UUWR_76

PR24 Draft Determination: Enhancement Case

PFAS - Enhancement case

August 2024

This document sets out the service enhancement expenditure and activity that we will undertake through AMP8 and supports our draft determination response document, UUWR_75.

United Utilities

Water for the North West

Contents

Appendices

Enhancement submission

Title:	PFAS
Price Control:	Water Network Plus
Enhancement headline:	This programme of work is an additional provision associated with new requirements issued by the Drinking Water Inspectorate (DWI) to progressively reduce poly and perfluorinated alkyl substances (PFAS) in drinking water. This requirement has been formalised in an Undertaking issued by the DWI. PFAS are man-made chemicals that have been found at low levels in the water environment and their unique chemical properties makes them non-biodegradable. These man-made compounds do not originate from water industry activity, but from a broad spectrum of household and industrial products since the 1950s from carpets to cookware and fire-fighting foams to hydraulic aviation fluids. Whilst we have a role in reducing the levels of PFAS in drinking water, more needs to be done by the government and regulators to control PFAS at source and eliminate discharges into the wider environment to minimise the need for additional future water treatment.
Enhancement expenditure (FY23 prices)	

	AMP8 Capex inc TI (£m)	AMP8 Opex (£m)	AMP8 Totex (£m)
Pre RPE and Frontier Shift	48.609	0.466	49.075
Post RPE and Frontier Shift	47.789	0.455	48.244

The table above shows the total expenditure, inclusive of accelerated programme and transitional investment, on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a pre efficiency and RPE basis.

This case aligns to :	Long-Term Drinking Water Quality Strategy Expenditure relating to this enhancement case can be found in CW3.94-96.
PCD	Yes

1. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• Understanding around PFAS is evolving. To comply with the latest DWI requirements, investment is needed to install specific treatment processes to enable the removal of PFAS to below the DWI Tier 1 threshold at two water treatment works (WTW) • PFAS are a group of man-made chemicals that have become ubiquitous in the environment from their widespread use and chemical properties. Research is ongoing to understand the mechanisms of PFAS toxicity and into the toxicity of the substances and their potential impact on human health. • It is crucial that the required investment is made in AMP8 as drinking water supplies in the affected areas are being put at increasing risk through the need to reduce output to mitigate against the presence of PFAS in raw water sources. Regulator and customer expectations with respect to PFAS are evolving and as such, we have been issued with undertakings to reduce PFAS concentration in our supply systems. • This investment is part of our long-term drinking water quality strategy which includes an adaptive plan for securing water quality for the future while taking into account climate change and contaminants of emerging concern. • Customers ranked *water that is safe to drink* as the highest of our priorities for AMP8, which is a strong indication that customers will support this investment.	*3.2* *3.2.2* *3.3* *3.5* *3.6*
Best option for customers	• Our options review has identified the need for additional treatment processes to effectively remove PFAS from raw water, as these compounds cannot be removed using conventional treatment. The most appropriate technology identified for the WTW included, is installation of granular activated carbon (GAC) contactors. The options assessment has considered the challenges faced at each water treatment works to ensure a robust solution is implemented, that will give the best value for customers. • The estimated cost to deliver (capex and opex) per annum for each named project is outlined in table 1. We made a technical submission to the DWI in June 2024 detailing the need to develop the current treatment processes at these locations and the anticipated benefits our consumers will realise by making these upgrades. • The anticipated utilisation rate of the named schemes is high, due to the chemical properties of PFAS and the ongoing need to reduce the concentration of PFAS in drinking water. We are currently imposing raw water blending plans to reduce the concentration of PFAS in drinking water. However, this is not a sustainable long-term	*4.2* *4.3* *4.6*

	solution due to the operational restrictions this imposes from limiting source water volumes.	
Cost efficiency	• The options development period followed a three-stage risk and value process, designed to positively challenge our projects and decisions. • We have taken learning from our AMP6 innovation roll out to implement a new Technology Approval Process which aims to identify opportunities for innovative technologies and nature-based solutions. We have incorporated technologies discovered through this route into our Process Decision Support Tool to identify opportunities that present the best value solutions. • The option selected for each site seeks to achieve the best value for the environment, society and UUW over the long-term. We used our value assessment tool to allow for the selection of the preferred solution based on the comparison of value between various options.	*5.2* *5.3* *5.4*
Customer protection	• We have developed a Price Control Deliverable (PCD) in order to protect customers' investment from delayed delivery, non-delivery or a reduction in programme scope. • Repayment for non-delivery would be made based on defined project milestones, adjusted for the size and scale of the project by the maximum capacity in Ml/d of the associated WTW.	*6.2* *6.2*

