelton site, when Bromide levels prior to UV irradiation are higher than 150 ug/l, we have experienced Bromate formation in final water exceeding the prescribed concentration or value (PCV) or Bromate (10 ug/l).

We are currently conducting bench scale bromate/ bromide testing at Rufford/Far Baulker to confirm the likelihood of the inherent risk being realised.

Figure 12: Raw water bromide levels at Rufford BHs, µg/l (2016-2023)



9.2 Cost efficiency

Some concerns: *We have some concerns whether the investment is efficient. The company does not provide sufficient and convincing evidence that the proposed costs are efficient.*

The company provides evidence of obtaining one supplier quotation for ceramic membranes that can provide the ultrafiltration required for DWI-approved cryptosporidium removal.

The company does not provide any evidence that the costs are efficient and noting that not all treatment options have been fully considered

Our response

Ultrafiltration membranes for disinfection could be either polymeric or ceramic. There are multiple advantages of using ceramic over polymeric. These include:

(1) Longer membrane life, 25 years vs. 5-7 years

(2) Less chance of membrane integrity breaches

(3) Ability to operate at high flux

(4) Tighter pore size distribution

(5) Ability to cope with higher solids loading.

We chose ceramic due to the above factors, particularly that ceramics are more resilient to raw water turbidity/solids challenges. With the expected changes in raw water quality that we will face under WINEP abstraction reductions (ref SVE08 Meeting future water needs business case) the future operating regime of Rufford will change (i.e. due to more frequent on/off cycles and/or longer "off" periods – for a borehole to remain available for supply it must be operated at least once every 28 days). Groundwater level rebound as a result, with greater interaction between groundwater and surface water, is likely to change WQ and need more resilient membranes than polymerics. This is the best option in the long term for customers, and mitigation of this risk is not included in our WINEP plans for this site (customers are not paying twice). More detail provided below

Consideration of other options other than UF membranes is outlined in the 'best option for customers' section above.

Hydrogeological impact of WINEP licence changes – further rationale for choosing Ceramic membrane option

Changes in groundwater level because of reduced abstraction and/or a change in operation (i.e. source on and off more frequently or longer off periods) can impact water quality through several mechanisms. It is important to note that not all water quality risks from reduced/change abstraction can be understood in advance of the change, future investments may be needed if/when risks materialise, hence WINEP investment does not capture all of the risk.

1. Water quality turbidity impacts because of abstraction reductions.
    a. Example – Burcot Turbidity – Planned reductions at Burcot result in groundwater levels being permanently within or passing through a water level with known higher turbidity more frequently. Investment has been included in WINEP to mitigate the issue as it is well understood compared to other sites.
2. Coliforms/Bacteriological– shallower groundwater levels potentially lead to shorter travel pathways to the abstraction for bacteriological contamination.
    a. Examples – Rufford – coliforms detected following groundwater level recovery because of the source being off for a period for BHCM
    b. Rednal – evidence of turning source off and on resulted in coliform detections when turned back on due to recovered groundwater levels. This is a general future risk that has not been accounted for in any WINEP investment (i.e. no WINEP investment in UV)
3. Nitrate – groundwater levels increase may result high nitrate horizons contributing more to the abstraction– either though more frequent off/ons of the abstraction – leading to start up spikes or lower general abstraction permanently changing the flow horizons contributing to the source
    a. Examples – Copley, Brockhill, Swynnerton, and Epperstone are all know to have nitrate spikes at start up, the inference being that there are likely high nitrate horizons contributing to the source. Reduction in abstraction could 1. Increase the frequency/duration of the nitrate spikes and/or 2. High nitrate horizons permanently contributing to the source resulting in overall increase in nitrate. 3. Changes to the catchment area contributing to the source.
4. Change in operational boreholes/regime resulting in water quality changes
    a. Example Clipstone Forest – four boreholes effectively with their own "mini" catchment. Changes in borehole use are known to impact water quality in other boreholes. With reduction in abstraction there is a risk of the water quality changes if the operation regime changes.

Assessing risk for WINEP

1. Changes in abstraction do not always have an immediate impact. Water quality changes can be gradual as the source catchment adapts to the new abstraction regime. This is also complicated where multiple sources share catchments. Under WINEP this is something that it difficult to assess and, as it may not have an immediate impact, it is hard to justify WINEP investment in Amp 8 but

may be something that ultimately needs investment in the future (that would not have been needed/or needed later if not for WINEP reductions)

   a. Evidence for this can be shown via relatively new sources that are still developing their catchments (e.g. Ruyton and Nescliffe) where nitrate concentrations are increasing as the catchment continues to be developed.

2. If a source has not previously been tested, investigated, or had significant operational changes, there is a lack of information to make firm judgment as to the future water quality risk from abstraction changes. This has been addressed through WINEP by including costs at approx. 15 groundwater sites to undertake pumping tests to better understand any risk and any mitigations that could be put in place (would need to check number and costs with CCS). Clipstone Forest was one of these sources.

Where sites were identified as potentially at risk of water quality changes due to reduced abstraction investment was included in the WINEP. Examples include Meriden Shafts – historical testing indicated higher nitrate at reduced abstraction so investment for a nitrate treatment plant was entered into WINEP, Eyton where nitrate is already above PCV and there is a risk to the blend with abstraction reductions and resilience.

9.2.1 Cost modelling

Our business plan included a scheme at Far Baulker and Rufford to address cryptosporidium risk, which was assessed by Ofwat through deep dives at draft determinations. Ofwat made an adjustment of 40% to our scheme costs following this assessment and said that we had not provided sufficient and convincing evidence that our costs are efficient.

We believe that the installation of ceramic membranes at Far Baulker and Rufford is analogous to the treatment works upgrades included within Ofwat's supply enhancement model. We are planning another treatment process upgrade at the same site which we reported under the WINEP WFD enhancement cost category. As with the PFAS/Algae scheme above, we have compared the combined cost of both treatment work upgrades at Far Baulker/Rufford against the unit cost benchmarks derived from the supply enhancement model.

Table 23: Costs and efficiency benchmarking for ceramic membranes

Ceramic membranes + WINEP WFD scheme	Totex	Category for Ofwat's supply scheme model	Applicable unit cost benchmark	Modelled cost	Implied efficiency score
Far Baulker / Rufford (combined)	£61.1m	Base activity scheme	£5.71m per Ml/d	£137.1m	0.45

This comparison suggests that our proposed treatment process upgrade costs at Far Baulker / Rufford are relatively efficient.

10. Lead removal at Homesford WTW

10.1 Best option for customers

***Some concerns 1**: We have some concerns whether the investment is the best option for customers. The company provides evidence that five alternative options have been considered. However, it does not provide sufficient and convincing evidence to demonstrate how the presented options costs and risks are calculated.*

Our response: The calculations of the presented options costs and risks are explained in Section **Error! Reference source not found.** above which provides more detail behind our CBA methodology and our Benefits Assessment Tool (BAT).

