Our PR24 Enhancement Strategies

PR24 Draft Determination Representations – August 2024

Part 1: Resilient to the risk of drought and flood

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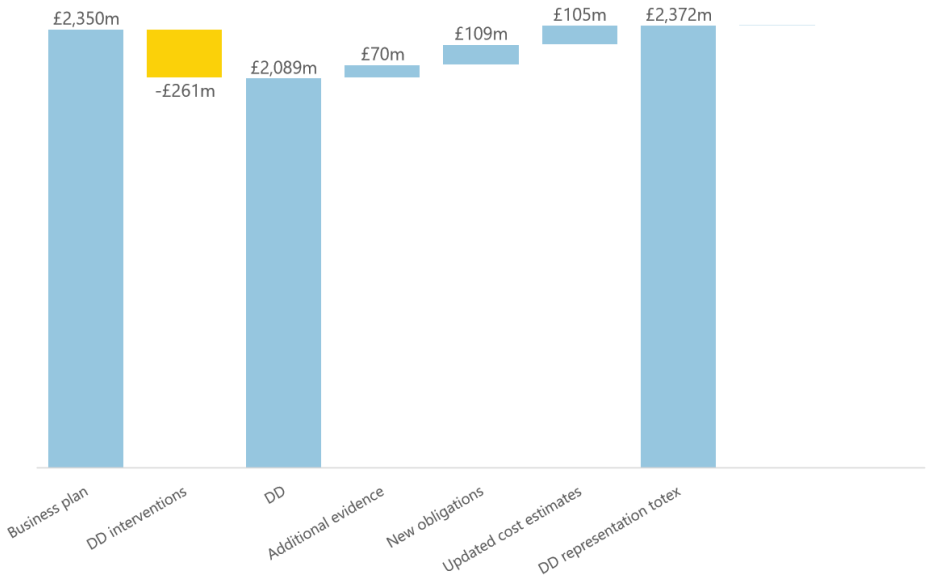
Resilient to the risk of drought and flood

1 Overview

This document sets out our Representations on the enhancement investments that we propose to make to help us achieve the ambitions set out in our Strategic Direction Statement. This specific section sets out investment to make the east of England resilient to the risks of drought and flooding. It follows on from our 'Resilient to the risk of drought and flood' (ANH26) enhancement strategies published alongside our original PR24 business plan. For each enhancement strategy we set out:

- **Investment summary** - In this section we summarise our requested totex for each enhancement strategy and highlight where these costs are reported in our updated data tables. We set out how our requested totex compares with our original plan (as at March 2024) and Ofwat's Draft Determination allowance
- **Context** - In this section, we summarise the investments that were included in our enhancement strategy in our business plan submission, and how this was assessed by Ofwat in its Draft Determination.
- **Our Representations** - This section contains our representations on Ofwat's Draft Determination. Here, we set out whether our representations align with Ofwat's Draft Determination; or whether we are providing further evidence or presenting new information such as updated cost data, evidence of need or wider drivers such as new obligations.

Figure 1 Representations investment summary



2 Interconnectors

2.1 Investment summary

	March 24 Business Plan (£m)	Ofwat DD position (£m)	Representation (£m)
Capex	550.7		633.8
Opex	1.4		0.6
Totex	552.1	529.8	634.4

In our updated data tables, these costs are reported against lines:

- CW3.50-CW3.52 (Interconnectors delivering benefits in 2025-2030) and associated CW12 and CW17 lines

This investment also includes the scheme Ofwat assessed as a 'resilience interconnector'.

As set out in our WRMP, we face significant challenges in balancing supply and demand in our region, driven in large part by licence caps and the need to support the environmental ambition to further reduce unsustainable abstraction from watercourses. Drawing on our AMP7 experience , we will continue our interconnector strategy by installing pipelines to transfer water from areas in surplus to those in deficit, helping to secure a reliable supply of water across all areas of our region whilst limiting the need to take more water from the environment.

2.2 Context

Ofwat assessed costs relating to supply interconnectors and resilience interconnectors separately.

2.2.1 Supply interconnectors - Ofwat's DD approach

Ofwat benchmarked the cost efficiency of our supply interconnector schemes across the industry using econometric modelling to set allowances, with WAFU benefit and length used as cost drivers. The unit cost calculation took into account both APR outturn and forward-looking forecast scheme costs and benefits.

Due to a perceived mismatch between data presented in our business plan data tables and our WRMP data tables, Ofwat removed 78 Ml/d of benefit from the scope of interconnectors ahead of unit cost modelling. The adjusted 100 Ml/d benefit (reduced from 178 Ml/d) was used to calculate an allowance through unit cost modelling. Ofwat suggested that table 3 in our enhancement strategy (ANH26) overstates the WAFU benefit of the schemes, and adjusts the WAFU benefit through bringing together the total costs of schemes alongside WAFU benefit.

£1.8m of costs for the Strategic Interconnector Hydraulic Model scheme were also removed due to a perceived overlap with base allowances.

2.2.2 Resilience interconnectors - Ofwat's DD approach

Our requested totex for East Suffolk WRZ IPZ (which formed our resilience interconnectors investment) was subject to a deep dive assessment. The investment received minor cost challenge relating to the need for enhancement investment and the best option for customers.

On the need for investment, Ofwat requested further evidence to demonstrate that the underlying need for investment is not covered by previous base or enhancement funding, and explain why the challenges such as the need to balance peak flows due to groundwater licences haven't been addressed in previous AMPs.

As to the best option for customers, Ofwat asked for more detail on the application for the 4 R's process in the optioneering process. Ofwat requested further detail on alternative options considered and the scoring mechanism applied to the derivation of a long list for resilience investment.

2.3 Our Representations

2.3.1 Interconnector model

Ofwat's interconnector modelled costs use cost drivers (principally the length of interconnectors and WAFU benefit) to derive an efficient cost for companies' cost allowances. This resulted in a total allowance of £524m for supply interconnectors (£19m lower than our requested allowance of £543m).

For supply interconnectors, we are:

- Providing Ofwat with updated cost information that is now available since we submitted our business plan;
- Setting out views on the Ofwat cost assessment approach to setting our interconnectors cost allowance; and
- We are proposing to rephase the delivery timescales for the Bexwell to Norwich interconnectors (consistent with approach for Grafham to Rede) which will impact the costs incurred in AMP8 and AMP9.

Latest cost intelligence

Our AMP7 interconnectors programme is the largest in the industry and experience has shown that there is significant cost and timing uncertainty in delivering large interconnector programmes. We are using the actual outturn costs of our AMP7 interconnector delivery to inform our cost estimates for our AMP8 interconnector programme. Since we submitted our business plan in 2023, we have continued to collect information on the delivery of interconnectors to enable benchmarking of our costs and ensure our AMP8 proposals remain efficient.

We have used actual costs of AMP7 delivery and revised forecasts to update our AMP8 costs as part of our Representations. Since our business plan submission we have seen a significant increase in the costs associated with the AMP7 interconnector delivery. As outlined in the assurance report by Aqua Consulting (provided as part of our representations on the interconnectors PCD), this is due to a combination of factors, such as increasing inflation in materials costs and labour, more significant environmental investigations, and delays to delivery primarily caused by late planning decisions and saturated ground conditions following the wettest 18 months on record. We have used this information to update our PR24 interconnector costs based on this outturn delivery benchmark. This increase has the biggest impact on the Grafham to Bury (CAM4 and SWC8) transfers.

To ensure that Ofwat uses the most up-to-date cost information to inform its view of efficient costs, the interconnectors model should be updated to include the latest year of available historic data (from APR24) and the updated forecast costs (submitted as part of companies DD representations).

Reflecting pipe material in modelled cost allowances

Whilst the interconnectors model includes drivers which will support setting companies' cost-efficient allowances, one driver that the model does not use is the interconnector pipe material. For pipes greater than700mm internal diameter, materials such as lined ductile iron (DI) and steel are more appropriate than plastic (HPPE). This is due to factors such as fitting constraints given that at this larger diameter, some fittings and fitting types are unavailable/unsuitable. DI and steel pipes are more expensive than plastic pipes which make up the majority of the interconnectors investment across the industry.We would expect higher interconnector costs for those greater than 700mm in diameter. For us, the largest pipelines which drive most of our costs are DI and steel.

It is likely that the model will not reflect the full costs (i.e. gives a lower allowance than required) for the efficient cost of these pipes absent of reflecting material type. This information is available to Ofwat as companies provided pipe material information for all of their interconnector investments in the business plan data tables. For Final Determination, given the difference in cost driven by pipe material, especially at larger diameters, it is essential that Ofwat reflect this in their cost assessment analysis.

Grafham to Bury interconnector (CAM4 and SWC8)

While most of our interconnector schemes were assessed by Ofwat as being efficient, the Grafham to Bury transfer received a cost challenge (£144m AMP8 cost allowance against a requested AMP8 totex of £191m). This interconnector scheme is important because of its strategic significance in resolving water supply issues ahead of the Fens Reservoir delivery.

In its assessment, Ofwat brought these two schemes together for a joint 50Ml/d WAFU benefit of the transfer from Grafham to Bury, as CAM4 feeds SWC8 in the long term. The short term configuration to support flow into Cambridge was not taken into account in the benefit assessed.

The model also did not take account that this scheme has a mid transfer treatment which is required for water chemistry (chlorination) to enable blending into the receiving zone. This is a significant cost driver for the SWC8 scheme which is additional to the mains, fittings, pumping stations etc. that are a more standard part of interconnector delivery. Therefore the £35.8m relating to chlorination should be assessed separately as this cost driver is not in the model.

We consider that these factors help to explain the difference in the costs of this scheme from the costs allowed by the DD interconnector model. These factors should be considered when setting the interconnector allowance. We suggest that removing the costs of chlorination from the interconnector model and instead assessing these costs through a separate shallow dive assessment, combined with consideration of pipe material, would ensure that the Grafham to Bury interconnector is assessed on a like-for-like basis with other interconnectors schemes.

Link to Supply-side improvements

In the Representations we provide for the Supply-side improvements for Colchester Re-use scheme, we request that two further interconnectors that are part of the overall re-use strategy for Colchester (ESX19b and ESX19c) are reallocated and assessed within the interconnector feeder model. For more information on this please see the following chapter.

2.3.2 Scope justification

As part of its cost model assessment, Ofwat combines the WAFU benefit of seven interconnector schemes into three combined schemes with a single WAFU benefit with the lengths of the interconnectors added together for each. Those schemes are:

- Total costs for interconnectors NBR6, NTB10 and NAY1 brought together alongside 45Ml/d WAFU benefit.
- Total costs for interconnectors CAM4 and SWC8 brought together alongside 50Ml/d WAFU benefit.
- Total costs for interconnectors NEH3 and NHL4 brought together alongside 5Ml/d WAFU benefit.

This combines a series of interconnectors to create a larger interconnector for the purpose of cost assessment. We have no issues with this approach in principle (though we consider that the capacity of the interconnectors, rather than the WAFU benefit would be more reflective of the actual cost drivers of the interconnector schemes). However an error has been applied in setting the cost allowance for the first scheme (NBR6, NTB10, NAY1). These schemes are 35.849km, 66.901km, and 13.719km. Rather than assessing the combined 116.47km, the interconnector uses a length of just 97.17km. We welcome Ofwat's response to our query on this matter which stated that this discrepancy was due to the model not using the updated length for NTB10, and that it will use the combined length of 116.47km to re-assess allowances in the Final Determination. Ofwat has stated it will correct the length of the EXC3 scheme from 13.76km as currently assessed to 7.831km as highlighted in our query OFW-IBQ-ANH-033.

Since submitting our October Business Plan we have worked further with our delivery teams who have experience of delivering the PR19 interconnectors, reviewing pipe routes and crossings. We now propose to phase the above combined scheme from Bexwell to Norwich (NBR6, NTB10, NAY1) over 7 years rather than 5 as was the case in our original plan. This revised profile will mitigate delivery risk. We will provide updates in our annual WRMP progress reporting to this effect and work with the Environment Agency on any implications for the timing of abstraction licence changes.

Data updates and error correction

We propose the following updates:

- In IC Model Data table where the schemes CAM4 and SWC8 are combined, only the storage capacity for one scheme had been included
- We have also corrected an error in our CW8 table for the storage volume for scheme SWC8 which should have been 25,000m3. The total volume of storage required across the 2 schemes is 37,500m3 which should be included in the updated modelling.
- We have also corrected an error in our CW8 table. The total volume of storage required across the 2 schemes is 37,500m3 which should be used in Ofwat's updated modelling.

2.3.3 Interconnector hydraulic model

Ofwat removed £1.8m in our plan for interconnector hydraulic model investment. As part of our DD representation challenge to limit our totex requirement, we have removed this investment from our enhancement totex in our Draft Determination representation.

2.4 Resilience interconnectors

In the Draft Determination, our East Suffolk WRZ received a cost challenge of £1.5m. This was driven by minor concerns on the need for the scheme and the optioneering process under taken. For this interconnector, we provide additional evidence to address these minor concerns. We have therefore retained the proposed investment in our DD representation.

2.4.1 Additional evidence - Need for investment

Ofwat partially passed the need for enhancement gate for this scheme. Its challenge was based on Ofwat having " residual uncertainty regarding why these challenges which have been increasing over time have not been addressed in previous periods".

Saline intrusion can be unpredictable and transient. There has been a steady increase in chloride levels detected in Belstead sources since 2017, reaching critical levels in 2020. At the time of developing our PR19 business plan, it was reasonable to assume that the episode could be transient and so we did not include enhancement investment in our plan at that time. However, the continued increase has now shown that this is not a transient issue and so there is an emerging need in AMP8 to alleviate pressure on the Belstead sources.

We therefore request that Ofwat removes its 10% cost challenge on the need for this investment.

2.4.2 Best option for customers

Ofwat had minor concerns on the "best option for customers" gate for this scheme. Its challenge was based on its view that "*The company does not provide sufficient evidence of the alternative options considered and the scoring mechanism applied.*"

Alternative abstraction regimes have been explored but none have been effective without leaving us at risk of failing to meet demand.There are no reasonable alternatives that enable us to balance flows. As there is only one feasible solution which meets the need for this investment, applying scoring mechanisms to different options would be redundant. We therefore request that Ofwat removes its 10% cost challenge on the best option for customers gate on the basis this option is consider best option for customers with no feasible alternative.

3 Supply-side improvements

3.1 Investment summary

	March 24 Business Plan (£m)	Ofwat DD position (£m) (incl contingent)	Representations (£m) (incl contingent)
Capex	371.3		350.4
Opex	3.8		3.2
Totex	375.1	316.0	353.6

In our updated data tables, these costs are reported against lines:

- CW3.41-CW3.43 (Supply-side improvements delivering benefits in 2025-2030) and associated CW12 and CW17 lines
- CW3.56-CW3.58 (Supply demand balance improvements delivering benefits starting from 2031) and associated CW12 and CW17 lines

3.2 Context

A key component of our WRMP24 is to maximise the use of existing water resources. Our supply-side improvements include the relocation of abstractions that are due to cease, enhancements to treatment works to allow them to operate at lower abstraction licence rates, backwash recovery schemes and the additions of new processes to allow variable water quality to be treated. All of these enhancements will increase our water available for use (WAFU), allowing us time to develop our Strategic Resource Options. We will also continue to develop our desalination options, building on our WRMP19 work, so that we are able to move to an adaptive pathway, if required.

We requested £375.1m for supply-side improvements, covering improvements delivering benefits in 2025-30 and those starting from 2031. Ofwat assessed the efficiency of supply side scheme costs through modelled benchmarking, using unit cost modelling based on the proposed option types of solutions.

3.2.1 Ofwat's DD approach

Post-modelling, Ofwat applied a series of adjustments (e.g., for PR19 non-delivery). Areas of challenge are summarised in the table below:

Table 1 Draft Determination - Areas of Challenge

Scheme name	Type of challenge	Summary of Ofwat challenge
Mablethorpe adaptive pathway option	Adaptive Planning deep-dive	Ofwat state "the company states that the option is needed in 2040, which also aligns with the option representation in the company's water resources management plan (WRMP), and shows a 7-year lead in time. This indicates that the scheme needs to start development in 2033 which falls outside of the next price control period (2025-30)." As such, they remove the costs of this scheme in full.
Hall WTW surface water enhancement, Lincolnshire East surface water enhancement and Ruthamford South surface water enhancement	Non-enhancement deep dive/ modelling	Ofwat apply a 20% challenge to these schemes. Ofwat raise minor concerns about the potential for overlap with base allowances. Ofwat state that this is because the provision of water treatment is included as a base activity and the company has not provided sufficient and convincing evidence to demonstrate how base activity is accounted for with these solutions.
Colchester Transfer; Colchester Pilot Plant; Colchester reuse	Scope justification/Large project adjustments & DPC/ modelling	Ofwat reduce the benefit used within the modelled benchmarking for these schemes, stating we have not provided enough evidence to demonstrate there is no duplication of scheme benefit. Ofwat adjusts the company-stated benefit down to the WRMP WAFU benefit where there are differences between the business plan stated numbers and the WRMP. Ofwat state that the company request does not meet the requirements for its Colchester Reuse scheme to be delivered under Direct Procurement for Customers (DPC), and therefore assess the scheme to be delivered in-house. Ofwat determine that for the large,

Scheme name	Type of challenge	Summary of Ofwat challenge
		complex supply schemes, a gated approach to funding should be followed. At the first stage they release 6% of the overall scheme cost (£4.991m) to undertake scheme detailed development and feasibility studies. Further funding is unlocked following demonstration of feasibility and successful planning.
Recirculation schemes	Modelling	Ofwat assessed these as low complexity schemes in its cost model
Groundwater and surface water schemes	Modelling	Ofwat assessed these as medium complexity schemes in its cost model
Bacton desalination	Strategic regional options model	Ofwat assessed Bacton desalination costs in its Strategic Regional Options assessment.

These post-modelling adjustments reduced Ofwat's final assessed totex allowance for supply-side schemes (delivering benefits in 2025-30 and from 2031) to £316m (including our contingent allowance).

3.3 Our Representations

3.3.1 Supply (AMP8) schemes

In assessing these schemes Ofwat has grouped our supply-side schemes into three categories of options. These are set out in the table below along with the unit rate allowance for each scheme. We provide our representations on each of the three types of options below.

Table 2 Supply-Side Schemes

Treatment schemes (£5.71m/Ml/d allowance)	Ground and surface water schemes (£2.91m/Ml/d allowance)	Other schemes(£0.32m/Ml/d allowance)
ANH_LNC30_Hall WTW surface water enhancement	ANH_LNE11_Lincolnshire East Groundwater enhancement	ANH_multiple_WRMP24 Supply Side Options - Recirculation Schemes
ANH_LNE12_Lincolnshire East Surface Water enhancement	ANH_LNN3_Lincolnshire Retford and Gainsborough resource optimisation	
ANH_RTS21_Ruthamford South surface water enhancement	ANH_FND22_Marham surface water abstraction relocation	
	ANH_SUE23_Suffolk East groundwater enhancement	
	ANH_SWC13_Suffolk West & Cambs groundwater relocation	

Treatment schemes

Ofwat assessed Hall WTW surface water enhancement, Lincolnshire East surface water enhancement and Ruthamford South surface water enhancement as 'treatment schemes' applying a unit rate of £5.71m/Ml/d which builds in a 20% cost challenge, reflecting the view that these schemes could include some base costs.

We have highlighted our concerns that the incorrect water available for use (WAFU) Ml/d value has been used for two of these schemes (Ruthamford South surface water and Lincolnshire east surface water). For some options, the WAFU benefit is impacted by the level of drought resilience. To avoid double-counting of impacts and benefits, we model options in both drought scenarios. As Table 4 of the WRMP tables only gives one column to provide WAFU benefits of options, it is not possible to include the WAFU benefit relative to the level of drought resilience in this table. We have populated WRMP Table 4 with the lower value of 1:200 or 1:500. However in the supply demand balance Table 3s and Option benefits Table 5 we use the varying WAFU numbers i.e. the benefits changes in 2039/40.This is explained in the supporting table notes submitted with our WRMP submission and sent directly to Ofwat on 19th September 2023. In the note we included the following table and explanation that we have populated WRMP Table 4 with the lowest value:

Table 3 WAFU benefits relative to drought scenario

Option Ref	Option Name	1:200 WAFU (Ml/d)	1:500 WAFU (Ml/d)	How the drought impacts the WAFU
EXS19	Colchester WRC direct to Ardleigh Reservoir (no additional treatment)	11.4	13.9	1:500 drought reduces the raw water available to Ardleigh WRW more than 1:200 does. The transfers of treated effluent to the reservoir is not impacted by the drought and can replace the additional raw water lost in the 1:500 scenario, therefore providing a greater WAFU benefit in 1:500
LNE12	Lincolnshire East Surface Water enhancement	13	7.3	The 1:500 drought reduces the amount of raw water available to be abstracted compared to 1:200, reducing the benefit of the option
FND22	Marham abstraction relocation	7.9	12.3	The 1:500 year DO benefit is higher than the 1:200 due to a considerable conjunctive benefit related to the large 1:500 impact in the Fenland WRZ. Even with the option in place, the overall 1:500 Fenland deployable output would still be less than the 1:200 Fenland deployable output, but this option would bring them closer.
RTS21	Ruthamford South surface water enhancement	9.5	6	The 1:500 drought reduces the amount of raw water available to be abstracted compared to 1:200, reducing the benefit of the option

We welcome Ofwat's response to our query OFW-IBQ-ANH-038, stating that as part of its Final Determination, it will cross-check the WAFU benefit of these schemes to ensure the value is consistent with the intended dry year scenario.

We acknowledge Ofwat's base cost challenge on these schemes, and recognise that whilst the principal purpose of these investments is to increase water supply and should be considered to be enhancement, a minority of this investment could overlap with base treatment costs.

In our representations, we have adjusted our requested costs for these three schemes together to align our overall costs for treatment schemes with Ofwat's Draft Determination. This aligns with Ofwat's cost model as-is, however, we note that when the cost model is corrected for the 1:200 WAFU benefit from the table above, this will have an impact on the DD cost allowance. The allowance for treatment schemes that results from Ofwat's cost model when updated for these schemes should be the allowance we receive in the Final Determination (assuming no significant changes to the approach for setting treatment allowances).