2. Introduction

2.1.1 This document sets out an enhancement claim of £49.075million to allow UUW to install new treatment processes at two water treatment works to address the presence of PFAS in the associated source waters. PFAS in drinking water is an evolving space and in December 2023, a letter was issued by the Drinking Water Inspectorate (DWI) setting out clear expectations of companies to progressively reduce PFAS in drinking water. Accompanying the letter, was a new requirement to submit a Section 19 Undertaking to formalise the AMP8 programme of work and to include any additional schemes to meet the revised expectations.

2.1.2 Our consumers have told us that their top 3 priorities are: water that is safe to drink; reliable water supply now and in the future; water that tastes, smells and looks good.

2.1.3 Our long-term drinking water quality strategy is aligned to this requirement as a sufficient and reliable supply of safe, clean drinking water is intrinsically linked to good public health and customer confidence in water supplies. Our 2050 ambitions are therefore to:

(1) Provide a service that is 100% compliant with regulatory, quality and environmental requirements;

(2) Provide a service which is resilient to challenges such as new water quality standards, climate change, asset health and potential risks from emerging contaminants;

(3) Ensure customers are confident and trusting of their drinking water quality; and

(4) Deliver for future generations by embedding sustainability, innovation and partnership working in our plans.

2.1.4 Poly and perfluorinated alkyl substances (PFAS) are a group of synthetic chemicals that include perfluorooctane sulphonate (PFOS) and perfluorooctanoic acid (PFOA) and other related substances. They have been widely used for a range of purposes from industrial to household products.

2.1.5 The removal of PFAS in water treatment is highly process-specific and cannot be achieved through conventional treatment processes alone[1].

2.1.6 To effectively remove PFAS from raw water, an additional treatment step is required. Studies to date have shown that filtration through granular activated carbon (GAC) at optimised flow rates can sufficiently remove PFAS to below DWI Tier 1 guideline concentrations.

2.1.7 Research into PFAS, its sources and treatment solutions for drinking water and wastewater processes is rapidly evolving across the industry. We have included PFAS in our Drinking Water Safety Plan (DWSP) risk assessments to establish any potential sources of PFAS in our Catchments. The outcomes of which [2]feed into our long-term water quality strategy to implement solutions where risks have been identified and where catchment solutions are unlikely to sufficiently reduce the risk.

2.1.8 Due to their widespread use, PFAS have been found to be ubiquitous in the environment and therefore, despite our well-established catchment management strategies, once a source of PFAS has been introduced to the environment, significant intervention is required to remove them. Whilst human exposure to PFAS from drinking water is considered to be relatively low when compared with exposure from other products and materials, such as textiles, cookware and food packaging, we are required by the Drinking Water quality Regulator (DWI) to reduce exposure from drinking water.

2.1.9 We are actively participating in industry research and special interest groups centred around PFAS in order to keep up to date with the latest developments in this field. The objectives of these groups

[1] . Kaboré, H.A. et al., 2017. Worldwide drinking water occurrence and levels of newly-identified perfluoroalkyl and polyfluoroalkyl substances. Science of the Total Environment, 616-617, pp. 1089-1100.

include the development of best practise guidance in relation to PFAS in the soil and water environment, and the exploration and assessment of new and emerging technologies to detect and treat PFAS as well as how to dispose of PFAS contaminated waste from some of these processes.

2.1.10 Following DWI guidelines, we have identified the need for additional control measures to be implemented at two WTW (Table 1) to reduce the concentration of PFAS in treated drinking raw water from the raw water concentration through additional permanent treatment solutions. The schemes are required at these sites due to the presence of individual PFAS in the raw water sources at Tier 2 concentration, where there is insufficient treatment to ensure that the final water concentration will be below the current Tier 1 threshold of 0.01 ug/l. Whilst we are currently proposing work at two WTWs during AMP8 at the current time, any changes to the regulatory requirements as more information becomes available, may require us to complete work at additional sites within AMP8 and beyond.