***Some concerns 2:** The company provides no clear evidence of any estimated performance levels of the proposed treatments, additional benefits and any associated cost reductions.*

Our response: In the section below we provide estimated lead removal rates based on the ceramic membrane pilot plant that we installed on site in February 2024 (6 months data) as part of transitional spend. In summary, the performance of the ceramic membrane exceeds that which we originally expected as part of our dialogue with the DWI on their PR24 queries about the mass flows of lead to customers – a concern that if we increased output of the works up to max abstraction flows with our predicted lead removal at the time, customers may experience an increase in lead mass flow. However, our trials are showing that more lead can be removed than we thought at the time of our submission which means that we can increase supply output from the works when customers need it without increasing, and likely significantly reducing, the mass flow of lead compared to current operation.

As part of our query process with the DWI on PR24 submissions, we provided a predicted mass balance (column [B] in table below) compared to the current situation [A] for customers supplied by Homesford.

DWI support and reporting milestones include a caveat that support is "…conditional on the pilot plant trials indicating the treatment can be achieved at full scale and there is no deterioration in the mass flow of lead to customers." Column [C] shows predictions based on the pilot plant results, which we have been running on site since February 2024 with even lower levels of lead for customers.

Table 24: Detailed removal rates and mass balance

Current pre-investment position **[A]**	**Estimated performance – *From our DWI PR24 query response (June 2023)*** ***[B]***	**Estimated performance – based on pilot plant (Feb to July 2024)** **[C]**
• Average Lead concentration in final water (since 2008): 2.5 µg/l Pb • Average Water into Supply (since 2008): [✂] Ml/d • Daily mass flow of lead: **75 g/d Pb**	• Expected concentration in final water after Lead removal: 1.5 µg/l Pb • WTW Output restored to design capacity: [✂] Ml/d • Daily mass flow of lead: **68 g/d Pb** If we can achieve the 1.5 ug/l final water concentration, then we could achieve a	• Expected concentration in final water after Lead removal: 0.14 µg/l Pb which is below the limit of detection • WTW Output restored to design capacity: [✂] Ml/d • Daily mass flow of lead: **6.8 g/d Pb**

	c10% reduction in lead mass flow as well as restoring the output of the works to original design capacity. This needs confirming though our pilot plant and detailed feasibility stages. We would need to achieve <1.67 µg/l at full output to ensure no increase in mass flow – and we would monitor and control accordingly to make sure any increase in WTW output would not increase lead loading to customers.	Since our DWI submissions, we now think we can achieve a c90% reduction in lead mass flow to customers at design capacity. Using the full abstraction of [✂] Ml/d will result in a maximum potential lead mass flow of 9.8 g/d – still an 87% lead mass flow reduction compared to current average supply out.

We haven't yet reported these results to the DWI (next milestone date is March 2025) but pilot results to date effectively fulfil the caveat to their support.

Figure 13: Graph showing that lead concentration in pilot plant treated water/permeate

(green line) is significantly lower than the treated water in the current works (yellow line).

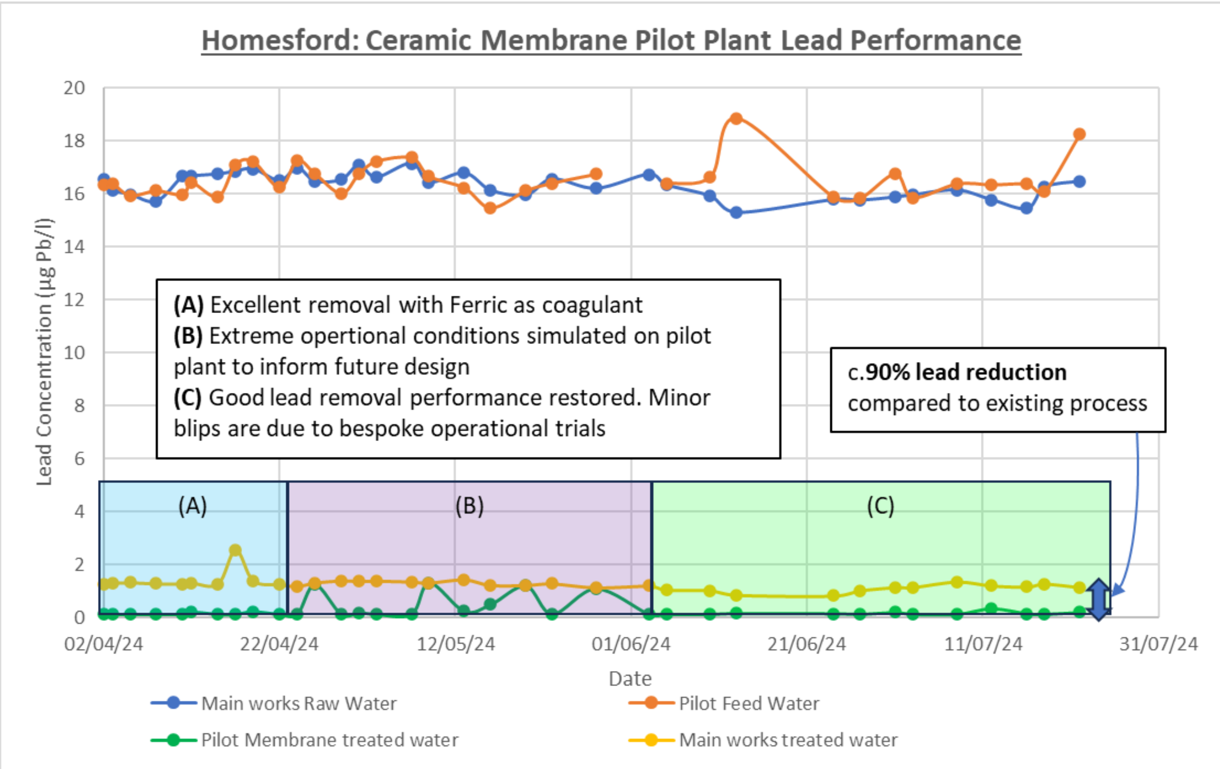


Figure 14: Pilot Plant results – Matrix showing the mass flow of lead to supply

Purple box shows the current lead mass flow, bright green box shows future expected maximum lead mass flow. Note future lead mass flow is likely even smaller than this, as concentration is often below Limit of Detection.