Groundwater and surface water schemes

Among the five schemes evaluated by Ofwat concerning groundwater and surface water, the ANH_FND22_ Marham surface water abstraction relocation should be considered and reviewed as a treatment due to its complex processes.This investment is comparable in process complexity (Treatment) to the ANH_LNE12_Lincolnshire East Surface Water enhancement. It involves a 13.2 km transfer, a network pumping station at Marham WTW including Pre Ozone, Clarification by DAF, Membrane Filtration, Post Ozone, and ancillaries equipment. A detailed scope/cost breakdown of the scheme has been provided in the cost efficiency site breakdown workbook submitted as part of our representations[1]. There is no overlap to base as this scheme was developed as new process stream due to water quality uncertainties.

Table 4

Investment ID	Investment name	Scope	Flow ML/d	CAPEX (£m) AMP8	Opex (£m) AMP8	Benefit Ml/d
I041169 and I041168	Marham surface water abstraction relocation	*13.2 km Water main ; NB 441 (mm) *3250 m3 treated water reservoir *234 kW Network Booster PS *136 kWAbstraction PS	13.6	47.97	0.193	7.9

1 -- see ANH_DD_022

Investment ID	Investment name	Scope	Flow ML/d	CAPEX (£m) AMP8	Opex (£m) AMP8	Benefit Ml/d
		*186 kW interprocess PS *Process units to treat 13.6 MLD; DAF Pre and post Ozone Membrane systems *Ancillaries				

Our full cost breakdown is set out in ANH_DD_022 Enhancement cost breakdowns.

Recirculation schemes (Other)

Through modelling, Ofwat make an allowance of £2.905m for recirculation schemes. Ofwat's modelling approach determined that this scheme is classified as 'other' option type, and applied the low unit rate of the industries 'other' schemes.

The schemes classified under this option type vary significantly. We believe this fundamentally impacts the comparability of the schemes through a median unit rate approach, given the impact this has on the total benefit in Ml/d and cost depending on the purpose of each scheme. For instance, the unit cost applied to our recirculation schemes is the same as that applied for the investment for increased pumping capacity for Yorkshire, and a new river head pump for Thames (a clear outlier in unit costs with a 60Ml/d benefit for only £1.2m of costs). These are not recirculation schemes and have very different cost drivers. The variability in the relationship between cost and benefit for these different schemes indicates they are not comparable for the purposes of cost assessment.Given the variability and range in the nature of the schemes that fall under this category, we request instead that Ofwat use the information that companies provide on the nature of these schemes to inform its view of cost efficiency. If this is not possible we consider that it would be more prudent to follow a shallow-dive efficiency approach. Without taking this approach, Ofwat risks miscalibrating allowances making an overly generous or overly stringent cost challenge on 'other' schemes, based on factors not associated with efficiency. To support Ofwat's assessment of our recirculation schemes we provide further information on these investments below.

Within our business plan, we provided the aggregate costs of our recirculation schemes. However, this cost line actually reflects recirculation schemes at thirteen separate sites. This means that our allowance of £2.9m equates to an average of £0.223m per site. However, this allowance will not reflect the site specific differenced which we consider can be significant.

In the table below, we have provided a breakdown of the costs required for each of the thirteen sites. We have provided a detailed cost breakdown for each of the 13 sites in our cost efficiency detailed breakdown submitted as a separate document as part of our representations.

The sites in the table below are the same as those in our original PR24 business plan and are aligned with WRMP24. However, in light of additional cost intelligence and more site level feasibility work including site visits, our costs for recirculation schemes increased from £7m to £14.094m. Recognising the potential interaction with base expenditure, we have reduced these costs by 20% reflecting the potential overlap with existing assets, deriving a revised totex presented in the table below of £11.425m:

Table 5 Recirculation scheme Costs

Investment code	Investment Name	AMP8 Capex (£m)	AMP8 Opex (£m)	Benefit (Ml/d)
I025501	FND26 Hillington Recirculation	0.385	0.008	0.24
I025509	EXS7 Gt Horkesley Recirculation	0.546	0.008	0.3
I043756	EXC7 Castle Hedingham Recirculation	0.352	0.008	0.3
I043757	NHL7 Rushall WW Recirculation	1.425	0.048	0.2
I043761	NNC6 Sheringham Recirculation	0.875	0.007	0.2
I043762	NAY5 Royston Bridge WW Recirculation	0.323	0.008	0.1
I043766	NAY4 Aylsham WW Recirculation	0.756	0.007	0.75
I043767	NNC5 Metton WW Recirculation	0.494	0.008	0.18
I043768	SUE25 Baylham WW Recirculation	0.239	0.009	0.17
I043772	LNE3 Covenham Recirculation	4.065	0.014	1.3

Investment code	Investment Name	AMP8 Capex (£m)	AMP8 Opex (£m)	Benefit (Ml/d)
I043775	NBR9 Carbrooke WW Recirculation	0.949	0.007	0.2
I043776	SUT6 Barnham Cross WW Recirculation	0.335	0.008	0.05
I043777	NED3 Dereham WW Recirculation	0.531	0.008	0.1
	Total	11.275	0.150	

We provide a full cost breakdown, please see ANH_DD_022 Enhancement cost breakdowns.

3.3.2 Supply (post-AMP8) schemes

Colchester reuse

The Colchester re-use scheme comprises of four investments:

1. Colchester reuse demonstration centre (Demonstration plant at Colchester WRC to test the re-use technology, provide sample data to feed risk assessments and share learning with the rest of the industry)
2. Colchester re-use plant (Full-scale 15MLD re-use plant at Colchester WRC (originally planned as DPC, now in-house)
3. Colchester re-use transfer (Transfer pumping station and pipeline from the Colchester reuse plant to Ardleigh Reservoir)
4. Transfer from Ardleigh Water Treatment Works (at Ardleigh reservoir) to supply at Great Horkesley

In the Draft Determination these were treated as three schemes, with investments 2 and 4 assessed together in a single allowance under 'Colchester reuse DPC allowance'. Because investments 2 and 4 are very different with different cost drivers, we have separated them to support Ofwat's Final Determination assessment. Using a holistic system thinking approach to this scenario, the team have developed an alternate approach to that in the business plan that delivers more benefit to customers and the environment and reduces delivery risk. The sections below outline the revisions to our plan.

Colchester reuse demonstration centre

Ofwat's Draft Determination derived an allowance of £6m for the Colchester reuse pilot plant scheme. We have been planning in detail the best approach to evaluating re-use technologies and now propose to test more than one treatment process, and also plan to have the plant operational earlier than planned to gain more sample result data to provide more time for risk assessments to be discussed with quality regulators, inform scheme design and share results with the industry.

Colchester re-use plant

For this scheme, Ofwat has allowed part of our costs as an upfront allowance and part as a contingent allowance. We retain the costs for this scheme as set out in our totex update, published in February 2024 when the decision was made to move to in-house delivery rather than DPC.

Obtaining consent for this scheme is particularly challenging given that in addition to normal planning considerations, the scheme is likely to be subject to an Environmental Impact Assessment, and the EA and Natural England will require evidence of no environmental harm arising from reduced flow from the WRC into the River Colne, and new brine waste stream from the re-use plant, to prove compliance with Water Framework Directive and Habitats Directive.

However, we believe the 6% development allowance should apply to the full scheme cost in both AMP8 and AMP9 in line with the approach to develop the DPC allowance for Bacton and other schemes in DD. We therefore propose alternate values for baseline and contingent as follows:

- the baseline allowance should be set at £7.30m, calculated as 6% of the full scheme cost of £121.829m
- the contingent allowance for development should be £114.51m for the remainder of overall costs. Based on our view of the delivery profile, we request that the contingent allowance for AMP8 should be set at £59.489m and have used this figure to adjust the financial model.

As explained above, we have also split these costs between the reuse plant (investment 2 above) and the onwards potable transfer to Great Horkesley scheme (investment 4 above) to more accurately reflect that these are two distinct schemes. Because the costs of these two schemes are currently both treated as a 'reuse' scheme in Ofwat's model, we consider that it would be more reflective of the nature of the scheme to separate out the transfer component of the scheme, assessing this within the interconnector feeder model, and only reflect the costs and Ml/d output of the Colchester reuse scheme through Ofwat's 'reuse' unit rate.

Colchester reuse transfer

We have significant concerns about Ofwat's approach. We suggest Ofwat assess the transfer scheme as part of its interconnector modelled allowance, and have provided cost driver data in CW8 to allow this.

As part of a review of the deliverability of this scheme, and to maximise benefits to customers, we have deferred the completion date of this scheme and reprofiled £9.1m of investment from AMP8 into AMP9 to align the delivery of this transfer with the timing of the Colchester reuse scheme (2032). This is following detailed advice and engagement with the EA and DWI concerning the permitting of the discharge from the reuse plant into Ardleigh Reservoir. The EA will assess the sample results from the demonstration centre against Environmental Quality Standards (EQS) and predicted no-effect concentrations (PNEC) for emerging chemicals, before authorising the discharge of flow into the reservoir.

Apart from this change, we have retained the initial costs of this investment as proposed in our business plan. As explained below we have opted to accelerate the transfer to Great Horkesley as this will be able to deliver benefits to customers by 2030 in combination with the new PR19 interconnectors being commissioned, which deliver flow to the same area.

Ofwat currently assesses this scheme using its "transfer (not IC) median unit rate". This takes the median unit rate of transfer schemes on an Ml/d basis and applies it to all companies' transfer schemes. For Anglian, Ofwat has reduced the Ml/d transfer capacity provided by the scheme to avoid duplicating allowances, thereby assuming a supply benefit of 2.1Ml/d.

We consider that this is an inappropriate way to assess the Colchester reuse and transfer scheme. The Ml/d supply benefit all comes from the reuse plant. The transfer component does not provide any Ml/d benefit, rather it transfers the Ml/d from where it is produced (Colchester site) to where it is needed (Ardleigh reservoir). The transfer of water is the main benefit of transfer schemes and not an Ml/d benefit. Assessing transfer schemes purely on an Ml/d benefit basis serves to give more allowances than needed for schemes which have a short transfer pipeline, and insufficient allowances for transfers which have a longer length.

Therefore, whilst the Colchester reuse transfer scheme is reported as a supply-side scheme, (as it is an integral part of the overall Colchester scheme), the nature of the investment is such that it would be better assessed in the interconnector enhancement cost model which reflects the length of transfers, WAFU benefit and other cost drivers in a way which can more powerfully assess the efficiency of this investment, than a simple unit rate per Ml/d can provide.

Transfer to Great Horkesley

This element of the Colchester reuse scheme provides the capacity to transfer the additional Ml/d from Ardleigh reservoir into public supply. Within our business plan, the costs of these schemes were combined with the Colchester reuse plant costs and so both were scheduled for completion in 2032. We have separated out these costs in our revised totex request (though we have retained the same overall totex allowance for the scheme) and this is reflected in the costs in table CW8.

Similar to the transfer costs referred to above, we consider that the main benefit of this scheme is the transfer of additional water from Ardleigh reservoir into supply, and not the production of additional Ml/d (which is provided by the Colchester reuse plant). Therefore the costs for this scheme should be assessed separately. As we set out above, we consider that transfer schemes should be assessed using Ofwat's interconnector cost model, and not assessed simply on an Ml/d benefit basis as it currently is in the supply model.

In reviewing the optimum approach to maximise benefit from the combination of all 4 schemes listed above we have opted to accelerate the completion of this transfer from 2032 to 2030. We believe that this will enable us to achieve early benefit as the earlier transfer to Gt Horkelsey removes a pre-existing peak capacity pinch point in the distribution network from Ardleigh WTW, and further utilisation of water via new strategic interconnectors transferring flow from Covenham in Lincolnshire.

Adaptive planning

Mablethorpe adaptative pathway

For Mablethorpe adaptive pathway option, we restate our business plan requested totex allowance of £8.894m.

Our requested allowance for this area was not allowed in the Draft Determination. This was on the basis that (i) we had not provided sufficient and convincing evidence that this investment was the best option for customers, and (ii) that the scheme needs to start development in 2033, which is outside of the PR24 price control window. We provide additional evidence below to demonstrate this investment remains necessary in AMP8.

Although (as outlined in our WRMP and business plan) the public water supply is not required until 2040, it is in our adaptive plan and may be required sooner; for example, the Environment Agency has already indicated that longer-term licence changes are likely to be more significant than those included in WRMP24. This was the case for the Fens Reservoir, for which Ofwat allowed adaptive planning funding at PR19.

More significantly, there is an immediate need for non-household supply for industrial purposes on the South Humber Bank. Non-household demand has historically been stable in the Anglian region but has increased in recent years, due to factors including onshoring of production (especially food and drink post-Brexit), supply chain issues, abstraction licence changes and water for net zero projects such as hydrogen which is a water-intensive process. The South Humber Bank as a major UK carbon emitting cluster is at the centre of plans to meet the Net Zero Strategy for hydrogen production in the UK.

Demands for water to achieve the decarbonisation goals are unprecedented. We have received requests for 38Ml/d of non-potable water for industrial use on the South Humber Bank during 2023-2024. Of this, we were unable to support 23.5Ml/d and dialogue is ongoing with the applicants to identify alternative water resources. Connections are typically requested with a short timescale which is not deliverable.

Given the current challenges for water supply to customers on the South Humber Bank, we are looking to bring the supply date forward to 2034. Moving forward the delivery of Mablethorpe adaptive pathway would remove the need for the delivery of two schemes over multiple AMPs, one to meet the current NHH supply challenge and the other to meet the public water supply option for 2040, making this intervention low-regret, and avoiding inefficient duplication of two separate investments.

Therefore, given the complexity of the Mablethorpe desalination scheme, it will be necessary to progress development within AMP8 to meet the amended timeline. We currently have limited data for scheme delivery in the North Sea; as such, investment in AMP8 is required to establish pipeline routes, materials and connection points for delivery (especially given the situation of the scheme in the North Sea), and to submit planning to ensure a supply date of 2034.

We believe the full cost of the development of this scheme may be in the region of £20.94m for the Mablethorpe adaptive pathway scheme in AMP8. The estimated capex for a 50Ml/d desalination plant (without transfer/interconnectors) is £343m, in addition to £71.897m for the transfer. Using the Major Infrastructure Methodology for determining development costs, and assuming at this stage the project will be regulated and therefore likely to go down the DPC route, £34m would be needed to develop a 50Ml/d desalination plant (excluding transfer) ready to start on site in AMP9 to be in supply for 2034.However, conversations are underway with non-domestic customers to co-develop and co-fund this development. We have therefore assumed at this stage that other partners will fund a proportion of the development (to include both NHH and public water supply), and we retain our business plan requested totex.

Marham surface water relocation

We have included additional costs for an adaptive planning investment for water reuse at Marham resulting in a £5m increase to reflect this scheme now being integrated in our Adaptive Planning programme.

Working with the Environment Agency since business plan submission we have conducted an investigation into resource availability for the relocation of Marham WTW's surface water abstraction on the River Nar. So far this investigation, and discussions with the EA and Natural England, suggest that the abstraction relocation may not be sustainable.

Through our Draft Determination representations, we are also asking for a new WINEP line under the SSSI driver to conduct a new AMP8 investigation to review and update the previous RSA investigation on the Nar. If this work concludes that Marham abstraction relocation is not sustainable, then we will need to develop new water reuse capacity in our Fenland resource zone to compensate river flows and support the relocation.

Reflecting this, we have updated our Marham scheme to enable an adaptive approach informed by the most up to date and accurate information. Whilst the WINEP investigation is ongoing, we propose to continue to develop the Marham scheme to relocate the intake to the works. This is the least cost option, required in 2030, for our Fenland WRZ.

To support flows in the river downstream of the new intake we could develop the Wisbech and/or Kings Lynn reuse as a compensation flow. As this is only required if the RSA investigation identifies the need for it, the work on these schemes should be considered part of the adaptive planning programme.

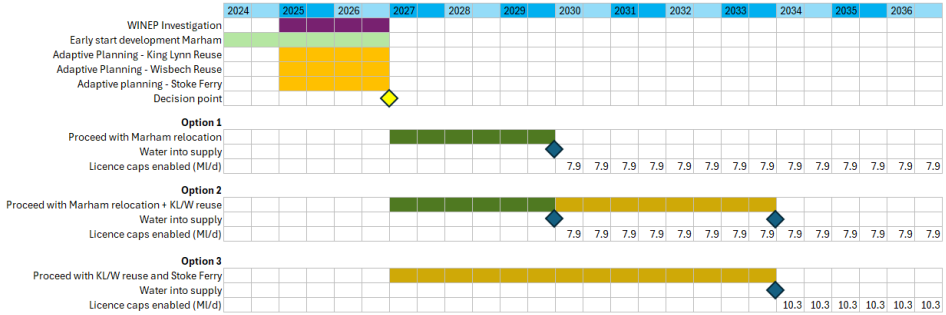
If the WINEP investigation demonstrates that the Marham WTW option is no longer feasible, then we would need to divert the treated effluent from Wisbech and/or Kings Lynn re-use to our Stoke Ferry WTW (also within our Fenland WRZ). This option is more expensive than transferring to Marham, so it would only be required following the output of the WINEP investigation. To reduce the risk of further delays to the capping of licences, we propose to develop this element of the reuse scheme through the Adaptive Planning programme.

All of the options enable licences to be capped in other parts of our system. The Marham relocation option enables reductions to occur in 2030. Developing the Stoke Ferry re-use option delays the licences caps till 2034.

The figure below shows the investigations and adaptive planning work coming together at the start of 2027 to enable a decision on which option to continue with into delivery. Our preference would be Option 1 as this is the least cost and provides a benefit soonest. Option 2 with a phased delivery enables licences caps

to start in 2030 but provides a fully robust scheme in 2034. There is a risk with this option that Natural England and the EA will not allow Marham to be operated in advance of the re-use compensation flow, which would delay the capping of licences until 2034. Option 3 switches over to developing the reuse and diverting and treating at Stoke Ferry WTW which has the longest lead time for benefit to enable licence caps.

Figure 2 Marham alternative options



We consider waiting for the conclusion of the proposed new WINEP SSSI investigation would jeopardise our ability to meet environmental obligations and ability to support Fenland WRZ. The EA has advised that delaying any options, and applying for an OPI on an upfront permit, will be looked at unfavourably.

We considered whether Bacton desalination could be brought forward at a larger capacity, however least cost modelling has shown this to be more expensive than developing a local re-use option. It would also require using up desalination capacity that could be used for more local addition needs driven by Habitat Regulations.

A full cost breakdown for Marham in the additional cost efficiency breakdown, is provided in a separate document as part of our representations.

Bacton Desalination

We included an allowance of £52.58m in our March 2024 costs for Bacton desalination having brought the investment into the plan from an adaptive pathway.

£46.09m of costs were allowed in the Draft Determination, £6.49m less than requested. £37.09m of this was allowed as a baseline development costs, and £9m as a contingent allowance.

Ofwat sets out how it has applied its updated methodology to setting costs for new SROs in the 'Major projects development and delivery' appendix. In this appendix, a benchmark of 5.5% of estimated capex has been applied for the development allowance of new major projects. In addition, a minimum allowance of £9million is awarded for DPC activities, plus 0.55% of a project's whole life cost to reflect variations according to size and complexity.

Using Ofwat's own calculation, we consider that £61.88m should have been allowed for Bacton desalination, as set out in the table below:

Table 6

	Component	Value
a	Estimated capital expenditure	£727.67m
b	Development cost multiplier	5.50%
c	**a x b**	**£40.02m**
d	DPC allowance	9
e	Whole Life Totex	£2,337.96m
f	WLT multiplier	0.55%
g	e x f	£12.86m
h	**d+g**	**£21.86m**
c+h	**Total development allowance**	**£61.88m**

The RAPID gate costs allowance tab of the Strategic resource options DD enhancement model shows that the costs for gate one and a large proportion of gate two costs have been disallowed.

We understand this is an Ofwat policy decision that feasibility work should be funded from base allowances. We recognise that the costs of producing strategic planning frameworks such as the WRMP and DWMP are paid for within base allowances, and that those documents include early feasibility for a wide range of options. In the case of WRMP often many hundreds of potential options.

However, we strongly disagree that base allowances can realistically cover all feasibility work beyond the production of the strategic planning frameworks. including RAPID gates 1 and 2. For context, the total allowance for capital maintenance of all existing assets in the Water Resources price control is around £40m for 2025-2030. If the costs of RAPID gate 1 and 2 were to be accommodated

for Bacton, as well as adaptive planning allowances above for Mablethorpe and Marham, that would require almost half of the total maintenance allowance, resulting in adisproportionate amount spent on future planning compared to the requirement for maintain the health of existing supply.

The Draft Determination position on early stage design and feasibility work, will hinder future drought resilience and progression of strategic water resource options, but also puts at risk the resilience of existing supply systems. We request Ofwat to amend the policy position on feasibility studies outside of strategic planning frameworks, and allow the investment in full as per PR19 allowances for other DPC schemes.

We consider that our original requested totex allowance of £52.6m remains the efficient view of totex for the development of Bacton Desalination. The need date for this project is not yet known and is dependent on the outcome of habitats investigations, but the current programme assumes a start-on-site date at the start of AMP9 to enable an into-supply date of 2034. This means that all project development and DPC costs will be incurred in AMP8.However, it is noted that this project will now be governed by the RAPID process, and that this allowance and associated delivery incentives should be adjusted to reflect progress and confirmation of need at the key gated milestones.

As for Colchester re-use scheme, we accept Ofwat's DD decision to make £9m of the DPC development allowance contingent on consents as described in the document 'Major Projects Development and Delivery'.

4 Strategic Resource Solutions

	March 24 Business Plan (£m)	Ofwat DD position (£m)	Representations (£m)
Capex	184.1		184.1
Opex	145.7		145.7
Totex	329.9	158.4	329.9

In our updated data tables, these costs are reported against linesCWW3.183-CW3.184 (Additional line 3 (SROs)) and associated CWW12 and CWW17 lines.

4.1 Our representations

We have presented our representations on Strategic Regional Options within our main DD Representations document (ANH_DD_001). Please refer tochapter 11 Developing Strategic Regional Options.

5 Storm overflows

5.1 Investment summary

	March 24 Business Plan (£m)	Ofwat DD position (£m)	Representations (£m)
Capex	479.1		583.2
Opex	9.7		16.0
Totex	489.9	562.4	599.2

In our updated data tables, these costs are reported against lines:

- CWW3.16-CWW3.18 (Increase storm tank capacity at STWs - grey solution) and associated CW12 and CW17 lines. This activity was previously included in our 'Increasing FFT and storm tanks enhancement strategy. We have moved these costs to align with Ofwat's treatment of Strom overflows allowances in the Draft Determination.
- CWW3.19-CWW3.21 (Increase storm system attenuation / treatment on a STW - green solution) and associated CWW12 and CWW17 lines.
- CWW3.22-CWW3.24 (Storage schemes to reduce spill frequency at CSOs etc - grey solution) and associated CWW12 and CWW17 lines.
- CWW3.31-CWW3.33 (Storm overflow - increase in combined sewer / trunk sewer capacity) and associated CWW12 and CWW17 lines.
- CWW3.34-CWW3.36 (Storm overflow - sustainable drainage / attenuation in the network) and associated CWW12 and CWW17 lines.
- CWW3.37-CWW3.39 (Storm overflow - source surface water separation) and associated CWW12 and CWW17 lines.
- CWW3.43-CWW3.45 (Storm overflow - sewer flow management and control) and associated CWW12 and CWW17 lines.
- CWW3.46-CWW3.48 (Storm overflow - new / upgraded screens) and associated CWW12 and CWW17 lines.

5.2 Context

This investment is required to address the potential for environmental harm and public health which can result from discharges from storm overflows. We will increase the capacity of our networks and improve management of surface water flooding in periods of high rainfall. The need for investment is predominately specified by statutory WINEP obligations. Our ambition to improve in this area is captured by our Get River Positive commitments, which we launched in partnership with Severn Trent in March 2022. In our PR24 business plan 'green' solutions (either as the full solution or via a blended approach) account for 48% of our preferred solutions to address storm overflows.

5.2.1 Ofwat's DD approach

Ofwat assessed all costs relating to Storm Overflows through 'PR24-DD-WW-Storm-Overflows', taking into account the scheme level storm overflow scheme data provided in IN23/05.

Ofwat assessed the different aspects of the investment strategy as outlined below:

Table 7 Strategy Assessment

Assessment method	Investment area
Econometric modelling	Grey/hybrid network STW storage
Deep dive	Grey/hybrid network (outliers schemes) STW storage (outliers schemes)
Benchmarking assessment	Green-only solutions Screen only solutions Wetlands

For network grey/hybrid network solutions and STW grey storage solutions, Ofwat used an econometric log linear triangulated model with upper quartile efficiency challenge to determine our costs.

For both solution types, Ofwat found our costs to be more efficient than the industry UQ and as a result granted a modelled allowance higher than our requested allowance. For the 34 outlier schemes assessed through deep dive, costs were permitted in full as Ofwat was satisfied these schemes presented efficient costs and that the company had provided compelling evidence the allowance above the benchmark was justified.

On green solutions, Ofwat derived the unit cost for green equivalent storage to benchmark companies against each other and therefore establish an indicative cost per m3 green storage.

On screen only costs, we received an efficiency challenge as our costs were perceived to be the least efficient in the industry.

On wetlands, no efficiency challenge was applied in order to encourage the use of green solutions at PR24.

Overall, of the £489.874m requested allowance in our March 24 business plan, we received an allowance of £562.4m. The WINEP adjustment was applied to the allowance.

5.3 Our representations

We strongly support Ofwat's approach in using granular, scheme level cost driver data in setting its allowance for our investments related to addressing harm from storm overflows. We particularly welcome that Ofwat has integrated the preference to encourage nature-based solutions into its approach to cost assessment as well as through setting the second highest unit cost as the upper limit for green storage unit costs. This marks a significant and positive step-change in approach, which supports the industry to develop a better understanding of the actual costs of delivery during AMP8 to inform future investment in AMP9 and beyond. As our business plan outlines, approximately 48% of our solutions to address harm from storm overflows are 'green' solutions (either as a full solution or via a blended approach), and it is encouraging to see a shared enthusiasm for this change in approach.

5.3.1 Cost efficiency

To derive our PR24 business plan costs, we applied our double-lock cost efficiency approach. This approach builds on our experience from delivery of similar schemes in AMP7, using scheme outturn cost data (including granular cost components) to inform the bottom-up development of costs. The second stage of the double-lock efficiency challenge combines this bottom-up approach with external cost benchmarking challenge. We benchmarked costs using WRC's TR61 as an external benchmark, and found that our overall storm overflow programme was 13% less expensive than industry data comparisons. More detail of our benchmarking activities can be found in section 5.3.2 of our enhancement strategy (ANH26).

Ofwat's PR24 cost model represents a further external benchmark to support our double-lock approach. This model utilises scheme-based granular detail of costs from all WaSCs. It thereby provides a strong like-for-like benchmark for our costs which was not available ahead of the Draft Determination. This model suggests that the industry benchmark for the scope of our Storm Overflows enhancement is more than the costs we included in our business plan, predominately driven by network grey/hybrid solutions and STW grey storage solutions.

The evidence from external cost intelligence (both from WRC's TR61 and Ofwat's cost model) suggests that the costs we included in our PR24 plan for storm overflows was lower than the efficient cost for delivering these schemes. When modelling solutions we have used an uplift to represent the impact of Climate Change.

Since our previous submission we have tested these models with the latest issue of the RedUp tool (This applies Climate Change to our existing Time Series rainfall datasets which are used to assess the spills). We see a general trend for increased volumes at spill locations. There is also a likely underestimation in relation to catchments sensitive to groundwater as we cannot predict what the water table seasonal levels should be when carrying an assessment. This is a particular risk for storage strategies including ‘grey’ tank solutions and ‘green’ lagoon solution. Given the importance of meeting the targets mandated in the Storm Overflows Discharge Reduction Plan for the environment of which we are custodian, ensuring we are appropriately funded to invest to meet these targets is crucial.

As such, we have aligned the costs of our Storm Overflows enhancement investment to the allowance permitted through Ofwat’s Draft Determination enhancement cost model. Ofwat's modelling gives an allowance of £562.4m. Therefore we adjust our requested totex for the investment presented in our March 24 business plan to this amount,although note the additional totex requirements identified post business plan submission outlined below for which we also request an allowance.

5.3.2 Changes since business plan

Since business plan submission, we have identified the following amendments to the totex requirements for our storm overflows programme:

EA permit fees

Changes in EA permit fees since business plan submission have increased costs (in addition to the opex maintenance costs) of green solutions post scheme completion. Both of these factors have also added costs to the delivery of our green storm overflow spill reduction solutions, which we have reflected in our updated totex. These costs were added before we applied the model uplift.

Scope changes -storm tanks auto-cleaning

Our previous scope assumptions within our PR24 business plan did not reflect the need for auto-cleaning. As part of our representations, we propose increasing the costs in enhancement investment to add auto-cleaning systems to 37 new WINEP storm tanks. We have identified the need for additional investment due to changing

minimum asset standards following learning from AMP7 delivery. This is driven by ensuring safety risk and operational activity of cleaning tanks after a storm; the systems will eliminate the need for manual storm tank cleaning post storm events.

This investment will enhance the performance and lifespan of storm tanks, improve environmental performance (i.e. improved storm effluent quality for tanks with overflows and reduced odour from storm tanks and reduce health and safety risks to our staff.

This proposed uplift in enhancement will add auto-cleaning systems to 37 new WINEP U_IMP6 storm tank schemes at an additional capex cost of £5.345m and 15 U_IMP4 spill reduction schemes at an additional capex cost of £2.919m.

This addition makes no change to the recommended solution of the provision of a glass coated steel tank sized to accommodate storm volumes.

Connectivity

A further assessment of previous offline storage installations in comparable locations has shown that localised constraints negatively impact the final location of the offline storage. This assessment has shown that additional lengths of gravity sewer and rising main will be required over and above those initially assessed to accommodate these constraints.

Investments have been included in the plan to improve the location of new storm tanks and their connectivity to existing systems within the water recycling centres. This proposed increase will improve the operability of the assets.

When estimating the gravity inlet and pumped return pipework for offline storage a number of factors are considered, including:

- Location of the offline storage in relation to the gravity sewer
- Diameter and length of the connecting gravity sewer
- Diameter and length of the return rising main.

From this an average length of gravity inlet sewer and return rising main was used in the initial estimates.

This addition makes no change to the recommended solutions.

AMP7 SOAF sites

This investment is for 6 new UWWTD overflow schemes which have been identified as being in cost beneficial locations following AMP7 SOAF (Storm Overflow Assessment Framework) investigation but which were not originally included as AMP8 schemes. The requirement to deliver these has resulted from exchange of letters between EA and AW about the AMP7 Storm Overflow Assessment Framework (SOAF) investigations post business plan submission. We confirm that these schemes relate to AMP7 investigations that identified actions (under the Urban Wastewater Treatment Directive) for AMP8 that were found to be cost beneficial for investment.

Cost benefit assessments have been based on reducing spills to 10 spills per annum with offline storage tanks. We opted for 10 spills in line with the Environment Act target (despite the UWWTD driver only requiring us to hit 40 spills per annum) to avoid revisiting these sites again in AMP9. The six sites are summarised below:

Table 8 Summary of Sites

	Site name	
1	Northampton Duston, Sycamore SSO IMP4	Storage
2	Winteringham, Station Farm SSO IMP4	Storage
3	Rayleigh West WRC EnvIMP4	Storage
4	Haslingfield WRC EnvIMP4	Storage
5	White Notley WRC EnvIMP4	Storage
6	Diss WRC EnvIMP5	Screen only

In line with the rest of our high spilling overflow programme, for schemes that have drivers to meet 40 spills in AMP8 and drivers in subsequent AMPs to meet an additional spill reduction target, we have promoted the schemes based on 10 spills per annum to avoid having to return to these catchments in subsequent AMP periods to meet Environment Act obligations.

For Diss the cost beneficial driver is for aesthetics, so only a screen is proposed.The WINEP obligation dates for all 6 schemes are March 2028.

Given overflows in our plan were selected on a prioritised basis, we originally proposed to the EA to bring these 6 sites forward into AMP8 whilst pushing back 6 other sites into AMP9 to retain the same overall profile. The EA rejected this proposal.

As such, we propose to amend our requested totex allowance through an increase of £4.9m to account for bringing these schemes into AMP8.

5.3.3 Impact of microbiological treatment on Storm overflow cost lines

As explained in the enhancement narrative for microbiological treatment, we have significantly increased our costs for that WINEP driver in response to new design guidance from the Environment Agency's technical consultant. In line with Ofwat's table guidance for PR24, where the costs of a scheme address more than one purpose, the costs of that scheme should be proportionately allocated to both lines. The new scope of the schemes to address bathing and shellfish water quality contain both disinfection assets and new storm tank storage capacity. We have therefore proportionately allocated the costs of these schemes between the relevant lines in CWW3, and also shown the additional m3 storage volumes in ADD19 and CWW20 to allow Ofwat to assess the additional storage required in the storm overflows model. This has added around £40m to the storm overflow costs.

6 Increasing FFT

6.1 Investment Summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	20.7		27.0
Opex	1.1		2.3
Totex	21.8	19.9	29.2

In our updated data tables, these costs are reported against linesCWW3.13-CWW3.15 (Increase flow to full treatment) and associated CWW12 and CWW17 lines.

6.2 Context

Flow to full treatment (FFT) refers to the maximum volume of wastewater a WRC must be able to treat at peak. If this flow is exceeded, for instance in the case of a storm or heavy rainfall, then the flow in excess of the FFT limit is diverted to storm tanks where the sewage is stored until normal conditions resume and the flow can be treated through the WRC.

In order to meet regulatory standards for flow treatment at WRCs and increase operational resilience of WRCs to storms and heavy rainfall, we will invest to increase our FFT capacity at WRC sites identified as having low permitted DWF to FFT ratios reach three times DWF capacity.

Our allowance for Full to Flow Treatment was determined through a shallow dive assessment, with our requested allowance being permitted in full (£21.8m).

6.3 Our representations

We welcome that Ofwat's assessment concluded our costs were efficient. In light of further engagement with the EA since business plan submission in particular around sites with high infiltration in the catchment leading to unusually high dry weather flows, we have revised the costs relating to two aspects of our FFT programme:

1. As agreed with the Environment Agency, we have replaced the scheme at Yardley Hastings (which was presented in our October 23 Business Plan), with a scheme at Little Bytham. The scheme at Little Bytham is more complex than the solution presented for Yardley Hastings and has a higher litres per second deficit required to be addressed (31.3 l/s in comparison to 2.6 l/s), requiring an additional £5.8m for scheme delivery in comparison to that outlined in our October 23 Business Plan.
2. Also agreed with the EA, the scheme at Wymondham has been re-costed based on a new l/s deficit to treat higher flows due to infiltration. This results in an additional £1.2m totex being required for scheme delivery.

As such, we amend our requested totex for our FFT investment strategy to £29.242m. To ensure we are able to meet the regulatory standards for flow treatment at the outlined WRCs, in particular the new requirements for the infiltration 'IMAX' calculation, we request that Ofwat assess and make an allowance for our additional costs outlined in this representation using the new flow deficit values.

This investment is required for the same reasons outlined in our business plan enhancement strategy (ANH26 section 6). It is required to ensure that we fully align with our statutory WINEP obligations as outlined by the EA. As outlined by ANH26 section 6, increasing capacity through biofilters were selected as our preferred solution in order to treat the required increase in FFT flow as it is a proven solution. Alternatives such as new WRCs and removing flow from the catchment were ruled out during the optioneering process as they are high cost and technically difficult solutions respectively.

As with other WINEP schemes, we have also updated the costs of permit application fees within these investments to match the latest published charging by the Environment Agency.

We provide a full cost breakdown by site in ANH_DD_022 Enhancement cost breakdowns.

7 Reducing flooding risk for properties

7.1 Investment Summary

	March 24 Business Plan (£)	DD Ofwat position (£m) (implicit base allowance)	Representation (£m)
Capex	46.1		92.5
Opex	15.4		15.5
Totex	61.5	91.3	108.0

In our updated data tables, these costs are reported against lines CWW3.156-CWW3.158 (Reduce flooding risk for properties) and associated CWW12 and CWW17 lines.

7.2 Context

We proposed this investment in our business plan to enhance our sewerage system to reduce the risk to properties and external areas of flooding from sewers. The investment programme proposed strategies to target blockages and hydraulic flooding risk.

Ofwat states that reducing risk of sewer flooding forms part of the modelled base cost allowances as part of the wastewater network plus cost area.

7.3 Our representations

We calculate that the implicit allowance for reductions in sewer flooding has been permitted through the wastewater network plus base models of £91.3m.

As Ofwat has noted in the DD, we reduced the costs between the final Drainage and Wastewater Management Plan (DWMP) and the October submission business plan. We sought to do this to re-profile and balance competing pressures for investment by aligning our plan to ONS2018 household projections and delaying investment linked to climate mitigation to be able to embrace digital technologies and partnership approaches (for example, through our advanced WINEP).

We propose to update our position using new evidence that suggests growth and climate change will more significantly impact our networks in AMP8, including:

- Government changes to national planning policy to create mandatory housing targets, alongside interventions to speed up the planning system.
- Our recent evidence has confirmed the link between the significant increase in pollution and sewer flooding incidents resulting from hydraulic overload, in keeping with our initial findings through our DWMP.

As part of our draft determination representations we submit a cost adjustment claim 'DWMP alignment' which introduces an uplift in the base models for sewer flooding to ensure constituency with the costs presented in our DWMP in addition to the implicit allowances for network reinforcement and sewer flooding.

We set out further details on these costs for our network in the base cost chapter of our Representations and our DWMP alignment cost adjustment claim ANH_DD_012.

8 Resilience (water)

8.1 Investment summary

	March 24 Business Plan (£)	DD Ofwat position (£m)	Representation (£m)
Capex	238.0		12.2
Opex	0.3		0.3
Totex	238.3	12.5	12.5

In our updated data tables, these costs are reported against lines CWW3.118-CWW3.120 (Resilience) and associated CWW12 and CWW17 lines.

8.2 Context

As part of our AMP8 investment plan and Long Term Delivery Strategy, we set out an ambitious plan to help us mitigate the biggest risks to providing a resilient supply of clean, safe drinking water to our customers. We proposed:

1. To invest to mitigate the premature failure of our climate vulnerable mains;
2. To address single points of failure across our water network; this includes where distribution water mains cross over, under and through pieces of critical national infrastructure.
3. Investing to mitigate against the impacts of surface water flooding at key water production assets including boreholes which are highly susceptible to flooding. This is to ensure that the impacts of heavy rainfall and sea level rise, both attributed to climate change, will be mitigated in the medium to long term.

For this programme of investment we requested an overall totex £238.3m.

Ofwat disallowed our requested totex for the water resilience in full.

Each investment was assessed separately through a deep dive assessment. We provide a summary of Ofwat's justification for removing all requested totex by investment area below:

Table 9 Removing Investment Justification

Investment area	Requested totex	Ofwat justification	Allowed totex (£m)
Climate vulnerable mains	198.124	Ofwat reject the allowance in full through the 'need for enhancement' investment criteria, stating we do not provide sufficient and convincing evidence that there is an increasing risk from hazards outside of its control (climate change). Ofwat state asset maintenance and replacement to ensure continued delivery of service is included in base allowances. Ofwat also apply a sector wide adjustment for mains renewal which will require all companies to renew at least 0.3% of our network annually during AMP8 through base allowances. Our business plan renewal rate as 0.126%, therefore Ofwat state we will be required to increase the renewals delivered from base to the sector wide adjustment.	0
Single points of failure	19.594+10.115 (assessed through two deep-dives)	Ofwat state for the proposed schemes there is insufficient and convincing evidence to demonstrate there is an increasing risk from hazards outside of company control. Ofwat state maintenance and replacement for continued delivery of service is included in base allowances.	0
Pluvial and fluvial flood resilience	4.55	Ofwat allow a sector wide enhancement uplift for companies to prioritise the most material climate related risks. This uplift is based on 0.7% of modelled base allowances (for water and wastewater services), with the percentage based on the median of efficient company requests in these areas.	0

Investment area	Requested totex	Ofwat justification	Allowed totex (£m)
		Ofwat state they expect that generic climate change risks identified by companies should be managed from base allowances, with this uplift is a one-off adjustment to address at a minimum additional flood and power resilience requirements from climate change.	

In place of this investment, Ofwat proposed an alternative climate allowance. This is materially lower than our proposed investment.

For the resilience uplift, companies must set out what schemes they will deliver for the additional uplift funding in their representations. This should include details of the schemes and why these have been prioritised. If companies do not present suitable schemes with clear deliverables for the uplift allowance it will be removed from allowances at final determination. Ofwat state price control deliverables will be set to ensure customers are protected in the event of non-delivery.

8.3 Our Representations

8.3.1 Climate vulnerable mains

We consider that the evidence we have available shows there is a significant risk to some of our mains due to the risk of climate change, aging assets and other factors.

Reviewing Ofwat's Draft Determination, investment drivers of this nature have been assessed under base expenditure.

We have therefore repurposed this evidence into a Mains Renewal Cost Adjustment Claim as part of our Draft Determination representation. The CAC will increase the level of capital maintenance to permit an increase in the mains renewal rate. Full detail is set out in our Mains Renewal Cost Adjustment Claim submission ANH_DD_010.

8.3.2 Single point of failure

As outlined in our business plan enhancement strategy (ANH26), in the development of this investment we carefully considered the activities that should be considered as base and those which represent enhancement. We consider investment from base allowances is to address existing risks from hazards. The evidence we presented in our enhancement strategy outlined that the SPOF programme was to manage increasing risks and risks outside management control. We do not consider that base allowances include cost drivers which cover the mitigation of risks from hazards which are increasing and beyond management control.

The removal of these costs from our plan presents an ongoing resilience risk for AMP8 given we contest base allowances are sufficient to manage forward-looking emerging resilience risks to our operations.

8.3.3 Resilience uplift

As part of the DD, Ofwat set out the expectation for companies to demonstrate which schemes they will deliver for the additional resilience uplift funding (of 0.7% modelled base allowances across water and water recycling services) or risk this being removed at Final Determination. Whilst we content the sufficiency of this allowance, the table below presents our selected schemes for delivery through the resilience uplift allowance.

We present schemes in the order of priority for delivery, based on the anticipated climate impact on our operations. The schemes below the red line are feasible schemes for delivery which we invite Ofwat to consider if it does not support the inclusion of any of our proposed schemes, or a greater uplift is permitted at Final Determination.