Matrix = Mass of lead to supply (g/d)		Deployable Output (Ml/d)					
Lead in permeate (ug/l)	0.1	4.0	4.5	5.0	5.5	6.0	6.5
	0.15	6.0	6.8	7.5	8.3	9.0	9.8
	0.2	8.0	9.0	10.0	11.0	[illegible]	13.0
	0.25	10.0	11.3	12.5	13.8	[illegible]	16.3
	0.3	12.0	13.5	15.0	16.5	[illegible]	19.5
	0.35	14.0	15.8	17.5	[illegible]	[illegible]	22.8
	0.4	16.0	18.0	20.0	[illegible]	24.0	26.0
	0.5	20.0	22.5	25.0	[illegible]	30.0	32.5
	0.6	24.0	27.0	30.0	[illegible]	36.0	39.0
	0.7	28.0	31.5	[illegible]	[illegible]	42.0	45.5
	0.8	32.0	36.0	[illegible]	44.0	48.0	52.0
	0.9	36.0	40.5	[illegible]	49.5	54.0	58.5
	1	40.0	45.0	[illegible]	55.0	60.0	65.0
	1.1	44.0	[illegible]	[illegible]	60.5	66.0	71.5
	1.2	48.0	[illegible]	60.0	66.0	72.0	78.0
	1.3	52.0	[illegible]	65.0	71.5	78.0	84.5
	1.4	56.0	[illegible]	70.0	77.0	84.0	91.0
	1.5	60.0	67.5	75.0	82.5	90.0	97.5

Significantly **reduced lead mass flow** to customers,

Some concerns 3*: The company state that the ceramic membrane preferred option for lead removal has the lowest whole life cost and third highest carbon costs. However, the information provided shows the preferred option having the highest total carbon costs. The company does not provide an explanation of this inconsistency.*

Our response: We acknowledge an inconsistency between the text in the business case and the values in Table 18. We can confirm that Table 18 is correct: our preferred option had the lowest whole life cost and the highest total carbon costs. Our conclusion regarding ceramic membranes in the case does not change;

"Of the three higher certainty options, the ceramic membrane option currently has slightly higher whole life costs and carbon. However, it is our preferred treatment option at this stage as it is considered the most reliable option, offering lower process risk and better lead removal rates. The option is also better suited to the base capital maintenance needs of the site."

Our pilot results to date affirm our conclusion of ceramic membranes as a reliable solution with low process risk, and whole life carbon is comparable to the higher certainty, and higher cost options of conventional filtration with a separate disinfection process.

Additional benefits of ceramic membranes are:

- Effectively providing a disinfection process
- Increased asset resilience to water quality fluctuations and increased flows due to membrane integrity

- Synergies of chemical usage with other processes to support the removal of chlorine gas from site

We believe our base contribution of £15.8m adds to this being the correct option for customers.

10.2 Cost efficiency

Some concerns 1*: We have some concerns whether the investment is efficient. The company does not provide sufficient and convincing evidence that the proposed costs are efficient.*

Our response: We provide more evidence behind our bottom up and top-down cost benchmarking which shows our proposed costs are efficient.

Some concerns 2*: A high proportion of the cost components are classed as non-standard. These costs are via supplier quotation from the only supplier of ceramic membranes that can provide the ultrafiltration required for DWI-approved cryptosporidium removal.*

Our response: We can confirm that there is only one supplier of ceramic membranes that are DWI-approved for cryptosporidium removal. The table below is based on information we provided to our legal team as part of the justification to proceed with a pilot trial with Nanostone, as the only available supplier of ceramic membranes for this application:

How/why did we decide to trial Nanostone for lead removal at Homesford?	**A DWI approved method to remove lead is required. For membrane options they require** - **Ability to take an up-front coagulant dose,** - **A pore size in the Ultra Filtration range, and** - **to be made of a material other than polymeric given the issues we have with those types of membranes currently.** **The only option on the market that meets all of these criteria is Nanostone.**
Why does it need to be DWI approved?	Under the Water Supply (Water Quality) Regulations 2016, water undertakers must ensure water supplied is wholesome (Regulation 4), and not introduce any substance or product into the water which does not comply with Regulation 31. We can ensure this by **complying specifically with Regulation 31.(4)a**, by only using products which the Secretary of State has, for the time being, approved the application or introduction of, and which is applied or introduced in accordance with any conditions attaching to that approval. The only membrane filtration technologies that can be considered for use for water treatment **must be on the approved products list**. Our project, due to timescales involved, also only considers solutions which are currently approved technologies at the time of options appraisal, and not any system which might hope to gain systems in the future.
Why does the membrane need to be ceramic?	[Also covered in our SVE13 business case] Polymeric membranes such as the Memcor product currently used at Homesford can have accelerated deterioration when they are operated with in-line coagulation for lead removal. Ceramic membranes are designed to utilise an upfront coagulant dose and should therefore not exhibit the same or similar accelerated deterioration (Nanostone are offering a 15 year warranty for membrane integrity). [We have built this additional membrane life into our 25 year BAT tool costings]. There are currently only two DWI approved ceramic membrane products available (PWNT CeraMac and Nanostone), but only the Nanostone product utilises Ultrafiltration (UF).
Why does it need to be Ultrafiltration?	The process currently in use at Homesford utilises polymeric membranes with a pore size in the UF range – originally installed for Cryptosporidium removal

	which requires this pore size and are also used as primary disinfection. A chlorine dose is then applied post-filtration. As the source water hasn't changed, the same level of pore size is required to provide the same degree of disinfection. As such UF membranes are required. PWNT CeraMac are not ultrafiltration membranes and therefore are not suitable for primary disinfection.

***Some concerns 4**: The company provides evidence of third-party benchmarking and assurance which suggests that the company is beyond the upper quartile for this scheme. However, the evidence provided does not qualify or quantify the benchmark comparison dataset.*

Our response: Section 3 provides an overview of our third-party benchmarking and section 10.2.1 offers an alternative method for independently benchmarking the costs.

10.2.1 Cost modelling

Our business plan included a scheme at Homesford WTW to address levels of lead in raw water, which was assessed by Ofwat through deep dives at draft determinations. Ofwat made an adjustment of 40% to our scheme costs following this assessment and said that we had not provided sufficient and convincing evidence that our costs are efficient.

We believe that the installation of ceramic membranes at Homesford WTW is analogous to the treatment works upgrades included within Ofwat's supply enhancement model. We have compared the new treatment process at Homesford against the unit cost benchmarks derived from the supply enhancement model.

Table 25: Costs and model results for Homesford lead removal

Ceramic membranes for lead removal	Totex	Category for Ofwat's supply scheme model	Applicable unit cost benchmark	Modelled cost	Implied efficiency score
Homesford WTW	£74.9m	Base activity scheme	£5.71m per Ml/d	£257.04m	0.29

This comparison suggests that our proposed treatment process upgrade costs at Homesford WTW are relatively efficient.

11. Catchment management

This section covers three schemes; the second phase of 10 year catchment management schemes, a catchment solution to River Severn Cryptosporidium and Severn Trent's fair share of an NRW required scheme on the River Dee. The River Severm scheme has been relocated from DWPA WINEP because the EA have withdrawn the driver, but in its place the DWI has issued a statutory notice and the River Dee Scheme has been removed because it is required by NRW and as such is also not listed in WINEP. In this section we provide the evidence to show that all three components are required and supported by our Regulators, they deliver further enhancements not previously funded and offer best value to customers and the environment.

The Final methodology recognises that the financial treatment of opex focused nature-based solution delivered through enhancement spend leaves a funding gap in the next asset management plan. This is because the econometric models are not adjusted until the following plan[8]. The methodology advised companies to make a cost adjustment claim where believe the base funding model for PR24 won't cover the cost of ongoing catchment and NBS schemes. The cost adjustment claim methodology states that new claims can not be introduced so we are unable to pursue this route. Therefore we retain the claim in this representation as we feel the clear benefits of this scheme deliver on the sentiment of the Ofwat policy. It is counter intuitive that Ofwat will only consider 10 year schemes that start in 2030 and not schemes that started in 2025.