Our schemes have been grouped into the following categories, and the sections below set out the description of these schemes, their need and how we have selected the best options for customers:

- Network climate resilience
- Climate change - temperature
- Climate change - flooding
- Climate change - algae
- Climate vulnerability - network
- Climate change - networks
- Climate change - water resources

Table 10 Resilience - proposed schemes

Investment Category	Investment Name	Scheme Category	AMP8 Capex (£m)	Cumulative Capex (£m)	AMP8 Opex (£m)	Benefits (EAB) (£m)	Costs (EAC) (£m)	Value (WLV) (£m)
I040279	CV - Region Temp Related Asset Failure TWD	Climate change - Temperature	0.93	0.93	0.09	15.45	0.14	15.31
I040278	CV - Reg Temp Related Asset Failure WTW	Climate change - Temperature	0.69	1.62	0.02	8.93	0.08	8.85
I010481	Bramford no.2 Flooding	Climate Change - Flooding	0.21	1.83	-	4.89	0.01	4.87
I010479	Bramford no.1 Flooding	Climate Change - Flooding	0.32	2.15	0.10	4.46	0.06	4.39
I010494	Westerfield BH 2 Flooding	Climate Change - Flooding	0.13	2.28	-	4.34	0.01	4.33
I040210	CV Regional Overheating Protection RW	Climate change - Temperature	1.12	3.40	0.04	3.84	0.13	3.71
I010498	West Bradenham 2 Flooding	Climate Change - Flooding	0.13	3.52	-	1.49	0.01	1.48
I019070	Beck Row Flooding	Climate Change - Flooding	0.19	3.71	-	1.33	0.01	1.31
I028139	Stuntney WR to Haddenham WT (Ely) Resilience	Network Climate Resilience	6.69	10.41	0.05	1.57	0.38	1.18
I018463	Swaton no.1 Borehole Flooding	Climate Change - Flooding	1.95	12.36	0.04	1.25	0.14	1.11
I040759	Wellington Plantation B Flooding	Climate Change - Flooding	0.23	12.59	-0.00	0.57	0.02	0.55
I040761	Wellington Plantation D Flooding	Climate Change - Flooding	0.23	12.81	0.00	0.57	0.02	0.55
I040461	Hillington Chalk 2 Flooding	Climate Change - Flooding	0.21	13.02	-	0.22	0.01	0,20
I040459	Hillington Chalk 1 Flooding	Climate Change - Flooding	0.10	13.12	-	0.21	0.01	0.20
I040474	Southfields Bore 2 Flooding	Climate Change - Flooding	0.02	13.14	-	0.10	0.0	0.10
I023214	Denton Lodge Borehole Flooding	Climate Change - Flooding	0.34	13.48	-	0.05	0.02	0.03
I010504	Wellington A Flooding	Climate Change - Flooding	0.24	13.72	-	0.05	0.02	0.03
I027411	Elsham WTW Cadney Intake Resilience	Climate change - Water Resources.	0.56	14.28	-0.00	31.51	0.03	31.47

Investment Category	Investment Name	Scheme Category	AMP8 Capex (£m)	Cumulative Capex (£m)	AMP8 Opex (£m)	Benefits (EAB) (£m)	Costs (EAC) (£m)	Value (WLV) (£m)
I010677	Cadney to Elsham Raw Water Main Resilience	Climate change - Water Resources.	0.78	15.05	0.00	25.24	0.04	25.21
I039050	CV-Condition & Criticality Investigation Water	Climate Vulnerability - Networks	1.61	16.66	-	0.00	0.08	-0.08
I039350	CV - Modelling Vulnerable Mains	Climate Vulnerability - Networks	1.97	18.64	-	-	0.09	-0.09
I039346	CV - Increased Pressure Monitoring	Climate Vulnerability - Networks	3.52	22.16	-	-0.00	0.56	-0.57
I044100	PR 24 Warren Hill WR2 - Longhill BH Reg26	Climate Change - Networks	2.18	24.34	0.02	-21.07	0.16	-21.22
I038970	Grafham WW-algal treatment challenge	Climate Change - Algae	14.39	38.73	1.10	127.28	1.39	125.89
I030164	Alton WW-Algal treatment challenge AMP8	Climate Change - Algae	5.22	43.96	0.25	15.53	0.44	15.08
I038972	Pitsford WW-algal treatment challenge AMP8	Climate Change - Algae	5.32	49.28	0.26	11.78	0.45	11.33
I038971	Ardleigh WW-Algal treatment challenge	Climate Change - Algae	5.00	54.28	0.23	9.53	0.42	9.11

2

We provide further justification for the selection of these schemes by category below. If Ofwat requires any further information to support these investments, we would be more than happy to provide this through the query responses.

Network climate resilience

Need for investment

Future climate scenarios predict more extreme soil moisture deficits, leading to more bursts and supply interruptions. This is a particular risk where the existing water network and soil types make the supply vulnerable to high fluctuations in soil moisture deficits. Where the zone would previously have had relatively stable conditions and therefore the impact on customers was much less frequent, these impacts are likely to become more frequent and the process of adaptation to less benign climate scenarios must take place.

The current feed from Ely Water Reservoir (WR) and Water Tower (WT) to Haddenham WT is a sole feed through an asbestos cement-lined water main in highly shrinkable fen soil. Haddenham WT feeds Sutton WT, and the only resilience to supply disruption is the storage within the WTs. The zone is isolated from adequate capacity supply, with natural and infrastructural barriers limiting alternative supply routes. The existing pipeline is prone to failure due to soil movement and is made of asbestos cement.

The pipeline is laid deep, complicating repairs and extending interruption times. The zone has seen a 10% increase in housing due to infill development, tightening the supply-demand balance and making it more likely for customers to experience

2 Definitions: Whole Life Cost - WLC (discounted) = CAPEX+CAPEX repeat+OPEX+OPEX repeat at 30 years then discounted. EAB - Equivalent Annualised Benefit = The benefit in £ that is expected each year following completion of the scheme. EAV - Equivalent Annualised Value. EAC - Equivalent annual cost (EAC) = the annual cost of owning, operating, and maintaining an asset over a defined period of time, in this case 30 years as per the requirements from Ofwat. Risk Index = Whole Life Cost/(Baseline Risk Value - Residual Risk Value)

supply interruption. The zone is also considered 'intra zonal' for the WRMP. As such the zone does not qualify for WRMP-led supply side investment, but demand side investment through leakage and smart metering is ongoing (although this does not fully mitigate the climate-associated risk).

We are proposing to reduce the risk of losing the supply to Haddenham WT, and therefore also Sutton WT. In 2022/23 we saw a burst on the main feeding Haddenham WT during the record-breaking summer temperatures and soil moisture deficit that realised this risk. The burst occurred on the asbestos cement main within the very high shrink swell soil at the time of maximum soil moisture deficit providing movement that put far too much pressure on the outside of the pipe. The demand in the zone was also very high at the time, as the unprecedented temperatures drove very high demand across our region and most of the UK. 272 properties were previously reportable as Properties at Risk of Persistent Low Pressure. During disruption issues these customers would be the first to see issues and may have low pressure even if widespread interruption can be avoided if a failure is quick to rectify.

The zone has therefore been identified as having three emerging climate resilience risks:

1. A single supply system where a single chain of assets which if disrupted can cause immediate issues. In the past we have delivered enhancement investment to reduce the percentage of customers supplied by single WTW however, in this case the hazard is not relating to a WTW but a single WT.
2. The main feeding the zone is made of climate vulnerable asbestos cement.
3. The prevalence of infill growth raising demand

Best option for customers

We consider two feasible options for this scheme.

1. Option 1: Approximately 9km of new water main at 300mm diameter from Stuntney WR to Haddenham WT. Includes a new pump set and DMA meter. Connection to existing mains at Halfway House for a resilience feed to Little Thetford.
2. Option 2: Approximately 6.5km of new water main at 300mm diameter from Stuntney WR to Haddenham WT. Connecting into the existing main from Ely WT and WR to Haddenham WT, which is climate vulnerable. Includes connection to existing mains at Halfway House for a resilience feed to Little Thetford. Approximately 4.2km of mains renewal would be required seperate to this investment.

Figure 3

In addition to the feasible options , at earlier stages of optioneering we considered and screened out the following options:

1. Feed from the Ruthamford System: This option was deemed too costly and impractical due to the small diameter of the existing main and the need for additional treatment systems.
2. Feed from the new strategic interconnector pipeline: This option was also screened out due to high costs and similar challenges as the Ruthamford System.
3. Import connection from Cambridge Water: This was considered not feasible due to insufficient supply and small diameter mains.
4. Mains renewal:this would only address one element of the hazard and therefore does not adequately address the full hazard. One of the above options would need to proceed as well to provide resilience.

We provide the outputs of our cost benefit analysis below.

Table 11 Cost Benefit Analysis

Option number	Type	Selected alternative	Capex (£)	RICs (£)	WLC (£) [a]	EAB (£) Equivalent Annualised Benefit [b]	EAC (£) Equivalent Annualised Cost [c]	EAV (£) Equivalent Annualised Value [d]	Mitigated risk (£)	Risk index (value) [e]
1	New supply mains to Haddenham WT	Yes	6.89	7.03	7.03	1.48	0.37	1.11	2.15	3.27
2	New supply mains to Haddenham WT via existing main	No	4.66	0.073	5.24	1.37	0.27	1.09	1.97	2.66

a Whole Life Cost - WLC (discounted) = CAPEX +CAPEX repeat +OPEX +OPEX repeat at 30 years then discounted
b EAB - Equivalent Annualised Benefit. = The benefit in £ that is expected each year following completion of the scheme.
c EAV - Equivalent Annualised Value
d *EAC - Equivalent annual cost (EAC) is the annual cost of owning, operating, and maintaining an asset over a defined period of time, in this case 30 years as per therequirements from Ofwat*
e Risk Index = Whole Life Cost /(Baseline Risk Value - Residual Risk Value)

For the resilience uplift enhancement investment, we have selected Option 1, which has a better cost benefit value (EAV) than Option 2. This is as Option 1 provides substantially more resilience benefit by not utilising the existing main, which for Option 2 would retain a single point of failure in connecting into the existing main. The benefit of the removal of this single point of failure in Option 1 which outweighs the increased cost incurred for the additional 2.5km of main required.Both options may be complemented with 4.2km of mains renewal from base renewal should sufficient allowance be made for our base mains renewal CAC to further increase resilience once the new mains are installed. Given the pressures on mains renewal allowances in base, without the resilience uplift opportunities for pursuing resilience via second feeds (new mains) in base will be severely limited in AMP8.

Climate change - temperature

Need for investment

The climate of the United Kingdom is changing, with the decade from 2012 to 2021 being on average 1.0°C warmer than the period between 1961 and 1990. This warming trend is causing changes in ecology, atmospheric energy, and industry conditions.

As the climate of the UK and particularly East Anglia continues to heat up there are challenges presented to the water industry that relate to the exposure of treatment processes and assets to high temperatures. These challenges include the effects of higher temperature to the structure and function of treatment chemicals, the deterioration in performance of physical assets and changes in the characteristics of the raw water presented for treatment through changes in algal populations, decreased pollutant dilution and flash flooding events.

The water industry operates with long-life assets that are designed for the prevailing conditions at the time of construction. It is only relatively recently that climate change is being considered during the design and construction process, leaving a legacy of assets not designed for current climate conditions.

Immediate actions and additional funding are required to protect the supply of wholesome and reliable water. The industry must adapt to become resilient to these changes, whilst also ensuring investment is made outside of base expenditure to facilitate the immediate actions required to protect the supply of wholesome and reliable water to customers.

The effects of increased temperature on electrical installations is pronounced. As temperatures increase electrical efficiency decreases which results in voltage drop increases and power loss. This can lead to either complete asset failure or reduce capability.

Another effect of temperature is simply overheating. During the unprecedented heat of the summer of 2022 (the peak of which was recorded within the Anglian Water region at RAF Conningsby in Lincolnshire) it was necessary to bring in portable air cooling systems to protect the function of key operational assets, which were at risk of asset failure due to overheating. This situation is likely to become more frequent as climate change progresses.

The risk to customers is that water supplies will become compromised either through raw water deterioration or the ability of assets to operate in these conditions, which will manifest as either a volumetric deficit or changes in water chemistry manifesting as acceptability challenges.

At the very time the customer demand for safe clean water is at its peak the industry will be struggling to fulfil its customers' expectations. The ultimate result of this situation is likely to be use restrictions, loss of supply and depressurisations. The health of the public will be put at risk both from the restriction of their water supply and from the increased risk of contaminant infiltration during loss of supply and depressurisation events.

The sites identified for temperature intervention were the result of the interventions that were required during the summer of 2022. A number of operational assets required interventions in terms of mobile air cooling in order to keep them operating. These assets were identified as the most vulnerable and most critical by the impact that their failure caused to water supply.

Best option for customers

In order to mitigate the effects of high temperatures many options were investigated and these are detailed in the section below:

Table 12 Temperature Mitigation Methods

Mitigation Method	Pros	Cons	Taken forward for resilience uplift (yes/no)	Long term
Painting of building fabric	This is a relatively low-cost option for small buildings.	Becomes prohibitive for large structures. Requires an investment in upkeep to make sure the reflective surfaces are maintained and do not reflect poorly on the company's asset conditions. May be difficult to gain planning permission. The existing building fabric may not be an appropriate surface for painting. This option does not aid the dissipation of heat generated within the building by heat creating assets.	No	Consider during new asset design
Shading	This can reduce solar gain within assets	Becomes prohibitive for large structures. Requires an investment in upkeep to make sure the shading surfaces are maintained and do not reflect poorly on the company's asset conditions. May be difficult to gain planning permission. The infrastructure around existing assets may make this option difficult to execute. This option does not aid the dissipation of heat generated within the building by heat creating assets.	No	Consider during new asset design

Mitigation Method	Pros	Cons	Taken forward for resilience uplift (yes/no)	Long term
Tree / Shrub Planting	The use of trees and shrubs has the potential to both enhance the environment and to provide shade for buildings. It does however have to be designed properly because the incorrect use of planting can actually diminish flow through buildings instead of enhancing it	This is not easy to fit in to existing built environments that are often hostile to more nature-based solutions. Roots and falling leaves have a management cost and care must be taken to ensure that pipework or drains are not compromised on site. incorrect planting designs can result in an even greater buildup of heat rather than helping to prevent it.	No	Consider during new asset design
Increased ventilation	This option allows heat buildup within buildings to be dissipated before it compromises the operation of the assets within a given area. It can reduce temperatures within buildings.	It requires power to run the systems and as such does not help in carbon reduction. This can only reduce temperatures to ambient levels outside of the building.	Yes	Consider during new asset design
Air conditioning	Forced air cooling gives a greater control over the temperatures that are achieved. Particularly appropriate for chemical storage where performance is closely linked to storage temperature for example Hypochlorite storage to prevent chlorate formation.	High power costs Should only be considered where all options are unable to achieve the required results.	Yes	Consider during new asset design

The outputs of our cost-benefit analysis for the options taken forward are presented below:

Table 13 Cost Benefit Analysis

Asset area	Alternative Name	Capex (£m)	RICs (£m)	WLC (£m)	EAB (£m)	EAC (£m)	EAV (£m)	Mitigated risk	Risk index (value)
Water Treatment Works [a]	Regional Increased ventilation program WTW	0.69	0.02	1.56	8.93	0.082	8.85	11.59	0.1
Water Treatment Works	Regional air conditioning	2.19	0.04	3.17	4.58	0.17	4.42	5.95	0.5
Raw Water	Regional cooling installations raw water	1.12	0.04	2.43	3.48	0.13	3.71	4.75	0.5
Raw Water	Regional air conditioning raw water	2.74	0.03	3.706	2.69	0.19	2.50	3.49	1.1
Treated Water Distribution (TWD)	Regional Increased ventilation program Water Networks - amber and red	0.93	0.09	2.97	15.45	0.14	15.31	20.06	0.1

Asset area	Alternative Name	Capex (£m)	RICs (£m)	WLC (£m)	EAB (£m)	EAC (£m)	EAV (£m)	Mitigated risk	Risk index (value)
Treated Water Distribution	Regional Increased ventilation program Water Networks - red only	0.73	0.03	1.92	9.54	0.10	9.44	12.32	0.2
Treated Water Distribution	Regional air conditioning TWD red and amber	3.29	0.22	6.81	14.69	0.36	14.34	19.41	0.4
Treated Water Distribution	Regional air conditioning TWD red only	2.61	0.05	3.76	14.71	0.20	14.52	19.43	0.2

a Blue shading indicates selected Alternatives for each category

In each group of assets the selected alternative is the option using increased ventilation rather than air conditioning. None of the affected areas involve chemical storage and as such the benefits gained from increased ventilation are in line with the costs incurred. These options are both the lowest cost and best benefit options for raw water and water treatment. In the case of treated water distribution the best option has proved to be the completion of both the red (highest impact on failure and direct impact on customers) and amber assets (high consequence on failure but not immediate impact on customers), while this does have higher capital costs it drives much higher benefits because of the number of assets covered.

Climate change - flooding

Need for investment

Scientists from the Met Office, Met Éirann, and KNMI have produced a report called the World Weather Attribution (WWA) co-ordinated study. The study concludes that rainfall associated with storms is becoming more intense and likely, with a 20% increase in intensity compared to the pre-industrial climate and prior to the current 1.2°C temperature rise. If global warming continues at its current rate and reaches 2°C, the intensity is likely to increase by a further 4%.

This increased rainfall puts assets constructed for previous benign conditions at greater risk of flooding. Boreholes with below-ground headworks are particularly vulnerable, as flooding can contaminate both raw water and the wider aquifer, risking the availability and quality of water provided to the public. The construction method of boreholes significantly impacts their vulnerability during high rainfall periods.

As demonstrated in the following images, the construction method of the first headworks in a below ground chamber presents a much higher risk during periods of high rainfall relative to a headworks constructed in an above ground kiosk:

Figure 4 Below ground headworks

Figure 5 Above ground headworks

As a result of this clear risk we no longer construct new assets as below ground headworks. For existing below ground assets, because of the hazard presented by climate change it is necessary to enhance the protection to flooding to ensure resilience of supply to the customer and for the aquifer. Below ground headworks present a clear pathway from the surface to the aquifer and as a result contaminants could be introduced in to the water supply should those below ground chambers flood. This would result in widespread do not use or boil orders being required until such times as the raw water was deemed to be acceptable for public water supply.

The sites for investment have been identified by the internal company CRAGS assessment process where the site is examined for risk factors that may affect public water supplies.

Best option for customers

The following table outlines the options consider throughout our optioneering process in order to address the risk of below ground headworks flooding:

Table 14 Risk Prevention Options

Options	Pros	Cons	Taken forward (yes/no)
Removal of the bore from supply and backfilling	The risk would be removed	This would result in a deficit in the water supply and would result in loss of supply to customers.	Only for Southfields number 2 as this bore is no longer needed and has been replaced.
Connection of the site output to some other network source of water	The risk would be removed	This would result in a deficit in the water supply and would result in loss of supply to customers. This would be prohibitively expensive even if there was the resource available to undertake this support work.	No
Drill a new borehole	The risk would be removed	This is a very expensive option	Yes
Raise the headworks to above ground, place a kiosk over it and backfill the chamber	Risk is removed. It is cost effective as it retains the use of existing assets. It does not require large amounts on main laying to connect new boreholes. It has minimal impact on the ecology of the area.	Scheduling of the work needs to be done around the need to keep customers on water.	Yes

Following this stage of the optioneering process, we conducted a cost-benefit analysis of the options taken forward:

Table 15 Cost Benefit Analysis

	Capex (£) (Summation across the whole program)	RICS (£) (Summation across the whole program)	WLC (£) (Summation across the whole program)	EAB (£) (Summation across the whole program)	EAC (£) (Summation across the whole program)	EAV (£) (Summation across the whole program)	Mitigated Risk (£) (Summation across the whole program)	Risk Index (value) (Summation across the whole program)
Raising Headworks	2.37	0.05	3.74	18.16	0.20	17.97	588.82	8.52
Borehole Replacement	18.01	0.15	21.89	17.54	1.15	16.40	0.85	44.24

3

For the majority of the program the most efficient and effective solution is to raise the headworks.

The exceptions to this are Swaton and Southfields. Swaton is currently sited within the carriageway of a major road and as such it would be difficult to execute a headworks raising project safely. For this site the selected option is to drill a replacement bore. In the case of Southfields the borehole that is the risk point is no longer required but still has to be backfilled so that the pathway to the surface is removed. This is the selected option for this site. We provide a full cost breakdown for these investments in ANH_DD_022 Enhancement cost breakdowns.

Climate change - algae

Need for investment

Climate change has a profound effect on algal species within surface water reservoirs. As the temperatures increase Blue Green Algae (Cyanobacteria) become more prevalent. These organisms are more mobile through the water column and are harmful to animals, humans and the ecosystem when large scale blooms occur. They are faster growing than other algal species and proliferate during high temperature periods. These species are also able to increase the ambient temperature of water bodies by transforming sunlight in to heat.

Algal blooms also have a large effect on water treatment processes. Algal blooms can overwhelm the clarification processes as the density of the raw water contaminants is changed and blinding of filters means that flows through treatment plants are reduced both by filtration rates and by increased demand for filter washing. From a water quality perspective, the breakdown of algal cells through treatment liberates algal toxins and these are deleterious to health. Algal breakdown also results in taste and odour issues in the final water and can have a profound effect on customer acceptability of the water.

Best option for customers

The control methods for algae are understood but their application within Anglian Water requires further study. This climate change category comes below the £12m cut off point from the Ofwat resilience uplift allowance so it proposed that further work and monitoring is undertaken during AMP8 to present a control strategy for the PR29 submission.

The sites that are selected for further study are Alton, Ardleigh, Pitsford and Grafham reservoirs. While the assessment of these investments appear to be highly beneficial there are knowledge gaps that require filling before a more accurate assessment can be made.

Alton is highly susceptible to algal growth and as such is one of the few remaining surface reservoirs where ferric sulphate removal of phosphate compounds is still permitted to occur. This process was put on hold briefly to assess the need to continue and within a period of approximately 2 years the algal population of the reservoir resulted in treatment issues at the works. Phosphorous removal has now been re-started and it will take several years to fully understand any residual need for treatment. Ardleigh Reservoir will be receiving water from an effluent re-use scheme within the next two AMPs. It will be necessary to understand the implications of this before any algal management strategies can be developed. The learning from these two sites will then be taken forward to solutions for Grafham and Pitsford.

3 N.B. It should be noted that the figures given in the above table for the cost and benefits of the Climate change - flooding program do not replicate the numbers in table 13 because two of the sites put forward for flood mitigation are not appropriate for headworks alterations.

Climate Vulnerability - networks

Need for investment

To fully understand the impacts of climate change and therefore be able to plan to mitigate them, companies need to be able to monitor and model their networks. By undertaking this work a greater understanding of the impacts and mechanisms of climate change can be more fully understood. This allows companies to put in place appropriate investment to protect the supply and service to customers

Best option for customers

Our Water Infrastructure Serviceability Performance Assessment (WISPA) tool, integrates various data streams to analyse the impact of climate change on subterranean water assets. WISPA highlights areas susceptible to climate-related failures and supports the prioritisation of climate vulnerable mains for renewal and ensures value for customers. It supports the prioritization of climate vulnerable mains for renewal and ensures value for customers. The basic core version of WISPA has been chosen, with additional developments potentially funded through other avenues.

The scheme 'CV -Incr Pressure Monitoring' supports the wider climate vulnerable mains investment, and specifically the CV Modelling Vulnerable Mains investment. To allow us to maximise the potential of our WISPA climate modelling tool, it is important that we bring in high quality data for that tool to best allow the WISPA model to detail the potential areas of risk, failure and prioritisation. Additional sensors would provide a specific benefit to the WISPA models. Over the past AMP, we have been installing a large amount of high frequency pressure monitoring devices across our DMAs as part of our Enhanced Pressure Monitoring Programme. This involved the investment from base capital maintenance of between 5 to 7 high speed, one second read, pressure sensors per DMA. These sensors have primarily been installed to provide high quality data for low pressure and interruption to supply purposes.

Our investigations have shown that the locations which benefit low pressure and interruption to supply are very different to pressure locations required to help provide data to improve our WISPA climate model. Therefore we are proposing an investment of an additional 1033 devices which will install additional pressure monitors across 50% of our total DMAs. We know that currently 71% of our DMAs have distribution mains within them which is deemed to be climate vulnerable, with 54% of DMAs having in excess of 1km of CVM. These additional devices would be installed where we currently have gaps within our data sets, providing insight into the health of our assets as well as network performance and conditions, which are key for helping to understand and prevent asset failure.

Pressure is one of the key drivers required to support the quality of data into the WISPA model. Therefore, for this investment, the installation of additional pressure monitors is the only available option. Using existing technologies and integrating them with our wider Enhanced Pressure Monitoring solutions is the most efficient option and drives the most benefit for our customers. We considered different scales of pressure monitoring installations, and this analysis is summarised below.

We provide cost benefit analysis of the available options below. The investments for CV - Incr Pressure Monitoring & CV - Modelling Vulnerable Mains do not have specific benefits attributed to them. These are supporting investments for the wider mains replacement programme thus the benefit is provided through that investment.

CV - Incr Pressure Monitoring

Table 16 Cost Benefit Analysis

Type	Selected Alternative	Capex (£)	WLC (£)	EAB (£)	EAC (£)	EAV (£)	Mitigated Risk (£)	Risk Index (value)
Enhanced Pressure Monitoring for climate vulnerability - 50% of DMAs	Yes	3.61	10.77	-0.003	0.56	-0.57	-0.003	-0.003
Enhanced Pressure Monitoring for climate vulnerability - 70% of DMAs	No	5.06	15.08	-0.005	0.79	-0.795	-0.005	-2,867.95
Enhanced Pressure Monitoring for climate vulnerability - 30% of DMAs	No	2.17	6.47	-0.002	0.34	-0.34	-0.003	-2,444.07

CV - Modelling Vulnerable Mains

Table 17 Preferred Option

Type	Selected Alternative	Capex (£)	WLC (£)	EAB (£)	EAC (£)	EAV (£)	Mitigated Risk (£)	Risk Index (value)
Ongoing development of the WISPA Climactic Mains Tool - Base	Yes	2.02	1.79	0	2.28	-0.09	0	-
Ongoing development of the WISPA Climactic Mains Tool - Gold	No	2.58	2.28	0	0.1	-0.12	0	-

These investments support our ambition of replacing 75% of our climate vulnerable mains by 2060, and provide the foundation to do this in a logical and prioritised order, providing maximum benefit to customers.

For CV - Incr Pressure Monitoring, the preferred option was based on a balance between effectiveness and cost with 50% of DMA coverage selected. In the case of CV - Modelling Vulnerable Mains, the least cost viable option was selected. We provide a full cost breakdown in ANH_DD_022 Enhancement cost breakdowns.

Climate change - networks (Warren Hill WR2- Longhill BH Reg26)

Need for investment

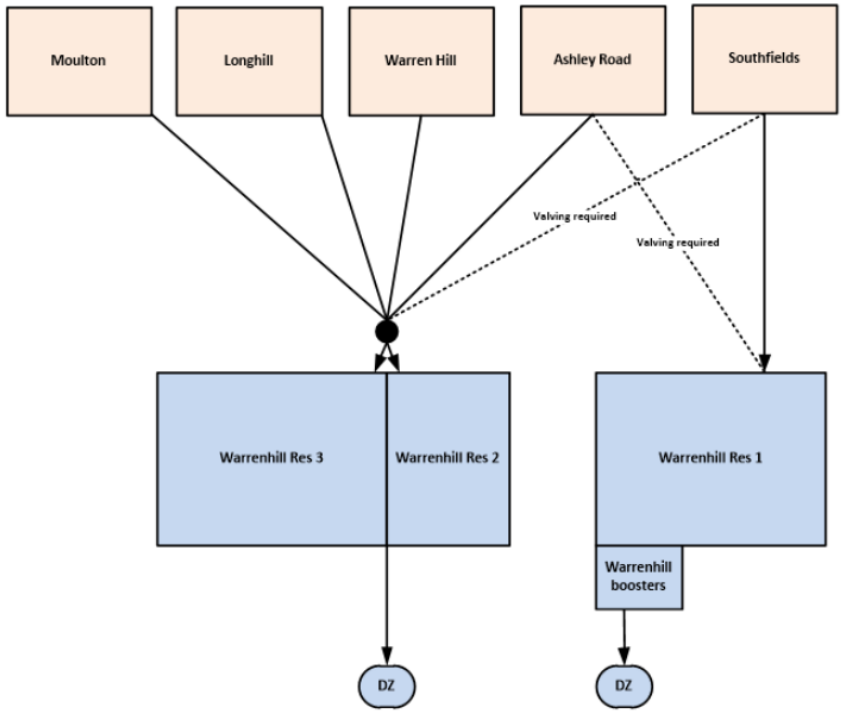
Currently all the Newmarket sources are classified as Tier 1 drought vulnerable. Tier 1 sources are those where drought yield is significantly below the abstraction licence and there is some risk to supply during drought.

Table 18 Newmarket Borehole Drought Vulnerability Assessment

Site	Geology	Drought Vulnerability Classification	Comments
Newmarket Ashley Rd	East Anglia Chalk	1	Severe drought risk to yield and supply impacts identified.
Long Hill	East Anglia Chalk	1	Severe drought risk to yield and supply impacts identified.
Moulton	East Anglia Chalk	1	Severe drought risk to yield and supply impacts identified.
Southfields	East Anglia Chalk	1	Severe drought risk to yield and supply impacts identified.

This presents a risk because of the high effect that drought has on the areas boreholes. As the borehole levels drop and they become more susceptible to turbidity incidents. Currently the contact times for some of the sites that feed the major storage point in the area is met in the mains on route to the reservoir.

Figure 6 Warren Hill Schematic



Plans are in place to ensure the contact time for Southfields is met on site and the disinfection arrangements for Moulton means that disinfection is achieved on site at Moulton. The site most affected by drought is Long Hill. The contact time for Long Hill is met through the contact main and storage time in Warren Hill Reservoir. This means that the supply for the whole of the area is tied in to the storage held within the reservoir and this reduces operational flexibility.

The result of this operation is that during periods of drought there are frequent turbidity incidents on site at Long Hill which while it does not compromise the . To remediate these and protect the water supply the contact main from Long Hill to Warren Hill must be drained and flushed. This results in high losses from the site at precisely the time when minimising losses is at its most important. In order to mitigate this and maintain compliance with Regulation 26 it is proposed to install complete disinfection on site. This will ensure that compliance with Regulation 26 is maintained, the site is able to operate independently of the reservoir and water losses in drought can be minimised.

This investment will reduce the risk of high water losses, loss of supply and a complex supply system that prevents operational flexibility.

Best option for customers

The following tables set out the options we considered to meet the required need, and the associated cost-benefit analysis conducted to inform this selection:

Table 19 Recommended solutions

Number	Recommended option	Alternative Name
1	No	Contact tank at Long Hill BH.
2	No	Increase mains length from Long Hill to Warren Hill WR to achieve CT.
3	No	UV plant at Long Hill BH.

Table 20 Cost benefit analysis

Alternative name	Capex (£m)	WLC (£m)	EAB (£m)	EAC (£m)	EAV (£m)	Mitigated risk (£m)	Risk Index (value)
Contact tank at Long Hill BH.	2.78	3.47	1.02	0.18	0.83	1.40	2.49
Increase mains length from Long Hill to Warren Hill WR to achieve CT	2.55	2.74	-319.13	0.14	-319.27	-404.43	-0.01
UV plant at Long Hill BH	2.28	3.86	1.02	0.20	0.81	1.38	2.79

4

The selected alternative is the construction of a UV disinfection stage. Although this is the second best option as defined above it does take in to account the particular restrictions around the site at Long Hill. This site sits right outside a particularly prestigious residence whose living rooms picture windows overlook the site to a view down the Newmarket Gallops. Any intrusive development like the construction of a contact tank is likely to be refused planning permission and high levels of objection from the Jockey club. It will be particularly advantageous in terms of construction time and real cost to construct to be able to construct the solution off site and have a very short installation time.

Climate change - water resources

Need for investment

As a response to a drier climate in what is already the direst region in the UK, the Environment Agency has responded by applying Sustainability Reductions on a number of water sources to protect the environment. Within WRMP19/PR19 and again in WRMP24/PR24 we have responded to invest in moving water from where we have more abstraction available in Lincolnshire to the south east of our region which is drier and has been subject to most of the Sustainability Reductions reducing our ability to abstract locally.

This asset system feeds the industry on the Humber Bank which is seeing considerable interest in climate responsive industry such as hydrogen gas generation, disruption to these assets would see disruption to the critical industries located there.

This has made the existing assets which feed the interconnector pipelines bring water south east much more critical than when they were first constructed. Loss of the chain of assets from the abstraction through to treatment and delivery into the interconnector pipelines would now cause a much wider disruption as they are essential for supplies across much more of our region.

Disruption to the flow to the Humber Bank industry would see disruption to the industries based there which would be of national significance.

Disruption supply to the interconnector pipelines would likely lead to compromised abstraction compliance in other systems and in the worst case interruptions to supply elsewhere in the network.

Best option for customers

The water mains and site were identified as they are the key abstraction raw water transfer main and treatment works were selected they are the key chain of assets to provide water to the interconnector pipelines for onward delivery through to the south east of the region.

As shown below a number of options were considered for the each of the investments, as presented in the cost benefit analysis summaries below:

Table 21 Elsham WTW Cadney Intake Resilience

Type	Selected alternative	Capex (£m)	WLC (£m)	EAB (£m)	EAC (£m)	EAV (£m)	Mitigated Risk (£m)	Risk index
PR24 Cadney Intake Replacement	Yes	0.57	0.66	0.31	0.034	31.4	38.63	0.02
WNI7 Cadney Intake Refurbishment	No	0.60	0.71	24.7	0.037	24.71	30.35	0.02

Table 22 Cadney to Elsham Raw Water Main Resilience

Type	Selected alternative	Capex (£m)	WLC (£m)	EAB (£m)	EAC (£m)	EAV (£m)	Mitigated Risk (£m)	Risk index
Like for Like Replacement	No	32.408	28.29	23.48	1.48	22.0	30,14	0.94

4 Definitions 1) Whole Life Cost - WLC (discounted) = CAPEX +CAPEX repeat +OPEX +OPEX repeat at 30 years then discounted 2) EAB - Equivalent Annualised Benefit. = The benefit in £ that is expected each year following completion of the scheme. 3) EAV - Equivalent Annualised Value 4) EAC - Equivalent annual cost (EAC) is the annual cost of owning, operating, and maintaining an asset over a defined period of time, in this case 30 years as per the requirements from OFWAT 5) Risk Index = Whole Life Cost /(Baseline Risk Value - Residual Risk Value)

Type	Selected alternative	Capex (£m)	WLC (£m)	EAB (£m)	EAC (£m)	EAV (£m)	Mitigated Risk (£m)	Risk index
New Raw Water Main Cadney to Elsham	No	33.763	30.06	26.25	1.57	24.6	32,55	0.92
New Raw Water Storage Reservoir	No	18.11	18.03	-20.33	0.944	-21.2	-26,21	-0.69
Condition Assessment of the Cadney to Elsham Main	No	517.45	1.41	-2.82	0.074	-76.9	0.0048	29.09
New Raw Water Main - Design Cost 15%	No	6.86	5.99	0	0.314	-314.10	55.02	108.97
New Raw Water Main - High Risk Crossings	Yes	0.796	0.69	25.24	0.036	25.20	32.67	0.02

In each of the above investments the best CBA alternative was selected, indicated by the highest value EAV.

9 Odour and resilience (water recycling)

9.1 Investment summary

	March 24 Business Plan (£)	DD Ofwat position (£m)	Representation (£m)
Capex	13.4		16.9
Opex	1.4		0.0
Totex	14.9	16.9	16.9

In our updated data tables, these costs are reported against lines:

- CW3.165-CW3.167 (Odour and other nuisance) and associated CWW12 and CWW17 lines
- CW3.168-CW3.170 (Resilience) and associated CWW12 and CWW17 lines

9.2 Context

This investment strategy is comprised of two components:

1. Investment targeted at addressing customer dissatisfaction with odours arising from our operations at Water Recycling Centres
2. Investment to improve the resilience of our water recycling assets emerging challenges.

9.3 Ofwat's DD assessment

9.3.1 Resilience

Pluvial and fluvial flood resilience

Ofwat state for Draft Determination, they make no specific enhancement allowance for flood resilience. Alternatively Ofwat propose a sector wide enhancement uplift (based on 0.7% base allowances) for companies to prioritise their biggest climate related risks.

Additionally, Ofwat sets out views within its deep dive assessment that would apply if the sector wide enhancement uplift had not been proposed. Ofwat raise some concerns relating to optioneering, stating further evidence is required on whether a sufficient number of alternative options have been considered and a cost benefit analysis for this investment.

On cost efficiency, Ofwat state further detail would be required on the bottom up cost build up as well as on external assurance.

Climate vulnerability condition and criticality investigation

Ofwat state further research into asset criticality should be undertaken within base expenditure allowances, as it is in the company's general duty to understand and manage risks to ensure continuity of service to customers. As a result, costs for this investment are rejected in full.

Reservoir Act

Ofwat state that we do not provide sufficient evidence to demonstrate this investment needs enhancement allowance, as it is the company's statutory obligation to maintain its assets and remain compliant to legal requirements. Costs for this investment are rejected in full.

9.3.2 Odour

This assessment was conducted via a deep dive. Ofwat states that the evidence provided indicates that investment to maintain the complaints levels relating to odour should be managed through routine expenditure funded from base allowances.

9.4 Our Representations

In our Draft Determination representations, we have have responded to Ofwat's proposal to demonstrate where we would spend the resilience allowance. The evidence for these schemes is set out below.

9.4.1 Resilience uplift schemes

As part of the Draft Determination, Ofwat set out the expectation for companies to set what schemes they will deliver for the additional resilience uplift funding (of 0.7% modelled base allowances across water and water recycling services) in their representations. We provide our supporting evidence to meet this expectation below.

Our proposed schemes can be categorised into two broad themes:

1. Pluvial and fluvial flooding;
2. Groundwater management.

We provide further detail on the need for investment below, outlining further our approach to optioneering and developing costs in order to support the investment.

Below we provide our list of selected wastewater resilience schemes for investment through the uplift relating to both pluvial and fluvial flood resilience, which amount to a requested totex of £16.9m. In addition, we provide a list of further sites where we have identified investment for improving resilience to external threats would be beneficial.

Table 23 Proposed investments

Area	Investment no.	Investment name	Description	Cost	Baseline risk (£k)	Whole life cost	EAB (Equivalent Annualised Benefit)	Risk index	EAV (Equivalent Annualised Value)
Pluvial and fluvial flooding									
Various locations	I038882	WRNI Pluvial, Fluvial and Coastal protection	"Installation of a number of flood protection options which include a range of; earth embankment, flood wall, demountable defences, strategic schemes, building level resilience. 22 modelled assets at risk taken from the Asset Flood Risk database from Business Resilience team (see attachments). Costs based on 13 WRCs at circa 150k ea and 9 pumping stations at circa 50k ea."	3,411,647	442.65	3,211,307	299,401	8.46	131,178
Anwick	I044082	Anwick WRC Flood Prevention	"The river that runs along the back of Anwick WRC has burst it's banks multiple times with the most recent event flooding the entire site and entering the Moy Park inlet well, causing compliance fails, a CAT2 pollution and much damage to equipment. Encapsulate the site fully with full flood defence system and final effluent pumping station to allow flows from site to discharge when river is high level. We have a flood wall then final effluent flows won't be able to gravity out as the river water would just back in- so it needs pumping out, we need path to the new FE pumping station and telemetry . "	1,806,465	310.335	2,818,735	251,438	9.58	103,780
Norton	I044083	AMP 8 Norton Flood Prevention	"The river that runs along the back of Norton WRC over tops its banks in periods of wet weather; flooding the entire site. Flood defence system and final effluent pumping station to allow flows from site to discharge when river is high level".	1,207,373	310.335	2,060,276	104,116	16.91	-3,810
Offord	I044006	Offord Cluny Station Rd CSO Storage	"During extreme weather events the CSO from the pumping station at Station Lane cannot discharge due to the watercourse levels being so high. The watercourse discharges to the Great River Ouse. As the CSO cannot operate flows surcharge the network and cause flooding and pollution.	618,596	127.764	704,719	76,672	7.85	39,755

Area	Investment no.	Investment name	Description	Cost	Baseline risk (£k)	Whole life cost	EAB (Equivalent Annualised Benefit)	Risk index	EAV (Equivalent Annualised Value)
			This alternative will provide 100m3 offline storage for flows when the CSO cannot freely discharge. This alternative will also reduce the number of spills from this CSO. This solution will need to be modelled prior to delivery to confirm storage volume required. This is based on 100m3 being returned at a certain flow over 9 hrs. Alternative cloned from an AMP8 CSO EnvActImp4 offline storage solution of similar size with volume adjusted".						
Total				**7,044,081**					
Groundwater Management									
Burnham Market (north norfolk)	I043994	Burnham Market River Inundation Prevention	"The Goose Beck which runs through the middle of Burnham Market has burst its banks and flooded much of the town. River water enters the foul network via unsealed manholes causing pollutions/flooding. There are a number of manholes close to the watercourse that are submerged when it bursts it's banks- 10 of these will need to be sealed. The ones closest to the watercourse will be worse affected".	54,795	43.671	50,172	32,083	1.34	29,455
St Ives	I043996	St Ives Somersham Rd River Inundation Prevention	"The Somersham Rd area suffers from river flooding causing river water to enter and overwhelm the foul network, causing flooding and pollutions. With River level s getting higher due to climate change this will only become a more frequent occurrence. Seal manhole lids to prevent river water entering the foul network when the river overtops. Modelled plan of mh's affected in attachments 62 mh lids to fit sealed covers to prevent flows entering them."	339,728	127.912	311,066	101,451	2.62	85,156
Grimston (North Norfolk)	I043571	Grimston Lateral Sealing from groundwater	"High flows in the sewer network in Grimston have led to multiple pollutions from the MH upstream of the pumping station on watery lane. When the groundwater gets very high flows enter from private customer laterals. This will become more frequent with climate change. CCTV foul sewer laterals of 156 properties (156 properties feed Watery Lane TPS) CCTV'd at an average of 20m each. Assume 50% of these would need lining."	390,434	427.186	357,495	339,342	0.90	320,614

Area	Investment no.	Investment name	Description	Cost	Baseline risk (£k)	Whole life cost	EAB (Equivalent Annualised Benefit)	Risk index	EAV (Equivalent Annualised Value)
Roydon (part of Grimston catchment)	I044000	Roydon Lateral Sealing from groundwater	"Roydon in North Norfolk area and Grimston catchment suffers from very high groundwater which enters the private customer foul laterals and causes flooding and pollution. With climate change episodes of excess sewer flow will become more frequent. CCTV 793 property foul sewer laterals (793 props feed Pott RowTPS) at an average of 20m each =gives 15860m of CCTV, Presume 50% of the sewer laterals would need lining. "	1,959,284	118.301	1,793,986	51	29.96	-42,814
Grimston	I043665	Gimston Improve land drainage	"Around the catchment of Grimston the local drainages ditches do not flow freely causing extremely high groundwater levels in the area and infiltrating into the sewer network causing pollutions and flooding. Clearance of the drainage ditches surrounding the village, a total of 8.3km- thereby reducing the effect of the additional water on the groundwater levels and reducing levels of infiltration to the sewer network. Costs to clear are high level estimates and lay land drains in Roydon and Grimston. Cost estimated at 3.5k per hectare based on the Agriculture and Horticulture Development Board info attached- 5 hectares in Roydon around playing fields require drainage, draining back to IDB ditches. "	35,000	480.579	32,355	126,011	0.16	124,316
Roydon (part of Grimston catchment)	I043663	Roydon Reinstate village pond	"Roydon village is part of the Grimston catchment which has suffered from multiple pollutions during extreme high groundwater levels and much negative PR. The area where the village pond used to be is boggy with a soakaway which is currently blocked and therefore surface water does not drain away increasing the water table in the area. Digging of new pond and weir chamber 50m of 150mm pipework that will drain to ditch. (owned by the owner of the flooded property, initial solution discussed) "	86,762	92.972	79,672	154,060	0.44	149,886
Tempsford	I044005	AMP8 Tempsford SWM	"Tempsford suffers for river ingress into the foul network causing flooding and pollution. This is exacerbated by rainfall entering the network via property surface connections. This will become more frequent as a result of climate change.	1,753,501	349.826	1,605,565	270,221	5.60	186,115