11.1 AMP7 continued catchment management schemes

We note that "AMP7 continued catchment management schemes" was not allowed in the DD assessment of our Raw Water Quality Deterioration business case, as part of a shallow dive. It has been acknowledged that there is currently a funding gap for on-going non-traditional solutions e.g. catchment management (Ofwat, 2022b. page 92). To fill this, a ten-year ongoing expenditure allowance (to be recovered over two price control periods) is allowed and we believe that our five continuation cryptosporidium schemes would fall within this allowance according to the Ofwat PR24 methodology.

The five sites under this scheme (Beckbury, Bratch, Grindleforge, Puleston Bridge, Tack Lane) were all supported by the DWI as part of our AMP7 Water Quality programme for twin track treatment mitigation and catchment management (DWI PR19 ref: SVT01,02,09,14,15). All are currently categorised as "high risk" for microbiology, with the main source of pollutant found to be from livestock farming. In AMP7, each catchment was assigned a pollutant reduction target based on the difference between the raw water concentration and water quality target (e.g. WFD/no deterioration etc). These concentration reductions have then been converted into pollutant load reductions. These are calculated for the 25-year programme of work, linked to the Effectiveness of Controls in the Drinking Water Safety Plan. Through our Farming for Water programme, we have been engaging with local farmers and delivering priority grant options under our Severn Trent Environmental Protection (STEPs) scheme – and are on track to meet the load reduction targets set for these five catchments[9]. However, we will need to either engage with new farmers and deliver the same amount and type of

[8] PR24 final methodology_Appendix 9 Setting expenditure allowances, section 6.4.2

[9] Please refer to Appendix SVE 4.04 '*UME04a Water WINEP DWPA*' which further explains how we have benchmarked our costs, considered alternative approaches to delivery e.g. reverse auctions, assessment of the most cost-effective catchment interventions (priority items) and an explanation of why the cost of catchment interventions has increased.

grant items or work with the same AMP7 farmers to deliver different grant options in order to further reduce the cryptosporidium load in AMP8. Our STEPs grants only provide 50% of the option costs and the farm is expected to match fund the remaining 50%. It is important to note that as catchment schemes change and evolve over multiple AMPs, customers are never paying for the same scheme options twice.

Each of the five catchments assumes an average ‘crypto relevant’ farmer uptakes £16,396 worth of catchment measures with Severn Trent over a 5-year period (based on previous experience in AMP 6 and 7). Measures include, but are not limited to, animal health plans, farmyard crypto risk assessments, livestock testing, fencing, buffer strips, herbal leys, livestock removal and slurry spreader upgrades. A 35% uptake rate was used, and it was assumed that improvements will be made over an initial 5-year period after which they will be sustained until year 30.

11.2 Crypto scheme for the River Severn

We have reallocated the investment that is not stated 5th July WINEP refresh to this raw water deterioration business case (see SVE 4.04 Water WINEP DWPA).

Shelton WTW, Trimpley WTW, Strensham WTW and Mythe WTW have all been experiencing water quality issues from cryptosporidium and/or bacteriological species in recent years. Investigations into the causes and trends suggest agriculture as the primary source, with detections worsening in times of flood and in wet seasons, in part due to the increase of total livestock numbers in some areas of the catchment. Without intervention from catchment management, the issue is likely to worsen alongside the more challenging weather.

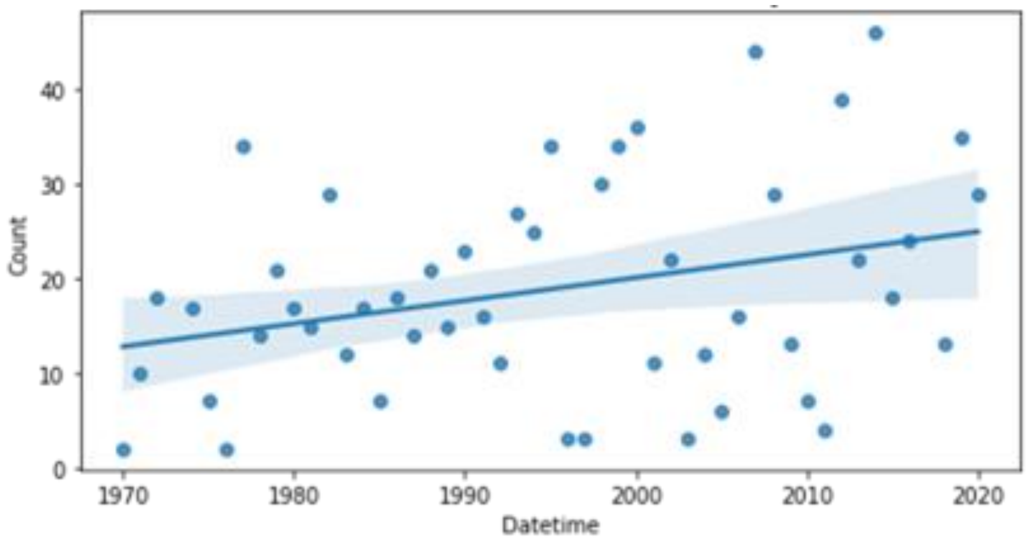
The DWI’s long-term planning (PR24) guidance requires companies to adopt a twin track approach that includes treatment and/or other operational control measures in addition to catchment management actions to mitigate the risks to consumers from raw water deterioration. This work complements our AMP8 investment plans for water treatment works e.g. Strensham. It particularly helps mitigate the increasing risk we are experiencing at our direct river-fed sites on the River Severn.

Since our PR24 submission, we received a draft Regulation 28 notice (SVT-2024-0000) in February 2024 from the DWI for Trimpley WTW due to Crypto detections in final water that occurred in January 2023. This statutory obligation is likely to be finalised this year and instructs us to carry out a review of catchment risks and sampling, as well as modelling and a review of treatment effectiveness and staff training, ultimately to inform the catchment management schemes required and potentially treatment changes on-site.

The Severn comprises three Drinking Water Safeguard Zones, and in response to risks from pesticides, we engaged with farmers and landowners, encouraging and incentivising them to make changes to benefit the water quality in the River Severn, and wider environment. Over the last seven years, this approach has successfully decreased mean and peak pesticide concentrations. We wish to build on the experience and relationships already gained from this work to target cryptosporidium and bacteria and improve water quality further in the catchment.

These risks are likely to increase in future as the climate changes. The Met Office reports a scientific study[6] which found that rainfall associated with storms is becoming both more intense and more likely. Storm frequency has increased from an estimated 1 in 50 years to 1 in 5 years. Climate change has also increased the amount of rainfall from these storms, making them about 20% more intense. As a result the River Severn flow is becoming more peakier (Figure 5) and if global warming reaches 2°C, storm rainfall could become a further 4% more intense and could occur about 1 in 3 years.

Figure 14: Flow above 95th percentile at Saxons Lode (River Severn)



A number of options were considered when designing and costing this catchment scheme, the three feasible options are listed below:

1. Working with livestock farmers in high-risk areas within sections of the existing River Severn safeguard zones (high risk areas of SWSGZ2100, SWSGZ2101, SWSGZ2102)
2. Working with livestock farmers in high-risk areas that are within 12 hours travel time of an abstraction point (Trimpley WTW, Strensham WTW Mythe WTW)
3. Working with livestock farmers in high-risk areas that are within 12 hours travel time of an abstraction point including Shelton WTW.