Area	Investment no.	Investment name	Description	Cost	Baseline risk (£k)	Whole life cost	EAB (Equivalent Annualised Benefit)	Risk index	EAV (Equivalent Annualised Value)
			Disconnection of SW from 100no. properties, new SW laterals, and new SW sewer to get flows to Suds solutions. This solution has not been modelled but will need modelling AMP8. A contributing area survey is planned yr5 of AMP7 to identify properties with surface water connections into the foul sewer. Diverting individual property surface water, away from the foul sewer to soakaways has not been considered for this alternative as this would only contribute to the high water table in the area."						
Sutton Staithe	I044106	AMP8 Sutton Staithe	"Sutton Staithe is on the Norfolk Broads ; it suffers with year round high water table which is exacerbated during periods of wet weather. The network is overloaded resulting in customer complaints. This issue is expected to worsen due to climate change. This alternative will provide offline storage to allow the CSO to discharge when the CSO cannot freely discharge. This alternative will also reduce the number of spills from this CSO. This solution will need to be modelled prior to delivery. "	607,077	127.764	692,329	76,672	7.72	40,404
Potter Heigham	I044066	AMP8 Potter Heigham SWM	"Potter Heigham suffers for river ingress into the foul network causing flooding and pollution. This is exacerbated by rainfall entering the network via property surface connections. This will become more frequent as a result of climate change. Disconnection of SW from 75no. properties, new SW laterals, and new SW sewer to get flows to Suds solutions This solution will need to be modelled before any work is carried out. This is based on 100m3 being returned at a certain flow over 9 hrs."	2,013,979	162.237	1,844,067	134,129	14.46	37,528
Horning	I044069	AMP8 Horning SWM	"Horning suffers from excessive flows and a high water table - it is on the Norfolk broads. The current sewerage network is suspected of sinking causing breaks in the lateral seals. Seal 100 manholes, cctv laterals to check for open joints (the networks is sinking and causing the joints to open) and reseal where required	1,598,885	423.667	1,463,993	281,608	4.88	204,917

Area	Investment no.	Investment name	Description	Cost	Baseline risk (£k)	Whole life cost	EAB (Equivalent Annualised Benefit)	Risk index	EAV (Equivalent Annualised Value)
			CCTV of laterals is 20m per property x 250 property"						
Outfalls	I044108	AMP8 Tidal Outfall Protection	"This investment is design to prevent the flood risk detriment caused by tide locked outfalls as a result of the impact of Climate Change onto our system Preliminary investigations within InfoNet predict an increase in risk of tidal interaction in a future scenario from a fully drowned outfall to flooding properties. The install of flap valves on outfalls reduce system surcharge levels to below property levels during a 30yr+CC design event and future MHWS. Allowed one flap valve per outfall pipe and that list are all the outfall pipes"	85,360	815.427	138,398	440,730	0.27	433,480
North Pickenham	I044093	AMP 8 North Pickenham SWM	"The sewer that serves Meadow Lane runs alongside the Wissey gets inundated during periods of wet weather and causes flooding to the customers. Sewer that runs alongside the River Wissey gets inundated during periods of wet weather and causes flooding to the properties on Meadow Lane. This is based on 100m3 being returned at a certain flow over 9 hrs. This alternative will provide offline storage to allow the CSO to discharge when the CSO cannot freely discharge. This alternative will also reduce the number of spills from this CSO. This solution will need to be modelled prior to delivery. "	524,197	155.992	577,159	79,727	6.19	49,493
Total (Groundwater)				9,449,002					
Total Climate Uplift				16,493,083					
Backup Proposals									
Hoveton	I044090	AMP 8 Hoveton SWM DD Resilience	"Hoveton suffers with the level of surface water within the foul network. Solution to disconnect the SW connection to stop the network overloading. Disconnect 100 properties with SW connections to foul and divert to 4x suds options around village (wetlands and ponds). Seal 25 manholes	1,901,456	22.621	1,741,037	14,719	-142.96	-76,485

Area	Investment no.	Investment name	Description	Cost	Baseline risk (£k)	Whole life cost	EAB (Equivalent Annualised Benefit)	Risk index	EAV (Equivalent Annualised Value)
			Disconnection of SW from 100no. properties and a new SW sewer to get flows to Suds solutions. Seal 25 manholes"						
Hickling	I044003	AMP8 Hicking SWM	"Hickling is situated on the Norfolk Broads and suffers from high groundwater which makes its way into the sewer network. Rainfall from surface connections exacerbates the issues and this will only become more frequent with climate change. Disconnection of SW from 100no. properties, new SW laterals, and new SW sewer to get flows to Suds solutions. This solution has not been modelled but will need modelling AMP8. A contributing area survey is planned yr5 of AMP7 to identify properties with surface water connections into the foul sewer. An assumption of 20% properties in the village (of c500 connected properties) are likely to have surface connections based on surveys completed in Grimston/Peldon."	1,753,501	125.183	1,605,565	97,179	20.61	13,073
Total				3,654,957					

Resilience uplift - groundwater schemes

Background

Climate change increases the frequency and severity of heavy rainfall events. With two significant wet weather events and unprecedented groundwater levels in the space of 3 years, and with warmer wetter winters predicted, a new, more holistic catchment based approach is essential to make communities more climate resilient.

When heavy rainfall impacted Norfolk during the winter of 2020/21, and then again during the winter of 2023/24, groundwater levels rose to record highs across a number of catchments, driven by the underlying ground conditions, which principally consist of chalk. In response to the flooding in 2020/21 the Norfolk Strategic Flooding Alliance (NSFA) was established, originally led by Lord Richard Dannatt and now by Henry Cator. The NSFA is a partnership of flood risk management authorities, including Norfolk County Council, District Councils, the Environment Agency, internal drainage boards, Anglian Water and many others. Similar situations have occurred in other areas of our region where chalk and limestone are close to the surface, such as in Lincolnshire and North East Lincolnshire, and across the Cambridgeshire Fens and Great Ouse catchment where saturated ground has a similar impact.

The impact of high groundwater

Across these areas a number of communities are very susceptible to high groundwater levels, particularly in North West Norfolk, the Broads, north Cambridgeshire, parts of Bedfordshire, west Lincolnshire and in/around Grimsby. Over the winters of 2020/21 and 2023/24 these communities suffered from extensive loss of service (unable to flush toilets, shower, wash up etc) as groundwater levels rose above the level of the sewer (but often not high enough to cause an actual flood), inundating the public and private sewer networks in these communities.

Unfortunately there is a lack of legislation that governs this type of scenario (where high groundwater levels impact sewerage assets, but do not cause an 'above ground' flood), and so we have held multiple workshops and discussions with NSFA partner organisations, in particular the Environment Agency, about managing groundwater differently in the future.

Traditional approach to high groundwater

Traditionally a water company's response to high groundwater levels would be to provide tankers to remove excess groundwater, mixed with wastewater, to be treated at a water recycling centre. Historically we have also used overpump

solutions, temporarily creating new storm overflows, to relieve the pressure on the sewer network. We have also spent significant totex on relining public sewer networks, but this approach has very little benefit, as groundwater only finds the next weakest point in the network, which may often be a private lateral. As such, a new approach is needed to ensure communities are resilient to a changing climate. Given the impact of high groundwater levels on a number of water companies, notably Wessex Water, Thames Water, Southern Water and Yorkshire Water, we believe that delivering such a new, catchment area based approach will also be nationally significant.

Catchment based approach

We therefore propose through the resilience uplift to explore and deliver a range of alternative catchment based groundwater management techniques which could include, but not be limited to the following.

Table 24 Catchment Based Management

Proposed catchment based approach	Details and benefits of such an approach	Risk, challenges and opportunities of such an approach
Build on existing pumping capacity	Where appropriate, existing boreholes (both water company and private boreholes) can be used, with the appropriate agreement, to local lower groundwater levels across catchments.	Over abstraction of groundwater goes against the current approach of cutting back on abstraction. This option therefore needs further regulatory discussions, which are currently ongoing. A receptor for the excess groundwater is also required.
Create new or reinstate old boreholes	We have identified a number of boreholes across affected catchments that can be reinstated. In many cases, new boreholes will be drilled at strategic locations across the catchment, undertaken in collaborating with the Environment Agency, to lower groundwater levels either locally or over a wider catchment.	Whilst creating a 'well field' is a proven catchment based approach to managing groundwater levels, often used in the energy industry, over abstraction of groundwater goes against the current approach of cutting back on abstraction. This option therefore needs further regulatory discussions, which are currently ongoing. A receptor for the excess groundwater is also required.
Developing adaptive abstraction regimes	Working with the Environment Agency, we have started discussions about creating more adaptive abstraction regimes, over abstracting in times of high groundwater, and abstracting less in times of drought.	Defra implemented a Regulatory Position Statement this winter which allowed for over abstraction. Whilst we welcomed this approach, it did not go far enough. Further work is needed to develop this approach, which will need trials across the country in catchments vulnerable to high groundwater levels.
Undertake improved maintenance on main rivers and ordinary watercourses	Once additional groundwater has been abstracted, it needs to go somewhere. One option is to discharge this water into existing main rivers and/or ordinary watercourses. However, in order for these watercourses to be effective at keeping groundwater levels low, they will need to have high conveyance rates. As such, additional maintenance will be required over and above existing maintenance regimes undertaken by the Environment Agency, internal drainage boards and riparian owners.	Opportunity to undertake this work in partnership with other risk management authorities.

Proposed catchment based approach	Details and benefits of such an approach	Risk, challenges and opportunities of such an approach
Reinstating ponds and ditches	In a number of communities historic drainage features such as ponds and ditches have been filled in, reinstating these features will help to manage water at a catchment scale, helping to keep this water out of the sewer network.	Whilst a simple solution, land owner approval will be required.
Developing appropriate water storage on land	Once additional groundwater has been abstracted, it needs to go somewhere. One option is to create small scale water storage reservoirs, often know as local resource options (LROs). These assets are often used by farmers for irrigation, but they could also be used to support more strategic water resource options.	Planning requirements often make delivering LROs difficult, so we have started engagement with local planning authorities to ensure this process is as smooth as possible.
Collaborate with Project Groundwater	Defra are currently funding three groundwater innovation projects, known as Project Groundwater. These projects run until 2027, and one of these is in Lincolnshire. This provides an opportunity to work in partnership with others to co-fund solutions and share knowledge across catchments.	Opportunity to deliver improved groundwater management through partnership funding, and collaborating with national partners to learn and innovate.

Resilience uplift - Pluvial and fluvial flood risk

Ofwat requested further evidence on whether a sufficient number of alternatives had been considered for this investment.

We considered a range of alternatives for this investment. We have experience of delivering flood risk management and mitigation measures, having protected both water and water recycling assets since AMP5. As such, we have a well-developed knowledge and understanding of the most suitable options available to protect assets on a permanent or temporary basis. Every operational site and its associated flood risk is different and therefore a range of options must be considered. We provided further information on this in our PR24 Asset System Resilience Appraisal (ANH38).

After undertaking modelling work to assess whether both water and water recycling sites are at risk of flooding, we determine whether a loss of service may occur and whether this will have an impact on customers or the environment. If so, then the following options are considered:

1. Do Nothing: Some sites may flood, but assets may already be resilient (for example electrical panels are already high enough to avoid flooding), so we would do nothing in AMP8. We will however keep sites under review and apply the latest modelling approaches to assess the impact of climate change in future AMPs.
2. Permanent flood protection measures: Where sites are vulnerable to a loss of service due to flooding, our first consideration is to see if a permanent flood protection measure can be installed. This could include, but not be limited to:
   a) creating earth embankments that tie in with natural high ground;
   b) building flood walls with appropriate flood gates for access;
   c) installing flood doors on buildings;
   d) installing air brick/vent covers to prevent the ingress of flood water;
   e) waterproofing the fabric of buildings and/or kiosks that are vulnerable;
   f) raising electrical panels above the maximum flood height.
3. Temporary demountable barriers: In some cases it is not always possible to deliver permanent flood defences. In these cases we will consider whether temporary demountable barriers can be used instead. We already own c. 300m of demountable defences which we currently deploy to sites that do not have permanent measures.
4. Partnership working: In some situations it may be possible to undertake schemes in partnership with other risk management authorities. We have extensive experience of working in partnership with others to reduce the risk of flooding to our assets, as described below. In all cases, this has led to schemes that are good value for customers as we can deliver more for less by working with others.
5. Flood Emergency Response Plans: Flood Emergency Response Plans (FERPs) are developed to ensure operatives understand how to react to flood alerts, and how to deploy the defences on their sites. Any site that has permanent flood defences, and those identified for temporary demountable barriers will have a FERP. In addition, there are sites where flood depths are so deep that a permanent or temporary solution is not advisable. In these situations a FERP will help assets to be safely isolated in the event of a flood.

We confirm that these alternatives were considered for each site, before finalising the proposed investment.

Ofwat requested further detail on the deliverables of partnership working.

When working in partnership with other risk management authorities a range of deliverable are often available, depending on the source of flooding. In most cases our previous work in this area has been with the Environment Agency or coastal risk management partners that are working to raise, reinforce, repair, refurbish, re-build or replace existing river and coastal flood defences. We have also worked with partners in the past to undertake beach recharge and recycling programmes or divert surface water runoff that is impacting our assets.

In each case where we have worked in partnership previously, our asset must be identified at risk of flooding, and it must be cost beneficial to work in partnership rather than in isolation. By working in partnership we can also often deliver standards of protection to our assets that are far greater than we can deliver by ourselves, often in the range up to 1:1000 for coastal flood schemes.

For example, the Wash East Coastal Management Strategy has created a sustainable long-term approach for managing coastal flood and erosion risk from Hunstanton to Wolferton Creek. Heacham Water Recycling Centre and an associated pumping station are at risk of coastal erosion and coastal flood risk. In partnership with the Environment Agency, the Borough Council of Kings Lynn and West Norfolk and the East Wash Coastal Management Community Interest Company we have been able to maintain the protection of these assets which are situated in flood zone 3 but benefits from a shingle ridge defence.

Hazard mapping shows that in the event of a breach or overtopping of the defence, the site would flood to a depth of over 2m. This is far greater than we would be able to protect against in isolation by delivering permanent or temporary defences on site, so this again shows the benefit of working with others to ensure the continued protection of our assets.

Therefore, this information outlines that we considered a range of alternatives for this investment.

Ofwat requested the criteria we used to support option assessment as set out in the option development process. The following schematic sets out this option assessment process followed to determine our preferred option for each identified site:

Figure 7 Option assessment process

As shown below, we outline how we have followed this process. Of the 25 sites (not currently including Anwick), two have the potential for a partnership solution, two have the potential for temporary barriers, whilst the rest are suitable for permanent flood solutions.

Table 25

Rank	Asset name	Is site at risk of flooding?	Is site already resilient?	Is flood depth greater than 2m?	Can the risk be mitigated through partnership?	Can a permanent solution be delivered?	Can a temporary solution be delivered?	Permanent traditional flood prevention solution
1	CLAYHILL WW	Yes	No	No	No			300m of flood wall round site and flood gates
2	GREAT BARDFIELD - BOREHOLE 3	Yes	No	No	Maybe/Yes	Yes or Partnership		Potentially flood walls 40m and gate. Partnership option, as close to Spains Hall estate. Natural flood management option
3	SALLE WW	Yes	No	No	No	Yes		Solution for 100m wall and gates
4	SOUTHEND - EASTERN ESPLANADE	Yes	No	No	No	Yes		Raise panels
5	SOUTHEND - KENSINGTON ROAD	Yes	No	No	No	Yes		Flood wall and gates 12m
6	CLEETHORPES - SCRIVELBY CT SP	Yes	No	No	Maybe/Yes	Yes or Partnership		Work with the EA/IDB to improve embankment
7	GRAYS - CENTRAL LONDON ROAD	Yes	No	No	No	Yes		Flood wall round entire building 50m and flood gate
8	BOSTON - NORFOLK PLACE SP	Yes	No	No	No	Yes		Flood doors or raise panels
9	BOSTON - LINCOLN LANE SP	Yes	No	No	No	Yes or Temp	Yes	Flood doors or temporary flood barriers
10	SOUTHEND - LIFTSTAN WAY (S W)	Yes	No	No	No	Yes		Flood doors
11	NORTHAMPTON-RICHMOND TERR #2SP	Yes	No	No	No	Yes		Flood doors
12	BARTON ON HUMB MALTKILN RD SSP	Yes	No	No	No	Yes		Flood walls 50m and gate
13	STIFFORD-WHARF RD SP	Yes	No	No	No	Yes		Flood wall 20m around building and gates
14	GRIMSBY-AUGUSTA OAKS SP	Yes	No	No	No	Yes		Flood wall around kiosk 12m and gates
15	GRIMSBY-ALEXANDRA DOCK PS	Yes	No	No	No	Yes		Flood gate on the access gate in the perimeter wall

Rank	Asset name	Is site at risk of flooding?	Is site already resilient?	Is flood depth greater than 2m?	Can the risk be mitigated through partnership?	Can a permanent solution be delivered?	Can a temporary solution be delivered?	Permanent traditional flood prevention solution
16	GREAT COATES WOAD LANE SP	Yes	No	No	No	Yes		Small kiosk in brick walled compound. Flood gate on perimeter wall.
17	SOUTHEND - EASTERN VALLEY SP	Yes	No	No	No	Yes		Brick Building in compound. Flood wall and gate. 100m
18	BRANCASTER STAITHE - STAITHE	Yes	No	No	No	Yes		Brick building with large windows. Flood Gate and Wall. 46m
19	SOHAM-FRANK BRIDGES CLOSE SP	Yes	No	No	No	Yes		Small Kiosk within wooden fenced compound. Flood wall and gate. 30m
20	MAYLANDSEA-SURFACE WATER SP	Yes	No	No	No	Yes or Temp	Yes	Flood Doors on the brick building (approx 1.25m Door) or consider temporary barriers to also include the electricity sub station.
21	KINGS LYNN - ST EDMUND ROAD	Yes	No	No	No	Yes		Site beside busy road. Well covers already mounted above ground level. Raise the two kiosk on plinths (two small roadside kiosks)
22	MARCH - ELLIOTT ROAD OV	Yes	No	No	No	Yes		Green Kiosk. Flood Wall and Gate around the Kiosk. 20m. Seal Well Covers
23	CULFORD THE STREET SP	Yes	No	No	No	Yes		Walk-in kiosk in large compound. Low wooden post and rail fence. Flood wall and gate around the site. 60m
24	SAXILBY-HIGH STREET TPS	Yes	No	No	No	Yes		Brick building down long drive. Flood Wall around building and well. 40m
25	WISBECH - EDINBURGH DRIVE	Yes	No	No	No	Yes		Potentially a kiosk or a flood wall

We provide a full cost breakdown in ANH_DD_022 Enhancement cost breakdowns

9.4.2 Odour and other nuisance

We have removed the costs proposed in our business plan for this investment. Whilst we have removed these costs from our plan, the increasing pressures from population growth, new developments, and climate change, we expect that enhancement investment will be required to address associated increases in odour-related complaints in future AMPs.

10 Security (water and water recycling) - NIS & SEMD

10.1 Investment Summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	53.3		40.0
Opex	8.7		5.6
Totex	62.0	41.6	45.6

In our updated data tables, these costs are reported against lines:

- CW3.121-CW3.123 (Security - SEMD) and associated CW12 and CW17 lines
- CW3.124-CW3.126 (Security - Cyber) and associated CW12 and CW17 lines
- CW3.138-CW3.139 (Additional line 5; DWI ECAF) and associated CW12 and CW17 lines
- CWW3.171-CWW3.173 (Security - SEMD) and associated CWW12 and CWW17 lines
- CWW3.174-CWW3.176 (Security - Cyber) and associated CWW12 and CWW17 lines

10.2 Context

In our plan, we outlined our commitment to increase operational resilience through a proactive approach to cyber and physical security. Our approach to security is driven jointly by the requirements of Regulations (Network & Information Systems (NIS) and Security and Emergency Measures Direction (SEMD)) and our understanding of business risk.

10.2.1 Ofwat's DD approach

The efficiency of our Cyber (water, and eCAF) costs were assessed through a shallow dive assessment. A company specific efficiency challenge was applied, resulting in an allowance of £27.0m.

Ofwat disallowed all enhancement expenditure relating to cyber security in relation to water recycling assets. Ofwat states that companies wastewater services are currently not included within the scope of NIS Regulations, and without any timescales for the inclusion of wastewater services within the scope of the regulations they reject all related enhancement costs. Ofwat set out that they expect companies to make sure their wastewater networks are resilient to cyber threats through ongoing base expenditure, and as part of their representations they expect companies to provide further detail of their cyber maturity across each area of their business ('Expenditure allowances', page 123).

The efficiency of our SEMD (Water and Wastewater) costs were determined through separate deep dive assessments. In the deep dive assessment, Ofwat stated that we have provided sufficient evidence why the investment meets the criteria for enhancement investment, and that they acknowledged that the DWI had issued acceptance notes for the 2025-30 period to ensure we meet our statutory requirements in this area with the considered best options and timescales for customers.

Ofwat outlined minor concerns on cost efficiency, identifying some gaps and limits in the evidence provided. They request further granularity of cost data for the proposed works at each site, and clarity on whether the outputs of the cost estimate processes have been assured by third-party assurers.

10.3 Our Representations

10.3.1 Cyber (water and eCAF)

We recognise the need for a proportionate shallow dive approach for areas of enhancement which are of lower materiality such as this. We consider that representations made for our more material water enhancements will improve the evidence base for cost efficiency, and so reduce the shallow-dive efficiency challenge that should be applied. We request that the shallow dive assessment and associated efficiency challenge is updated to reflect the revised costs and evidence in other areas of our water enhancement programme.

10.3.2 Cyber (water recycling)

At the time of developing our business plan, conversations with the DWI indicated that NIS Regulations would likely become enforceable for water recycling services within AMP8 through legislation which was awaiting parliamentary review.

We have since sought further clarification from the DWI, who have stated there are now no plans to bring wastewater into scope of NIS Regulations through the Cyber Security and Resilience Bill within the immediate future. As such, we remove this investment of £16.4m from our proposed totex. In the eventuality water recycling services are brought into NIS Regulations in future AMPs, we maintain enhancement expenditure will be required.

10.3.3 SEMD

In ANH_DD_022 we provide a full cost breakdown for each site where we propose investment.

The investment asset breakdown provides an information of the assets used, such as fencing, alarm systems and CCTV as well as the key attributes. These costs include the labour, plant, material and prelims. We have used both our asset cost models based on outturn cost and the on-site design data to construct the key cost assumptions and estimations.

We used our historic outturn cost data from previous similar projects which reflect the actual costs of procuring, installing and commissioning the solutions. By using our historic data and group delivery approach, we ensure that our cost estimation is realistic and efficient.

Therefore, we have developed our cost forecasts drawing from our outturn costs and experience delivering similar projects. These reflect our lessons learned from delivering these schemes in the past, as well as the actual costs incurred. Our proposed costs reflect our continuous improvement in delivery in this area, ensuring that we capture the benefits of economies of scale, standardisation and optimisation of design and delivery. We trust this additional information meets Ofwat's requirements and that our costs for this activity will be allowed in full.

We welcome Ofwat's clarification of its expectations for third party assurance of costs in response to our query OFW-IBQ-ANH-025. Following this query response, we have sought additional third party assurance on targeted enhancement investments that meet Ofwat's expectations. We will provide the outputs of this assurance separately following the submission of our Draft Determination Representations.

11 Addressing raw water deterioration

11.1 Investment Summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	175.4		218.1
Opex	6.3		7.3
Totex	181.7	150.0	225.4

In our updated data tables, these costs are reported against lines:

- CW3.97-CW3.99 (Addressing raw water quality deterioration (grey solutions)) and associated CW12 and CW17 lines
- CW3.132-CW3.133 (Additional line 2; PFAS) and associated CW12 and CW17 lines

11.2 Context

Delivering safe, clean water is the most vital service we offer, therefore we need to protect our customers from increasing nitrate levels in our raw water sources. Our nitrate concentration prediction models indicate that nitrate concentrations in some raw water sources will soon reach a point beyond which current treatment solutions at each site will be unable to ensure compliance with the Drinking Water Inspectorate's nitrate standard of 50 mg/l. To make sure we continue to comply with this standard, we will invest in new and upgraded water treatment works to protect customers from changes in water quality due to rising nitrate levels in raw water. We are also working to better understand the potential impact ofpoly-fluorinated alkyl substances (PFAS) compounds on the environment and health. As agreed with the DWI, we will invest to upgrade water treatment works to protect customers from the risk of 'forever chemicals' (PFAS) in water and investigate how we can help tackle the issue in the long term.

11.2.1 Ofwat's DD approach

Ofwat assessed our requested totex to address raw water deterioration through a combination of benchmarking, shallow dive and deep dive assessments. Our proposed totex for PFAS removal was reallocated to RWD, and assessed as part of this request. The below table sets out the assessment type used for each scheme, and whether the investment driver is PFAS or nitrates:

Table 26 Raw Water Deterioration Assessments

PFAS Virgin GAC Replacement - multiple sites	Deep dive	PFAS
Two Mile Bottom	Deep dive	Nitrates (deep dive)
Marham	Deep dive	Nitrates (deep dive)
Ulceby	Deep dive	PFAS
Parsonage Street	Deep dive	PFAS
Clay Hill WTW	Modelled	Nitrates
Risby WTW	Modelled	Nitrates
North Pickenham WTW	Modelled	Nitrates
Beachamwell WTW (Ryston)	Modelled	Nitrates
Congham WTW	Modelled	Nitrates
Twelve Acre Wood	Modelled	Nitrates
Houghton St Giles WTW	Modelled	Nitrates
Nunnery Lodge / Barnham Cross	Modelled	Nitrates
Ringstead	Modelled	Nitrates
Lyng Forge WTW	Modelled	Nitrates
Beckrow	Shallow dive	PFAS
PFAS Strategy	Shallow dive	PFAS

Ofwat use scheme level data to develop benchmarking models for ion exchange (which we propose as our preferred solution for our nitrate schemes). For the nitrates schemes assessed through modelling, we received an allowance of £69.325m, in comparison to the requested £73.780m. As requested in our October Business Plan, Ofwat excluded Denton Lodge nitrate removal scheme as the DWI did not provide a letter of support.

Two nitrates schemes (Marham and Two Mile Bottom) were assessed through a deep dive assessment. Ofwat raised minor concerns on whether the investments are the best options for customers; although they recognise we set out alternative options, they ask us to provide further evidence to demonstrate that our chosen options are the most cost beneficial. They also request nitrate reduction calculations alongside supporting narrative. Ofwat also raised minor concerns on cost efficiency, stating that a detailed build-up of option costs and benchmarking would provide more confidence in the costing approach.

The PFAS schemes assess through deep dive received an adjustment based on Ofwat's minor concerns relating to optioneering and cost efficiency. On the best option for customers, Ofwat request evidence of a cost benefit analysis to demonstrate the chosen option is the right solution, as well as more clarity on the optioneering process and the rationale for the selection of preferred alternatives. Ofwat also require evidence on current raw water PFAS levels or expected removal rates at selected site, as well as evidence of the quantified benefit for the proposed solution.

Two schemes were assessed through shallow dive; an 8% shallow dive efficiency challenge was applied.

11.3 Our representations

11.3.1 Nitrates

Modelling costs

Ofwat has used the single cost driver of treated flow (Ml/d) to derive the efficient costs of nitrates schemes below £10m. This resulted in a £4m cost challenge to our modelled nitrates costs. Whilst the treated flow is a cost driver, we do not think that this alone explains what the efficient costs of nitrates schemes should be. When we undertook external benchmarking of our costs against TR61 we found that our costs were 47% below the equivalent benchmark. On balance, we consider that the benchmarks we have used to develop our nitrate enhancement costs are a more accurate reflection of the efficient costs for these schemes than the Draft Determination cost model. On this basis we have retained the costs included in our March 2024 plan for these schemes and invite Ofwat to consider the cost efficiency evidence submitted as part of our plan, alongside its cost modelling assessment.

11.3.2 Deep-dives: Marham and Two Mile Bottom

Best option for customers

For the two nitrates schemes (Marham and Two Mile Bottom), Ofwat requested us to provide further evidence to demonstrate that our chosen options are the most cost beneficial, and request nitrate reduction calculations.

In our business plan (ANH26, pages 169-170), we outlined the options we considered through our feasibility assessment for nitrate risk reduction and whether they were feasible options in the short to medium term and would address the nitrate risk in AMP8. As requested, we provide further details of the cost benefit analysis we conducted to establish our preferred option. The following table presents the Whole Life Costs of each of the options presented in table 85 of our enhancement strategy (ANH26). It also provides an explanation of the options discounted earlier during the optioneering process. Please note that the Whole Life Cost is a summation across the whole of our nitrate programme, which subsequently lead to the selection of Ion Exchange as the preferred option for all our nitrates schemes including Marham and Two Mile Bottom.

Table 27 Cost Benefit Analysis

Option	Capex	Whole Life Cost [a]	Equivalent Annualised Benefit [b]	Risk index [c]	Equivalent Annualised Value [d]	Explanation
Catchment management	N/A	N/A	N/A	N/A	N/A	The control of nitrates using catchment management has been ongoing within Anglian Water since AMP 4. Catchment management is not effective as a sole solution for nitrates reduction; nitrates are still rising within many of Anglian Waters Groundwater sources and are not predicted to diminish within the time frame of the Long Term Delivery Strategy.

Option	Capex	Whole Life Cost [a]	Equivalent Annualised Benefit [b]	Risk index [c]	Equivalent Annualised Value [d]	Explanation
Blending	N/A	N/A	N/A	N/A	N/A	Because of reductions in abstraction licences and rising groundwater nitrate levels blending is no longer an option for the sites identified as requiring investment. There is no longer the available water to facilitate blending options.
Ion exchange with lagoons	£100,894,344	£141,600,976.44	£56,881,745.21	35.30	£49,464,049.35	Selected as the most appropriate investment option due to lower OPEX costs and lowest risk index. In time these investments may also create a beneficial environmental asset by the use of lagoons to collect raw water that has had no chemicals added to it.
Ion exchange without lagoons	£100,161,995.02	£153,048,365.57	£56,882,570.27	42.45	£48,865,208.69	Discounted because of the high impact of increased tankering of startup and commissioning water
Reverse osmosis	£131,346,073.68	£322,225,731.66	£52,158,540.80	89.90	£35,278,908.07	This technology employs high energy usage due to water being pumped through the membranes at very high pressures. It also requires alkalinity and pH adjustment post treatment. Membrane asset life can be as low as 7 years, at which point they would need replacing. 25-50% of the starting water stream is disposed of as concentrate this would mean that the supply demand balance would not be maintained in an already water stressed area. The significant waste stream volume and disposal requirements means that this option has a significant carbon footprint
Biological nitrate reduction	N/A	N/A	N/A	N/A	N/A	This option was discounted prior to cost analysis because: This technology is not used in the UK water industry. Any biological treatment process is subject to shock conditions which can result in failure of the treatment process. The amount of time required for the commissioning of the biological process is larger than all the other available technologies, this means startup rates of weeks or months rather than minutes. The bacteria are highly sensitive to small changes in the environmental conditions and operational routine events like borehole changes could result in the process no longer working until it reestablishes its self. If the water parameters are variable, so are the treated water parameters; Additional processes are needed to eliminate substances resulting from microbial activity such as nitrites. For a proper operation, careful maintenance and monitoring of biomass and its composition are required.

Option	Capex	Whole Life Cost [a]	Equivalent Annualised Benefit [b]	Risk index [c]	Equivalent Annualised Value [d]	Explanation
Electrodialysis	N/A	N/A	N/A	N/A	N/A	This option was discounted prior to cost analysis as this technology is only used for low volumes of water. Importantly it is not used in the UK water industry. Presently it is not a solution that is permitted due to Regulation 31
New source exploitation	N/A	N/A	N/A	N/A	N/A	This option was discounted prior to cost analysis due to the following reasons: Drilling new boreholes within the same aquifer is unlikely to yield water that is free of nitrates, or have significantly differing nitrate levels than the current operational sources. With our continual challenge of licensed abstraction reductions under our WRMP this option is unlikely to result in substitute sources.

a Whole Life Cost - WLC (discounted) = CAPEX +CAPEX repeat +OPEX +OPEX repeat at 30 years then discounted
b EAB - Equivalent Annualised Benefit. = The benefit in £ that is expected each year following completion of the scheme
c Risk Index = Whole Life Cost /(Baseline Risk Value - Residual Risk Value)
d EAV - Equivalent Annualised Value

Given the cost-benefit appraisal, we selected ion exchange plans as our preferred solution. It has been selected as the most appropriate investment option due to lower opex costs and lowest risk index.

For our preferred solution, we also provide below the nitrate reduction calculations for Marham and Two Mile Bottom. These figures provided are from Aecom's external audit report. The report confirms that the design basis we use is correct and have been applied equally to all alternative options evaluated.

Table 28 Nitrate Reduction Calculations

Category	Background data	Two Mile Bottom		Marham WTW	
	Unit	2025	2037	2025	2037
Bore Hole Flow					
	MLD	8.64	8.64	11.39	11.39
	m3/d	8640	8640	11387.52	11387.52
	m3/hr	360	360	474.48	474.48
	l/s	100	100	131.80	131.80
Sample Data					
mean	mg/l as NO3	41.3	48.2	86.90	85.80

Category	Background data	Two Mile Bottom		Marham WTW	
	Unit	2025	2037	2025	2037
legal limit	mg/l as NO3	50	50	50.00	50.00
treated Upper limit	mg/l as NO3	45	45	45.00	45.00
treated target conc	mg/l as NO3	43	43	43.00	43.00
treated lower limit	mg/l as NO3	30	30	30.00	30.00
I Ex plant outlet	mg/l as NO3	3	3	3.00	3.00
Load					
Av Nitrate load in	kg/d	356.832	416.448	989.58	977.05
Target nitrate load out	kg/d	371.52	371.52	489.66	489.66
Nitrate to be removed	kg/d	-14.688	44.928	499.91	487.39
Salt/ Brine use					
kg Salt / kg Nitrate removed		7.4	7.4	7.4	7.4
salt used	kg/d	0	332.4672	3699.35	3606.66
salt used	tonnes/yr	0	121.350528	1350.26	1316.43
Brine solution conc	% W/V	6	6	6	6
Brine solution volume used	m3/d	0	5.54112	61.66	60.11
Backwash/ rinse					
Backwash vol required	m3/d	0	5.54112	61.66	60.11
total Waste produced	m3/d	0	11.08224	123.31	120.22
total Waste produced	m3/yr	0	4045.0176	45008.76	43880.97
I Ex plant fee					
feed Flow split	%	0	0.115044248	0.52	0.52
feed Flow required	l/s	0	11.50442478	68.96	68.13

Category	Background data	Two Mile Bottom		Marham WTW	
	Unit	2025	2037	2025	2037
feed Flow required	m3/d	0	993.9823009	5958.43	5886.30
feed Flow required	MLD	0	0.993982301	5.96	5.89
Waste volume produced	% of vol treated	0.02	0.02	0.02	0.02
Waste volume produced	m3/d	0	19.87964602	119.17	117.73
Waste volume produced	m3/yr	0	7256.070796	43496.53	42970.01

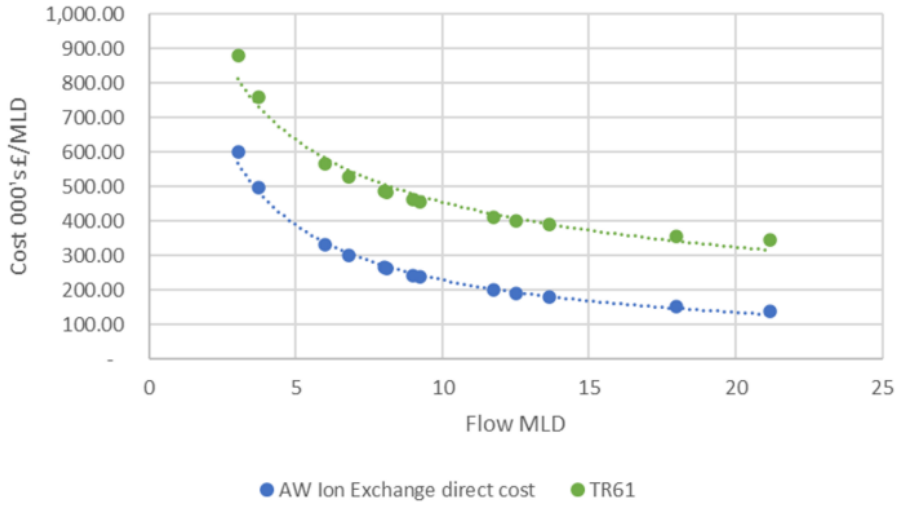
Cost efficiency

In response to Ofwat's request we provide a full cost breakdown for the schemes at Marham WTW and Two Mile in ANH_DD_022 Enhancement cost breakdowns.

On benchmarking, we applied our cost efficiency 'double-lock' on nitrates schemes through the following methods to ensure the efficiency of our plan:

- Scheme outturn costs: We have continuously captured outturn costs data of all projects delivered in our capital investments including granular cost components such as pipework, pumps, and ion exchange systems. These outturn costs have been the inputs to the cost models to each specific assets. Building outturn costs into our cost assumptions in this way builds cost efficiency into the build up of costs.
- Industry cost models from TR61: For nitrates, we have sought assurance on the efficiency on the costs of the ion exchange plants through by benchmarking to the model build by WRCs TR61. From TR61, we are able to reliably compare 50% of the total direct asset costs (covering ion exchange plant costs) of the programme with the industry benchmark. In the process of cost benchmarking we identified efficiencies on nitrate removal which resulted in a £21m reduction in our costs. The graph below shows the comparison of our costs against the TR61 benchmark which demonstrates that our costs are on average 47% lower than the benchmark cost/ Ml/d flow rate basis:

Figure 8 Ion exchange cost benchmarking

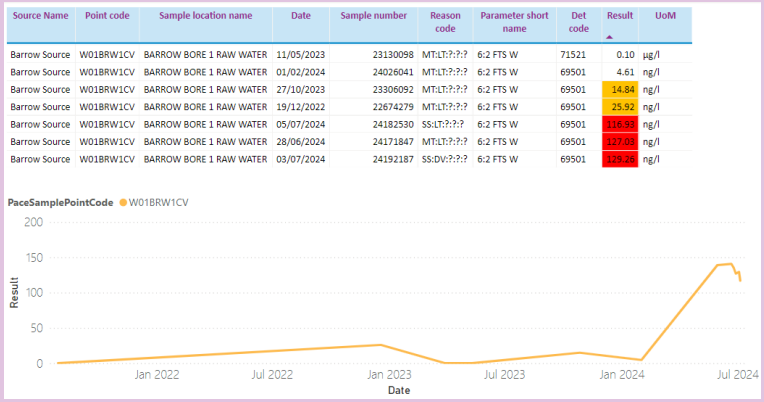


11.3.3 PFAS

New obligations

Since business plan submission, we have identified two new sites requiring PFAS treatment. The table below summarises the affected sites and justification for investment. For both sites, we have received DWI letters of support for GAC media treatment.

Table 29 Affected Sites Investment Justification

Site name	Need for investment
Barrow WTW	The contamination of the Barrow aquifer was reported at the request of the Environment Agency as an incident 19 July 2024. Barrow groundwater site has triggered tier 3 (greater than or equal to 0.1 µg/l PFAS in final water). This presents a risk as Barrow groundwater blends with our Goxhill groundwater source (tier 2, less than 0.1 µg/l) and Thornton groundwater source (tier 1, less than 0.01 µg/l). In the Chief Inspectors Report (CIR) published July 2024 the Inspectorate updated that PFAS guidance will be issued in the summer 2024 with an information letter. This guidance will consolidate and supersede all previous guidance and information letters regarding PFAS monitoring, risk assessment and reporting requirements as well as Inspectorate expectations for AMP8 and beyond. The key update in the guidance is the inclusion of an additional compound, 6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB), which is already being tested by many companies. This will become a requirement from January 2025. 6:2 FTS (6:2 fluorotelomer sulphonate, one of the identified 47 PFAS compounds) is of particular concern in this source as shown by the sharp increase in results in the table below. Barrow final water also has 5 different PFAS compounds detected at tier 2 levels. 
Warren Hill Reservoir	Warren Hill Reservoir final water is supplied by our Southfields groundwater source. We have identified that as Southfields source is a tier 2 raw water is the sole supply to Warren Hill Reservoir (final water), this results in Warren Hill reservoir final water also classifying as a tier 2 site. The source has 8 different PFAS compounds detected. For tier 2 final waters, the DWI requires review of any control measures and existing treatment and the preparation of measures to prevent the supply of water to consumer with levels less than 0.1 µg/l

Source Name	Point code	Sample location name	Date	Sample number	Reason code	Parameter short name	Det code	Result	UoM
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	11/05/2023	23130098	MT:LT:?:?:?	6:2 FTS W	71521	0.10	µg/l
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	01/02/2024	24026041	MT:LT:?:?:?	6:2 FTS W	69501	4.61	ng/l
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	27/10/2023	23306092	MT:LT:?:?:?	6:2 FTS W	69501	14.84	ng/l
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	19/12/2022	22674279	MT:LT:?:?:?	6:2 FTS W	69501	25.92	ng/l
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	05/07/2024	24182530	SS:LT:?:?:?	6:2 FTS W	69501	116.93	ng/l
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	28/06/2024	24171847	MT:LT:?:?:?	6:2 FTS W	69501	127.03	ng/l
Barrow Source	W01BRW1CV	BARROW BORE 1 RAW WATER	03/07/2024	24192187	SS:DV:?:?:?	6:2 FTS W	69501	129.26	ng/l

For these sites, in line with the approach taken for our other sites triggering tier 2 and 3, we propose to replace existing GAC media with virgin GAC as this is the most cost-beneficial option to address PFAS while minimising the possibility for compound breakthrough. Please refer to section 11.2 in our enhancement strategy (ANH26 of our business plan) for more detail on the optioneering process for our tier 2 & 3 sites, and our cost benefit analysis provided below.

Best option for customers

Ofwat requested through the deep dive assessment additional detail on our cost benefit analysis to demonstrate the selected option is the right solution.

The first section of investment is for the removal of PFAS on treatment plants that already have a carbon filtration stage. For these works the most cost effective and chemically effective treatment option is to change the carbon for virgin carbon to ensure optimal PFAS removal. The cost benefit analysis of this is shown below against membrane filtration. It should be noted that PFAS removal by Ion exchange has not been assessed because there is no resin that is currently approved under Regulation 31 (Materials in contact with water).

Table 30

	Capex (£)(Sum over whole program)	RICS (£)(Sum over whole program)	WLC (£)(Sum over whole program)	EAB (£)(Sum over whole program)	EAC (£)(Sum over whole program)	EAV (£)(Sum over whole program)	Mitigated Risk (£)(Sum over whole program)	Risk Index (value)(Sum over whole program)
Membrane treatment plant	696,909,253.56	527,173,159.74	8,548,014,634.95	364,864,608.53	447,783,443.11	-82,918,834.58	426,239,435.29	£696,909,253.56
Carbon replacement	39,850,129.08	-	52,388,847.22	477,324,317.82	2,744,363.39	474,579,954.43	663,536,388.20	£2.36

The second section of treatment works are those that do not currently have a carbon filtration stage. For these assets the costs of building a carbon filtration stage has been assessed against the use of membrane filtration. These results can be seen below.