Each feasibility scenario assumes an average 'crypto relevant' farmer uptakes £16,396 worth of catchment measures with Severn Trent over a 5-year period (based on previous experience in AMP 6 and 7). Measures include, but are not limited to, animal health plans, farmyard crypto risk assessments, livestock testing, fencing, buffer strips, herbal leys, livestock removal and slurry spreader upgrades. A 35% uptake rate was used and it was assumed that improvements will be made over an initial 5-year period after which they will be sustained until year 30.

Due to cost benefit analysis (Table 16), we do not propose to run this cryptosporidium catchment scheme in all areas of the existing safeguard zones. The selected areas are based on:

- high risk areas of the catchments (grassland areas, livestock densities, proximity to the watercourses)
- travel time to the WTW in respect of an oocyst lifecycle
- deliverability of the scheme on the ground
- wider benefits

Table 16: Summary of the monetised whole life costs and benefits of the 3 feasible catchment schemes

Category	Key metrics	Option 2	Option 3	Option 5
		2020-21 prices (WINEP compliant) 30-year time horizon		
Key cost benefit ratio	Social benefit cost ratio (BCR)	1.09	1.18	0.95

EA WINEP outcomes	Overall EA WINEP impact	£22,764,176.80	£22,760,397.07	£28,698,323.92
	WINEP impact: Natural environment	£22,720,889.82	£22,720,772.13	£28,635,510.10
	WINEP impact: Net zero	£43,286.98	£39,624.94	£62,813.82
	WINEP impact: Catchment resilience	£0.00	£0.00	£0.00
	WINEP impact: Access, amenity and engagement	£0.00	£0.00	£0.00
Costs and risks	Financial costs and risks	£20,821,311.51	£19,281,239.16	£30,354,669.21
	Operational and embodied carbon	£0.00	£0.00	£0.00

It is important to note, that the whole life costs of this scheme appear high when compared to other catchment schemes. This is because this scheme is effectively 3 schemes combined, as it will operate in the catchments upstream of Trimpley WTW, Strensham WTW, and Mythe WTW, all of which would normally be costed as separate individual schemes. However, Table 3 indicates that for Option 3 the overall WINEP impact to the natural environment and net zero is higher compared to the financial costs and risks with benefits primarily driven by benefits to the natural environment. Option 3 also has a higher Social Benefit Cost Ratio than the other options, owing to the more targeted nature of the catchment scheme of engaging grassland farmers within 12 hours of one of the abstraction points (Trimpley WTW, Strensham WTW, and Mythe WTW only). Additionally, it is more deliverable on the ground than option 2 from a logistical perspective.

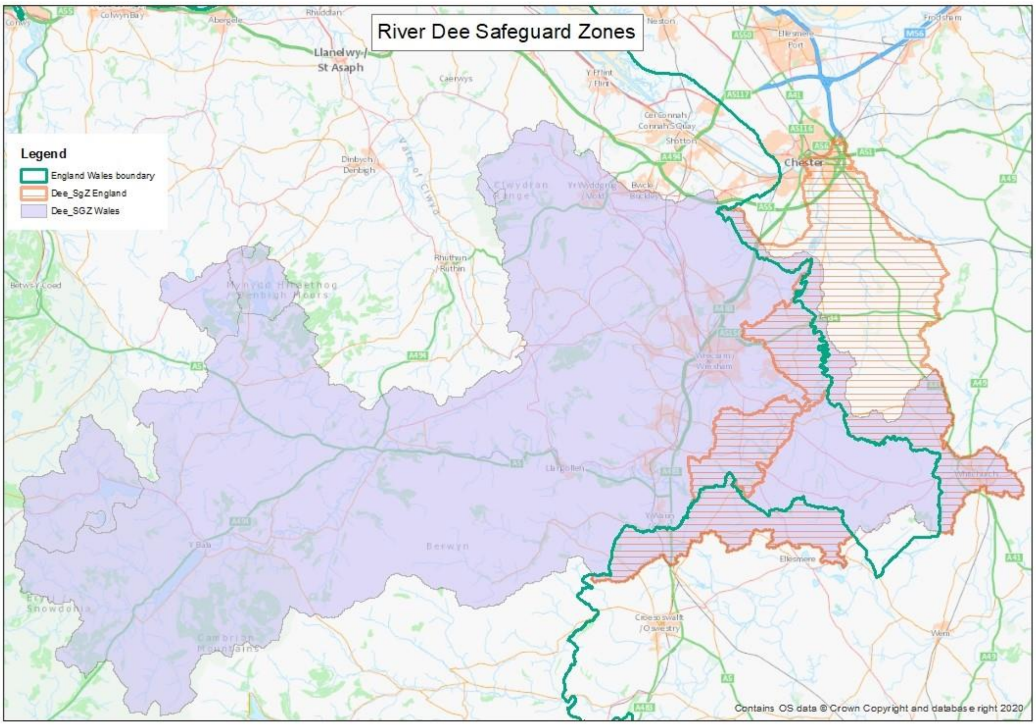
More detailed information on this can be found in our Severn Trent Options Development Report, River Severn crypto scheme.

11.3 The River Dee

We have reallocated the investment that is not stated 5th July WINEP refresh to this raw water deterioration business case (see SVE 4.04 Water WINEP DWPA).

The River Dee is the only Water Protection Zone (WPZ) in the UK, set up in 1999 after a serious water quality incident in 1984. The WPZ designation targets controlling risks from industrial pollution by limiting the amounts of chemicals that may be stored on sites. It has been very effective and over the past 23 years, the risk from industrial chemicals has declined while contaminates arising from agricultural activities has increased. The River Dee is also designated as a Safeguard Zone by both England Environment Agency for turbidity and pesticides and Wales Natural Resources Wales for pesticides and bacteria. Figure 15 below shows the 2 Safeguard Zone boundaries.

Figure 25: Map showing 2 Safeguard Zone boundaries in the River Dee catchment



Joint Working

The 'Deesit' arrangements (Dee Situation Report – name given to the routine analysis carried out on River Dee samples) have already provided the mechanisms by which the four water companies can work together and for mutual benefit. By having one AMP8 catchment scheme we can share knowledge and resources to ensure a more effective and efficient catchment improvement project is delivered. This approach is a long-term ambition covering the next three AMP periods until 2040. All four water companies experience water quality issues at their WTW with turbidity. United Utilities funded an AMP7 WINEP investigation into turbidity that identified a large proportion of the sources being runoff from livestock activities. This scheme will deliver the recommendations from that investigation. The Welsh part of this work sits on the Welsh NEP so that the work can also be delivered on land in the Dee catchment in Wales.

Options Considered

Summaries of unconstrained, constrained and feasible options are provided below with supporting evidence. Our unconstrained list comprises:

Working with all livestock farmers across whole catchment – scoped out due to the prohibitively large number of farmers, and the distance from the abstraction points (i.e. travel time is too great in some areas).

Targeting all livestock farmers in the area that encompasses all the high risk sub-catchments identified in the PR19 investigation and all other sub catchments within 12 hour travel time of the most upstream WTW (Llwyn Onn WTW) – Entire sub-catchments have been included where they intersect with the

12 hour travel time buffer from the abstraction point. This has results in some sub-catchments not already within the existing English Safeguard Zone being included within this option – these will be funded via the Wales NEP as they are within the Welsh SgZ boundary. Within these catchments high risk areas have been determined using grassland field satellite data.

Targeting livestock farmers with land within 300m of the main WFD watercourses – scoped out due to targeted nature of delivery, which may miss point source large farms further away than 300m.

Only option 2 made it through the screening process using the following criteria:

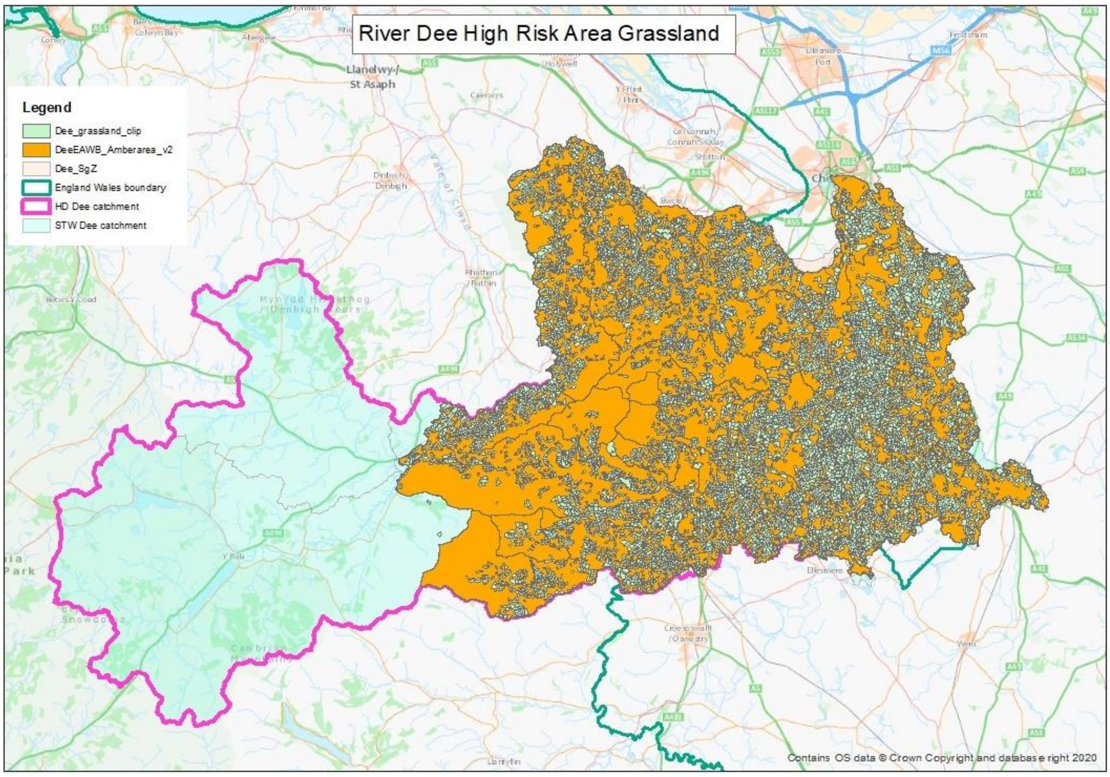
- The option is expected to meet statutory obligation(s) or meet non-statutory requirements
- The option contributes to the WINEP wider environmental outcomes
- The option is technically feasible
- The option is deliverable

<u>Feasible Option</u>

Option 2: Overall Catchment Scheme

Working with livestock farms with grassland within 12 hour travel time (orange shading) of the most upstream water treatment works (Llywn Onn) that abstracts from the river (Figure 16).

Figure 16: River Dee catchment high risk area

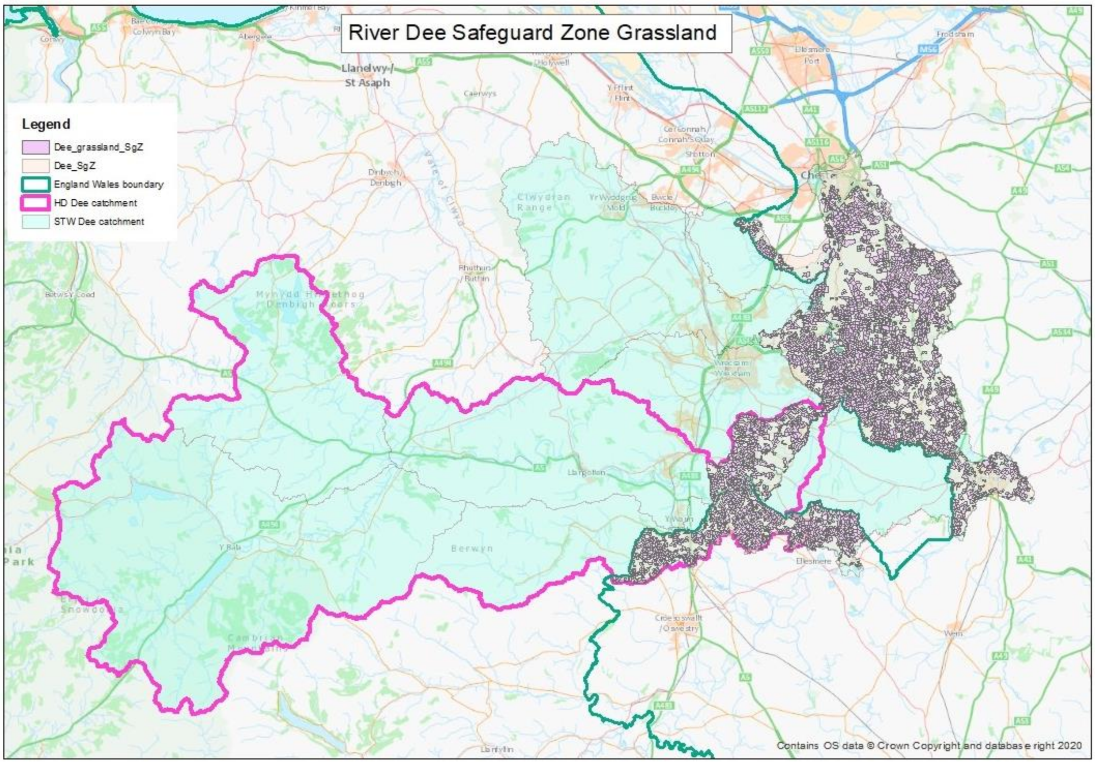


There is estimated to be between 700 and 800 farms. Part of the project will be to get the landowner data to enable contacting and targeting work with these farmers.

Catchment scheme within England Safeguard Zone

Within the England WINEP the area where work will be delivered will be within the Safeguard Zone designated by the Environment Agency (Figure 17).