Table 31

Alternative Name	Capex (£)	RICS (£)	WLC (£)	EAB (£)	EAC (£)	EAV (£)	Mitigated Risk (£)	Risk Index (value)
Southfields WTW Carbon Adsorption	14,057,234.15	107,135.42	16,668,557.79	101,715,705.07	873,174.01	100,842,531.06	132,055,262.26	0.13
Southfields WTW PFAS Removal By Membrane Treatment	13,860,603.14	2,066,516.99	46,316,489.36	122,879,442.11	2,426,265.98	120,453,176.13	143,801,270.92	0.32
Parsonage St WTW Carbon Adsorption	11,901,724.65	144,418.32	14,897,655.22	5,117,202.81	780,406.17	4,336,796.64	6,643,333.58	2.24
Parsonage St WTW Carbon Adsorption with RGFs	15,567,249.32	170,869.20	19,447,248.75	2,777,382.11	1,018,734.34	1,758,647.77	3,605,691.32	5.39

Alternative Name	Capex (£)	RICS (£)	WLC (£)	EAB (£)	EAC (£)	EAV (£)	Mitigated Risk (£)	Risk Index (value)
Parsonage St WTW Membrane plant	14,184,434.98	171,536.35	17,953,387.76	5,082,558.99	940,479.18	4,142,079.81	6,630,392.18	2.71
Ulceby BS Carbon Adsorption	13,803,778.95	221,690.88	18,598,019.72	17,684,386.31	974,247.90	16,710,138.41	22,958,596.04	0.81
Ulceby BS UF membrane plant	17,919,795.01	252,732.22	23,915,230.13	16,809,257.20	1,252,787.29	15,556,469.91	21,817,017.65	1.10
Beck Row Washwater System	5,051,447.84	85,252.32	6,699,928.01	6,871,544.54	350,972.36	6,520,572.19	8,878,659.68	0.75
Beck Row Waste WTW PFAS Removal By Membrane Treatment	5,598,665.41	799,662.35	17,870,187.10	7,606,211.44	936,120.75	6,670,090.69	8,901,468.31	2.01
Barrow WTW Carbon Adsorption - DD	27,867,781.64	493,240.00	37,498,232.24	101,288,093.75	1,964,326.02	99,323,767.73	131,500,070.43	0.29
Barrow WTW Membrane Filtration - DD	45,604,049.42	18,511,882.62	297,643,128.20	96,647,300.18	15,591,885.42	81,055,414.76	125,444,266.18	2.37

In each case the lowest cost and whole life cost option is the introduction of a carbon based removal stage. This is also the removal process that has the most currently valid evidence of efficacy.

Optioneering process

Ofwat requested through the deep dive assessment a clear explanation of the optioneering process and the rationale for the selection of preferred alternatives.

As set out in our business plan enhancement strategy, our options consideration (ANH26, table 89) and feasibility assessment (ANH26, table 90) outline the options we considered for PFAS risk reduction and whether they were feasible options in the short to medium term and would address the PFAS risk in AMP8. The same process was applied to the investment proposal for PFAS removal at Barrow WTW And Warren Hill reservoir WTW (supplied by Southfields raw water source). These included:

- Catchment management opportunities
- Blending where available at the site
- Replacement of the existing GAC media with virgin carbon
- Ion exchange treatment specific for PFAS removal (of note is that there is not a Regulation 31 approved resin)
- Advanced oxidation
- Enhanced GAC regeneration.

Our PFAS Undertaking requires us to undertake catchment investigations. This a key element of our AMP8 PFAS strategy, and will inform what options we have on catchment management in AMP8 to reduce PFAS at source. Investment proposals have been included within our PFAS strategy submission and our undertaking requires us to undertake catchment characterisation and investigations. We know from our sampling programme that a number of our sources are contaminated with PFAS. We have identified PFAS in all of our raw water surface waters, and in a number of our groundwater sources where contamination has already occurred within the aquifer will be an issue for a significant number of years. Therefore, with DWI Letters of Support, we must invest to address this emerging risk where instructed through DWI guidance (DWI IL 03/2022).

Through our optioneering process, we worked with subject matter experts to which technologies are currently being used for PFAS removal in the UK, which were feasible technologies for use and importantly which have Regulation 31 approval for use in drinking water treatment.

Through this optioneering process, we ruled out a number of options as unfeasible in meeting the requirements set out in the DWI's guidance. The options we deemed unfeasible are summarised in our business plan (ANH26 table 89 and 90), and we present additional information below to be read in parallel:

Table 32 Unfeasible Options

Option	Why deemed unfeasible through optioneering process
Blending	The availability of a blend option is not feasible for the majority of the sites within this proposed investment, where blend water is available then it must be a low PFAS source and available at sufficient blend capacity, (and not compromise other parameters being blended for , i.e. nitrate). It must be noted that there is no online PFAS monitor to verify any blend point, and PFAS has been detected in all source waters. For the sites identified for investment, PFAS levels are too high at the selected site to blend with other waters.
Ion exchange treatment	Ion exchange treatment for the new PFAS treatment investment sites was ruled out due to there not being a Regulation 31 approved PFAS resin currently available. Additionally we recognised that ion exchange waste streams are a concentrated waste of the parameter being treated, therefore disposal of heavily concentrated PFAS waste streams are likely to be an issue with any discharge permitting requirements.

Based on this optioneering, for the sites where there is no current treatment solutions, we select the installation of GAC equipment for PFAS removal as the preferred treatment.

For sites where there is already GAC systems for PFAS removal, we considered whether to select either regeneration of GAC or replacement with virgin GAC media as the preferred option. We selected replacement with virgin GAC media for the following reasons:

- The efficiency of GAC media in removing PFAS declines as macro and meso pores become exhausted, resulting in the breakthrough of PFAS compounds. The timing of the breakthrough depends on the adsorption capacity of the carbon, this is measured by the iodine number. Our regeneration policy requires the carbon iodine number to be above 600 mg/g upon regeneration (and return back to site), to allow for optimal adsorption capacity of the media. Virgin GAC has an iodine number of 1000-1050 mg/g, while regenerated GAC media has a much lower iodine number as the number declines over time as the carbon adsorption sites become full. Therefore, although virgin carbon and freshly regenerated carbon both provide effective PFAS removal for a period of time, virgin carbon will provide adsorption capacity for a longer period of time compared to regenerated carbon simply due to the higher starting iodine number.
- We have worked with Cranfield University to build our understanding of the optimal treatment solutions for PFAS removal. We commissioned research with Cranfield University in 2022 to undertake a project on the efficacy of the regenerated carbon testing with Beck Row raw water and carbon, comparing newly regenerated and the oldest GAC media from the site. The study found removal is better at longer contact times and with newly regenerated carbon, and that removal is dependent on the specific PFAS compound and therefore the number of carbons and chain length as well as functionality.
- On this basis, we selected virgin carbon media as our preferred option given the efficiency of this option for PFAS removal, reducing the expected frequency for replacement or regeneration of media. Our DWI PFAS strategy Undertaking requires that for all sources that fall into tier 3 to design, develop and implement mitigation to reduce PFAS concentrations in drinking water to at least tier 1 concentrations. For all sources in tier 2 design a proactive and systematic risk reduction strategy to progressively reduce PFAS concentrations in drinking water. This research demonstrates virgin replacement will optimise this treatment stage reducing the risk of PFAS breakthrough and therefore the potential for elevated PFAS levels in the final water.

Raw water PFAS levels and removal rates

Through the deep dive assessment, Ofwat asked us to provide evidence of the raw water PFAS levels and expected removal rates at the selected sites.

DWI guidance outlines the expectations of the Inspectorate when sites trigger different PFAS tiers, which is determined through the concentration of any PFAS in the final water. The following table outlines the DWI tier categories, and outline the expectations of the DWI regarding actions:

Table 33 DWI Tier Categories

Tier	Concentration of any PFAS in final water	Actions (not exhaustive, summary of main points from DWI IL 03/2022)
Tier 1	Less than 0.01 µg/l	Continue to monitor

Tier	Concentration of any PFAS in final water	Actions (not exhaustive, summary of main points from DWI IL 03/2022)
Tier 2	Less than 0.1 µg/l	Continue to monitor, liaise with DWI of any increasing trend. Review any control measures such as blending procedure including efficiency, control and monitoring of that measure. Prepare measures to prevent the supply of water to consumers with > 0.1 µg/l. Consult/discuss with UKHSA and local authorities.
Tier 3	Greater than or equal to 0.1 µg/l	Wholesomeness concentration in the final water. Notify of an event . Notification of an event to DWI, UKHSA and local authorities. Prepare emergency contingency measures to prevent the supply of water to consumers with > 0.1 µg/l.

The following table provides a breakdown of the raw water PFAS levels at the raw and final waters at selected sites for the virgin replacement media investment (in addition to Parsonage Street and Ulceby ground water sites investment proposed for GAC media installation). It shows the water treatment works listed in bold and the associated raw water monitoring point. All tier 1 category sources listed have had PFAS detections above the Limit Of Detection (LOD), and all have had a sample result > 5ng/l detected in the last 12 months at a source level.[5]

Table 34 Tier Category of Samples

WTW and source	Point code	PFAS Tier Categories
Branston Booths WTW	W01BRB1CN	Tier 2
Branston Booths borehole source	W01BRB2CV	Tier 1
Branston Booths borehole source	W01BRB4CV	Tier 1
Ardleigh WTW	W01FIN5CN	Tier 2
Ardleigh Reservoir - inlet to the works	W01RAW2CD	Tier 1
Isleham WTW	W01ISL1CN	Tier 2
Beck Row Boresite feeds into Isleham WTW	W01BECCV	Tier 3
Covenham WTW	W01COV3CN	Tier 2
Covenham Reservoir - raw water inlet to the works	W01COV1CD	Tier 1
Elsham WTW	W01ELS2CN	Tier 2
Elsham Reservoir (Cadney Carrs) - raw water inlet to the works	W01ELS1CD	Tier 1
Ulceby borehole source (feeds into Elsham WTW)	WO1ULC2CV	Tier 3
Ulceby borehole source (feeds into Elsham WTW)	W01ULC3CV	Tier 3

5 Each PFAS sample is analysed for the 47 PFAS compounds and it is difficult to present that for all of the works listed below, therefore we have provided the highest tier category observed at the sample point code.

WTW and source	Point code	PFAS Tier Categories
Hall WTW	W01HAW0CN	Tier 2
Hall Reservoir - raw water inlet to the works	W01HAW0CD	Tier 3[a]
Parkfield Reservoir final water WTW	W01PFR CN	Tier 2
Parsonage Street borehole source (feeds into Parkfield res)	W01PAR CM	Tier 2
Alton WPM	W01ALT CN	Tier 2
Alton Reservoir - raw water inlet to the works	W01ALTWCD	Tier 1
Heigham WTW	W01WKS9CN	Tier 1
Costessey Pits - borehole source	W01COS2CV	Tier 1
Costessey Pits - borehole source	W01COS3CV	Tier 1
Heigham WTW - inlet to the works	W01WKS1CC	Tier 1
Heigham WTW - borehole source	W01BOW2CV	Tier 1
Heigham WTW- borehole source	W01BOW2CV	Tier 1
Mousehold WTW	W01THP CN	Tier 1
Mousehold borehole source	W01THP1CV	Tier 1
Mousehold borehole source	W01THP2CV	Tier 1
Bedford WTW	WO1BOW2CN	Tier 2
Bedford raw - River Ouse	W0IBDW0CB	Tier 1
Etton WTW	WOXETT1CN	Tier 1
Etton borehole source	W01ETA9CV	Tier 1
Etton borehole source	W01ETB9CV	Tier 1
Etton borehole source	W01NBR2CV	Tier 1
Grafham WTW	W01GTW1CN	Tier 2
Grafham Reservoir - raw water inlet to the works	W01GTW1CD	Tier 1

WTW and source	Point code	PFAS Tier Categories
Morcott WTW	W01MOROCN	Tier 2
Morcott WTW - Rutland Reservoir raw water inlet into the works	W01MOROC0	Tier 1
Pitsford WTW	W01PTW1CN	Tier 1
Pitsford Reservoir - raw water inlet to the works	W01PTWOCO	Tier 1
Ravensthorpe WTW	W01RVW3CN	Tier 1
Ravensthorpe WTW - Ravensthorpe Reservoir raw into the works	W01RVW2CO	Tier 1
Ravensthorpe WTW - Hollowell Reservoir raw into the works	W01RVW4C0	Tier 1
Wing WTW	W01WGW6CN	Tier 1
Wing WTW - Rutland Reservoir raw water inlet into the works	W01WGWSC0	Tier 1
Saltersford WTW	W01SAL1CN	Tier 2
Saltersford WTW raw water inlet to the works	W01SAL1C0	Tier 2
Marham WTW	W01MAR1CN	Tier 2
Marham WTW - River Nar inlet to the works	W01NAR CB	Tier 1
Marham WTW - borehole source	W01MAR3CV	Tier 2
Marham WTW - borehole source	W01MAR5CV	Tier 1
Marham WTW - borehole source	W01MAR6CV	Tier 1
Marham WTW - borehole source	W01MAR8CV	Tier 2
Marham WTW - borehole source	W01MAR9CV	Tier 3
Marham WTW - borehole source	W01MA10CV	Tier 2
Stoke Ferry WTW	W01STO CN	Tier 1
Stoke Ferry WTW	W01STO1CN	Tier 1
Stoke Ferry WTW - River Wissey raw into the works	W01STO CB	Tier 2
Stoke Ferry WTW - borehole source	W01STO CB	Tier 2

WTW and source	Point code	PFAS Tier Categories
Stoke Ferry WTW - borehole source	W01WWPSCV	Tier 1
Stoke Ferry WTW - borehole source	W01WWPGCV	Tier 1
Watton WTW	W01WTTOCN	Tier 1
Watton East Boresite	W01EWA2CV	Tier 1
Watton WTW - borehole source	W01WAN1CV	Tier 1
Watton WTW - borehole source	W01WAN3CV	Tier 1
Barrow WTW[b]	W01BRW2CN	Tier 2
Barrow borehole source	W01BRWOWV	Tier 3
Goxhill borehole source	W01GOXOWV	Tier 2
Thornton borehole source	W01THOOWV	Tier 2
Warren Hill reservoir No 1 final[c]	W01WH11CN	Tier 2
Southfields borehole source	W01STHOWV	Tier2

a 6:2 FTAB 48th PFAS compound to be added to the Annex list January 2025
b Post Draft Determination submission
c Post Draft Determination submission

From our previous experience of delivery, we have established GAC is an effective method of removing PFAS. Removal rates (the frequency that GAC must be replaced or regenerated) is fundamentally driven by the length of time it takes to observe breakthrough of PFAS compounds when the macro and meso pores become exhausted. We selected replacement of GAC media with virgin media as our preferred option, as virgin GAC media has a much higher carbon iodine number in comparison to regenerated GAC media, therefore has a much better absorption capacity and retains this capacity for longer than regenerated media.

Given variables such as the raw water challenge, organics loading, and the age of the carbon, it is not possible for us to provide an exact quantified removal rate for GAC. Pesticide risk as well as the PFAS chain length and functionality also affects the required removal rate.

Although we cannot quantify the expected removal rate, our experience of delivering GAC solutions to date have provided us a good understanding on approximate timescales for replacement at the selected sites.

Cost efficiency

In ANH_DD_022 Enhancement cost breakdowns, we provide a full cost breakdown by site to give further insight into our key calculation and assumptions used in cost development. We also provide a table with the unit rate build up for GAC media replacement.

Benchmarking

As part of our double-lock approach to cost efficiency, we have also undertaken top-down benchmarking of our costs.

Table 35 Anglian Water PR24 Benchmarking - Raw Water Deterioration PFAS (by COCE)

Scheme no	Scheme	AW Capex (£m)	Benchmark (£m)	Variance
I039133	Parsonage St WTW WQ Compliance	11.9	11.6	1.76%

Scheme no	Scheme	AW Capex (£m)	Benchmark (£m)	Variance
I039195	Ulceby WTW WQ Compliance	13.8	15.0	-8.55%
IO39836	Beck Row WTW WQ Compliance	5.0	5.8	-14.18%
IO40312	Barrow WTW WQ Compliance	27.8	21.9	26.81%
IO43556	Southfields PFAS Compliance	14.0	12.6	11.23%
	Total			8.01%

To ensure the costs we have proposed are efficient, we partnered with Mott McDonald and AECOM (COCE) to compare our costs for these investments with comparable schemes across the industry. Our benchmarking partners considered the full cost breakdown of all 5 schemes in the programme representing £72.6 million of costs. COCE has provided a full comparison of cost at asset level on each project and provide an efficiency assessment at programme level

Overall, the estimated costs are aligned to the sector benchmarks, and appear to be reasonable costs for the scopes of work as currently defined. Each project contains elements costed above the benchmark equivalents, and some below. The , and the total costs are within the degree of estimating uncertainty expected of an AACE Class 4 estimate. Barrow WTW exhibits a greater variance due to the risk attached to installing a 1800 m3 GAC system compared to the average 280m3 volume at the other sites

11.3.4 Shallow dive assessment

For Beck Row and the PFAS strategy investments, we recognise the need for a proportionate shallow dive approach for areas of enhancement which are of lower materiality such as this. We consider that representations made for our more material water enhancements will improve the evidence base for cost efficiency, and so reduce the shallow-dive efficiency challenge that should be applied. We request that the shallow dive assessment and associated efficiency challenge is updated to reflect the revised costs and evidence in other areas of our water enhancement programme.

12 Lead reduction

12.1 Investment summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	5.8		5.8
Opex	13.3		8.9
Totex	19.1	15.8	14.7

In our updated data tables, these costs are reported against lines:

- CW3.103-CW3.105 (Addressing raw water quality deterioration (grey solutions)) and associated CW12 and CW17 lines
- CW3.106-CW3.108 (Lead communication pipes replaced or relined) and associated CW12 and CW17 lines
- CW3.109-CW3.111 (External lead supply pipes replaced or relined) and associated CW12 and CW17 lines
- CW3.112-CW3.114 (Internal lead supply pipes replaced or relined) and associated CW12 and CW17 lines
- CW3.115-CW3.117 (Other lead reduction related activity) and associated CW12 and CW17 lines

12.2 Context

As part of our long-term integrated lead strategy, which sets out our path to removing all lead pipes in our network by 2050, we will invest to reduce the exposure of customers to lead in the highest risk locations in our region. Alongside continuing with our long-term lead pipe replacement programme, we will work with local authorities and schools to benefit the most at-risk vulnerable customers and children.

12.2.1 Ofwat's DD approach

Expenditure relating to lead reduction was assessed through the following methods:

- Lead communication pipe costs were derived by triangulating a econometric benchmarking model (using company requested totex as the dependent variable and the number of communication pipes replaced as the independent variable) with the industry median cost.
- Supply pipe replacement costs were assessed using a unit cost approach, with the median unit cost used for external (£2,073) and internal (£711m) supply pipes replaced.
- Other lead reduction related activity we proposed (aside from seasonal phosphate dosing) was assessed through a shallow dive assessment. Due to the immaterial costs, Ofwat apply a company specific efficiency challenge.
- Investment for seasonal phosphate dosing was assessed through a deep dive assessment. Costs were disallowed in full at the need for enhancement investment stage due to Ofwat's concerns that "increasing dosing is not a long-term sustainable strategy and is inconsistent with the lead strategy that the DWI approved."

12.3 Our representations

12.3.1 Lead pipe replacement

Ofwat uses a modelling approach to assess costs for the three components of the lead replacement programme. Naturally, a modelled approach will simplify the cost drivers for these programmes to a small number of variables (in this instance, the number of lead pipes to be replaced) and not take all variables into account which will have some influence on costs. Nonetheless, Ofwat cost model and the data submitted in companies plans provides a useful cross-check to our own costs, to support our own double-lock assessment of our cost efficiency

In this particular case, the communications pipe model gives us more than our requested allowance, and the supply pipes models give us less than our requested allowance. In the round, Ofwat's modelled allowances produce a similar result to that supported by our cost efficiency double-lock approach (which utilised our observed outturn costs and external cost benchmarking by KPMG). We have therefore kept the totex in our plan for lead communication and supply pipes unchanged at:

- Lead communication pipes: £5.8m
- External lead supply pipes: £6.1m
- Internal lead supply pipes: £1.5m

12.3.2 Lead strategy

We welcome that Ofwat has assessed our lead strategy enhancement costs separately to the costs for lead pipe replacements. This appropriately reflects the the different types of activity involved in each of these investments. We recognise and support that the materiality of the lead strategy investments merits a shallow

dive cost assessment approach. Anglian's shallow dive cost challenge is 8% based on the efficiency of other parts of our water enhancement programme. We have provided additional evidence to support the efficiency of our costs in these other areas of enhancement. We request that the shallow dive cost challenge is updated in light of this evidence. We have kept our view of totex unchanged from our business plan at £1.4m as this remains our view of the efficient costs for this investment.

12.3.3 Seasonal phosphate dosing

Our seasonal dosing investment was included in our plan to lessen the impact of the warmer weather on the dissolution of lead into pipes. This type of investment has been allowed as enhancement in previous price reviews and provides additional customer benefit to customers who have lead pipes that have not yet been replaced through the lead pipe replacement programme. We have therefore included it as enhancement within our PR24 plan.

We also note that additional pressures elsewhere in our plan driven by factors outside of our control are increasing pressures on customer bills. From the Draft Determination deep-dive assessment, we also understand Ofwat is unlikely to accept this as additional enhancement expenditure. We have therefore removed our seasonal phosphate dosing enhancement costs from our plan.

13 Improvements to taste, odour and colour

13.1 Investment Summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	3.8		3.8
Opex	0.1		0.1
Totex	3.8	3.5	3.8

In our updated data tables, these costs are reported against lines CW3.91-CW3.93 (Improvements to taste, odour and colour (grey solutions)) and associated CW12 and CW17 lines.

13.2 Context

We proposed a limited programme to improve service at three sites where taste and/or odour has been detected in laboratory sampling. We only propose schemes where the DWI will have issued decision letters either commending for support or providing letters of support and subsequently Regulation 28 notices (where applicable) with AMP8 completiondates.The details of the investment as presented in our business plan (ANH26) remain correct.

Our costs for this investment were assessed through a shallow dive. As the proposed costs were below the shallow dive threshold, a company specific efficiency challenge was applied. The shallow-dive cost challenge has been set based on the assessed efficiency of other parts of our enhancement programme.

The company specific efficiency challenge of 8% reduced the allowance from £3.841m to the permitted allowance of £3.534m.

13.3 Our representations

We recognise the need for a proportionate shallow dive approach for areas of enhancement which are of lower materiality such as this. We consider that representations made for our more material water enhancements will improve the evidence base for cost efficiency, and so reduce the shallow-dive efficiency challenge that should be applied.

We have retained our totex investment request for taste and odour unchanged as this remains our view of the appropriate efficient cost for this investment.

love every drop
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