Figure 17: River Dee Safeguard Zone Grassland



The Safeguard Zone covers 35,339 hectares and the grassland within it covers 17,731 hectares. With an average farm in the catchment calculated to have 62 hectares this equates to working with roughly 286 farms. Assumptions around farmer uptake can be seen in earlier in this document[4].

Third party Agricultural Advisors will engage targeted farms to encourage reduction in erosion that results in nutrient and sediment losses to surface water, along with preventing animal manure runoff with the ultimate aim of reducing and reversing the rising trends at abstraction points. Farmers will be offered specialist farm advice visits and funding towards on-farm improvement works under a grant scheme, offering up to 50% of the cost of the grant item. The local Agricultural Advisors will also run technical events for farmers. In addition, the scheme will also be supported by monitoring water quality and soil sampling.

Severn Trent have put £827,000 into their plan for this scheme on top of £47,000 for further investigation work (Table 26).

Table 26: Cost breakdown

Scenario no	Scenario	No of crypto relevant farmers	Area (ha)	Total Cost (£)	35% uptake cost	ST contribution assuming 50% match funding
2	High risk areas (grassland) within English Dee SgZ	286	17731	£4,681,339	£1,638,469	£819,234

Table 27 details a summary of the monetised whole life costs and benefits of the scheme over a 30 year time horizon, as well as the benefit cost ratio.

Table 27: CBA Summary

Category	Key metrics	2020-21 prices 30-year time horizon
Key cost benefit ratio	Social benefit cost ratio (BCR)	2.29
EA WINEP outcomes	Overall EA WINEP impact	£6,299,512.34
	WINEP impact: Natural environment	£6,275,622.85
	WINEP impact: Net zero	£23,889.49
	WINEP impact: Catchment resilience	£0.00
	WINEP impact: Access, amenity and engagement	£0.00
Costs and risks	Financial costs and risks	£2,745,387.44
	Operational and embodied carbon	£0.00

These costs and benefits assume that improvements will be made over an initial 5-year period after which they will be sustained until year 30.

Stakeholder Engagement

Stakeholder engagement forms a crucial part in developing our catchment schemes. To develop these options we have engaged with the following organisations and individuals:

- The Wales Land Management Forum sub-group on agriculture and the Welsh Government-led Dee Stakeholder meeting, asking for support and collaboration with innovative ideas of methods for delivering catchment improvements.
- Welsh Dee Rivers Trust, North Wales Wildlife Trust, Cheshire Wildlife Trust, the Middle Dee CaBA partnership. All are already working in the catchment.
- Natural England, EA and NRW are engaged with regularly as part of the Dee catchment protection working group.

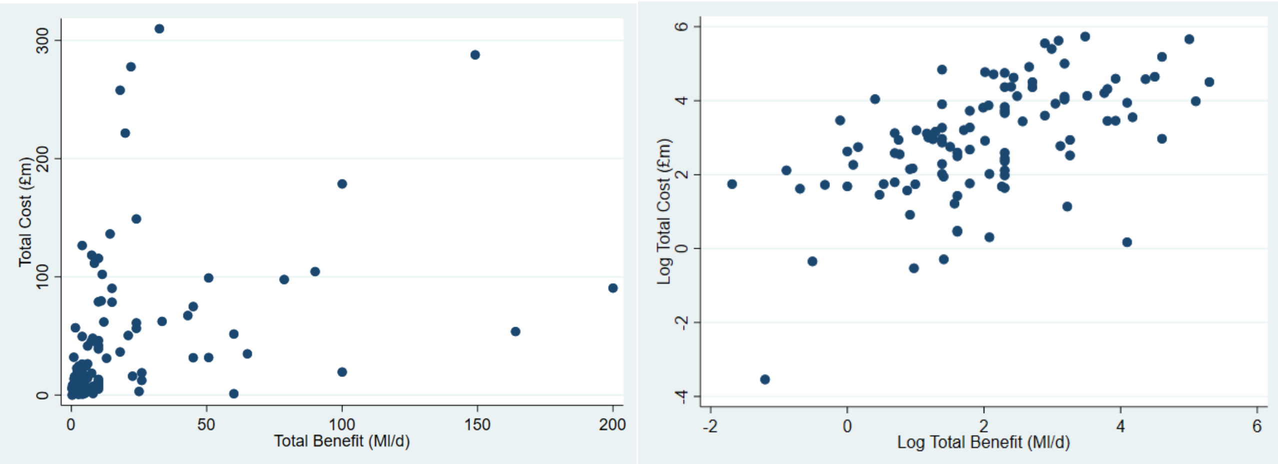
Appendix A: Updated cost models used for benchmarking

This appendix provides the full details of the modelling approach that we are suggesting would be an appropriate way of assessing efficient costs for the raw water projects.

How we made the models

We adopted a log-log functional form because a clear relationship between cost and scale is not visible in the linear data given the orders of magnitude differences in both cost and scale for scheme level data. Taking logs allows for a clear linear relationship between cost and scale to be exposed – this is what we want for least squares modelling and the difference is shown in figure 18 below.

Figure 18: Scatter plots showing the relationship between linear cost and benefit (left), and logged cost and logged benefit (right)



Additional covariates are better able to account for differences around scale where there is a clear linear relationship between cost and scale. A log relationship also allows for economies of scale to be directly estimated, and allows for a more complete assessment of outlier schemes. Econometric models with a log-log or log-linear specification have been used by Ofwat in PR24 draft determinations for several enhancement categories (e.g. supply interconnectors and storm overflows).

As part of our modelling exercise, we extracted data on scheme costs, benefits (in terms of Ml/d) and scheme characteristics from Business Plan data table CW8 for all companies that reported schemes under the relevant categories, i.e. Anglian Water, Affinity Water, Northumbrian Water, Southern Water, Yorkshire Water and Severn Trent. This gave us a relatively large number of scheme-level observations (92) for water treatment works upgrades. We then included all opex and capex reported against each scheme for all years in the reporting period (including pre-2025 and after 2029-30).

We then carried out some pre-modelling adjustments to the data to ensure comparability. This included:

- Combining schemes at the same site by summing up the costs and benefits. For example, Northumbrian Water's Langford scheme and Yorkshire Water's Monkton Moor scheme. This allows economies of scale to be taken into account as part of the modelling.
- Where an interconnector scheme also included upgrades to water treatment works, we have only considered the treatment works component. For Severn Trent, this affected the Carsington to Tittesworth scheme. We do not know if other company schemes are affected in this way.

- Conversely, there are schemes listed in the supply-side benefits category that include interconnectors. Where applicable, we have removed the interconnector cost from the scheme and considered this separately in the interconnector model. For Severn Trent, this is the case in the Strensham scheme (supply).
- Finally, we used dummy variables to account for differences between activity costs as set out in the table below. We used three different specifications for our models.

Scope and specification of our models

Below are the models that we have developed and used in this analysis.

Table 28: Model specifications – WTW upgrades

	Model Spec 1	Model Spec 2	Model Spec 3
Dependent variable	Ln(Cost)	Ln(Cost)	Ln(Cost)
Constant	Yes	Yes	Yes
Explanatory variable 1	Ln(Benefit in Ml/d)	Ln(Benefit in Ml/d)	Ln(Benefit in Ml/d)
Explanatory variable 2	-	Dummy for water resource upgrade	-
Explanatory variable 3	-	Dummy for licence transfer	-
Explanatory variable 4	-	Dummy for full WTW upgrade*	-
Explanatory variable 5	-	Dummy for nearly full WTW upgrade*	-
Explanatory variable 6		Dummy for part WTW upgrade*	-
Explanatory variable 7		-	Dummy for WTW upgrade
Summary of the model specification	• A simplistic unit costs model. • **We consider this a control only. It shows performance improvement from a more appropriately specified model.**	• A more appropriately specified model designed to acknowledge differences between treatment upgrade interventions. • **We consider this to be the most coherent model specification.**	• A simplistic unit cost model with consideration only as to whether or not the model observations are for a WTW upgrade (which will reduce the noise from costs relating to other non-treatment supply interventions). • This is the most analogous to the Ofwat DD supply modelling approach as all treatment interventions are still considered to be equal. • **We show this for comparability.**

**The WTW upgrade dummy variables attempt to show differences between treatment upgrades by considering how many processes will be upgraded. A full WTW upgrade will include the provision of all processes (e.g. Pre-treatment processing, Clarification, Filtration, Chlorination, and additional processes as required to manage specific raw water risks. We considered a 'Nearly full WTW upgrade' to include all but one or two of the sequence of treatment processes. Finally, we considered a 'Part WTW upgrade' to include the provision of only one or two treatment processes*

We the created a series of models using this specification by sequentially increasing the scope of the dependent variable by adding more raw water deterioration driver types. This allowed us to test different scopes of coverage of schemes included within the model to see how that affected the robustness of model results, with selected scopes set out in the table below.

Table 29: Selected scope of models tested

	Schemes included in scope	Rationale for increasing the scope of the dependant variable	Number of observations
Model scope 1	All supply schemes in CW8	The supply interventions that underpin the model.	29
Model scope 2	All scope 1 schemes + Lead and Algae raw water deterioration schemes	We consider that the Lead (Homesford) and Algae (Whitacre) interventions are the most analogous to SDB supply interventions. This is because the interventions proposed will fundamentally modify/replace major component of the existing WTW treatment processes	31
Model scope 3	All scope 2 schemes + PFAS raw water deterioration schemes	This builds on the previous scope by add in the PFAS schemes. These relate to installation of an additional treatment process at the end of the existing process flow. Consequently these are less analogous to a full supply intervention meaning that explanatory variables will need to work harder.	35

We have not included the Nitrate or Crypto schemes into the above models. This is because these interventions have more specific cost drivers than the other intervention. We have not yet been able to find a specification of the appropriate robustness.

Testing the robustness of our models

In general, we found that the models performed well and in line with our expectations.

The coefficients have the expected sign and their magnitudes did not look out of place given the underlying economic and engineering rationale for their inclusion.

The estimated coefficients are statistically significant (most at 99%). The only exceptions to this are the coefficients on the dummy variables for water resource upgrade and licence transfers (neither of which we are seeking outputs for).

The range and standard deviation of scheme-level efficiency scores are not out of line with those from models that Ofwat has used elsewhere in its draft determinations.

We believe that the distribution of efficiency scores (i.e. requested totex divided by modelled cost) for each scheme included in the model can be a powerful indicator of the robustness and reliability of the model as a predictor of efficient costs, and it is particularly useful as a tool for making comparisons between models. There are different ways to measure and compare the distribution of scheme-level efficiency scores. We have looked at two metrics: the range and the standard deviation of efficiency scores produced by the model. These are set out in Tables 30 and 31 below.

Table 30: Range of scheme-level efficiency scores from our models

What RWD schemes are included?	Model Spec 1	Model Spec 2	Model Spec 3
Model scope 1 (SDB CW8 schemes only)	11.59	6.08	5.73
Model scope 2 (above +Lead + Algae)	11.82	5.92	5.89

Model scope 3 (above + PFAS)	9.87	5.86	7.05
Spec summary	Control	Preferred specification	Most analogous to DD supply modelling approach

Table 31: Standard deviation of scheme-level efficiency scores from our models

What RWD schemes are included?	Model Spec 1	Model Spec 2	Model Spec 3
Model scope 1 (SDB CW8 schemes only)	2.18	1.26	1.37
Model scope 2 (above +Lead + Algae)	2.14	1.20	1.34
Model scope 3 (above + PFAS)	1.81	1.16	1.35
Spec summary	Control	Preferred specification	Most analogous to DD supply modelling approach

These figures suggest that Model Spec 2 (our preferred specification) out performs both the control (spec 1) and the specification most analogous to the DD supply modelling (spec 3).

We have also considered how the distribution of efficiency scores from our models compare with those of efficiency scores from selected models that Ofwat has used in setting enhancement allowances in draft determinations. We found that the distribution of efficiency scores from our models compares favourably with the distribution of scores from models that Ofwat has used.

Table 32: Range and standard deviation of scheme-level efficiency scores from selected Ofwat DD enhancement cost models

Enhancement cost model	Range of scheme-level efficiency scores	Standard deviation of scheme-level efficiency scores
Supply interconnectors – historical	1.90	0.53
Supply interconnectors – forecast	2.51	0.59
Supply interconnectors - triangulated	**2.16**	**0.53**
Growth STWs - GS1	8.29	1.15
Growth STWs - GS2	8.36	1.13
Growth STWs – triangulated	**8.32**	**1.13**
P removal - PR1	16.664	1.05
P removal - PR2	16.663	1.02
P removal - PR3	16.663	1.32
P removal - PR4	45.309	2.07
P removal – triangulated	**18.35**	**1.20**

Coefficients and statistical performance of our developed models

Table 33: Model coefficients

	Model 1	Model 2	Model 3
lnbenefit	0.7353767***	0.5919274***	0.7218263***
RES		0.2813848	
TRA		-0.7332224	

WTWFull		1.87827***	
WTWNearlyFull		1.647952***	
WTWPart		1.238871**	
1.iswtw			1.584855***
Constant	1.343841***	0.7094045	0.4366208
n	29	29	29
Adj R-squared	0.2795	0.6450	0.6378

Table 34: Results with Lead costs added

	Model 1	Model 2	Model 3
lnbenefit	0.7505429***	0.5771426***	0.6694996***
RES		0.2986488	
TRA		-0.7247421	
WTWFull		1.90062***	
WTWNearlyFull		1.605472***	
WTWPart		1.249006**	
1.iswtw			1.54693***
Constant	1.326073***	0.7236196*	0.5198938*
n	31	31	31
Adj R-squared	0.3544	0.6856	0.6701

Table 35: Results with Lead, Algae and PFAS added

	Model 1	Model 2	Model 3
lnbenefit	0.6212498***	0.439499***	0.4931554***
RES		0.4593737	
TRA		-0.6457917	
WTWFull		2.108694***	
WTWNearlyFull		1.801029***	
WTWPart		1.112135**	
1.iswtw			1.443032***
Constant	1.489265***	0.85596**	0.8005287**
n	35	35	35
Adj R-squared	0.3640	0.6970	0.6212