2.1.11 To improve our performance and enable us to supply a consistent water supply of reliable quality, we have identified two WTW impacted by PFAS in the raw water source which cannot be treated by the conventional water treatment processes at the WTW. In order to mitigate the risk posed by the presence of PFAS in raw water at present, we have implemented intelligent blending plans to control the concentration of PFAS in treated drinking water at Royal Oak WTW. We recognise that this is not a long-term solution due to the restrictions this imposes on our water resources. At Wickenhall we have detected concentrations marginally above the Tier threshold in the final water. We are required to comply with DWI's requirements to progressively reduce the concentration of PFAS in drinking water to at least Tier 1 concentrations.

2.1.12 Under the AMP8 methodology for calculating unplanned outages, the requirement to include outages on account of poor raw water quality, where this has previously been an exclusion, it is no longer possible to turn off the WTW or reduce flows, without incurring a penalty.

Table 1: Proposed scheme and associated cost at selected WTW

Water Treatment Works	Technology Summary	Estimated Cost to Deliver (Capex)	AMP8 Opex	Estimated Opex per Annum (AMP9 onwards)
Wickenhall	GAC contactor installation	£21,245,120	£102,009	£1,075,002
Royal Oak	GAC contactor installation at 3 boreholes	£27,364,241	£363,785	£1,448,283

2.1.13 Capital expenditure in AMP8 will be utilised to build the specific treatment solutions required to remove PFAS from drinking water to the required levels, as detailed in DWI Tier guidance. Operational expenditure includes maintenance of equipment as well as the cost associated with reactivating GAC or replacing with virgin carbon. Industry research is ongoing to establish the required route of handling PFAS contaminated GAC media – should virgin GAC be required to keep levels of PFAS to a minimum, our AMP9 and beyond operating costs will increase. Should this be the case, it will be reflected in our PR29 business plan submission.

3. Need for enhancement investment

3.1 Introduction

3.1.1 The presence of PFAS in raw water sources as a consequence of industrial and consumer activity is an emerging and evolving risk that we are working closely with regulators to address. This historic, third-party, activity has led to a two of our water treatment works assets being unable to robustly treat the incoming raw water to a standard that is accepted by our consumers and regulators.

3.2 Evidence Enhancement is required

3.2.1 We have allocated enhancement expenditure to nominated WTW with PFAS present in the raw water source at the DWI Tier 2 (or above) concentration and there is not currently an enhanced treatment process installed at the WTW to effectively remove the PFAS, Table 2. Our selection process involved reviewing water quality sample data and the drinking water safety plan (DWSP) risk assessment, in line with DWI guidance.

3.2.2 Research into the health effects associated with increased exposure to specific PFAS is constantly evolving. Public knowledge and concern is growing in this space and many groups are calling for action from Water Companies to reduce exposure to PFAS from drinking water.

3.2.3 The DWI published guidance for Water Companies in relation to PFAS in July 2022 (Information Letter 03/2022), setting out their expectations in relation to sample result submission, adherence to the tier system and updated risk assessments. Additional clarification has been provided by DWI on sites in tier 2 of the guidance to confirm that companies must implement measures to secure PFAS concentration in drinking water in tier 1.

3.2.4 The existing, conventional, water treatment processes at the named WTW are not capable of removing PFAS. Moreover, the current mitigation measure is to blend raw water supplies with those not contaminated by PFAS to reduce their overall concentration in drinking water. Without this mitigation, these compounds would pass through the WTW, affecting the quality of the water supplied to consumers.

3.2.5 The constant blending of sources can lead to deficiencies in production capacity due to restrictions on raw water source volumes to achieve the appropriate blending ratio which presents a significant challenge during the warm and dry months when demand for water is at its highest and the rate of surface water replenishment at its lowest.

3.2.6 Water quality sampling has revealed PFAS concentrations above the Tier 1 threshold (<0.01 µg/L) at raw water sources supplying the named WTW. The sample data further supports the knowledge that PFAS are not biodegradable as the concentration identified has remained consistent throughout the period in which samples have been collected.

Table 2: Sample results

Sampled Date	Determinand Name	Result µg/L	Sample Location	WTW	Tier
[✂]	[ ]	[ ]	[✂]	[✂]	-]
[✂]	[ ]	[✂]	[✂]	[✂]	-]
[✂]	[ ]	[✂]	[✂]	[✂]	-]
[✂]	[ ]	[✂]	[✂]	[✂]	-]
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Sampled Date	Determinand Name	Result µg/L	Sample Location	WTW	Tier
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[✂]	[ ]	[✂]	[✂]	[✂]	-]
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3.3 Scale and Timing of the Investment, including Validation from Appropriate Sources

3.3.1 At each periodic review, we have prioritised the WTW with the greatest need for intervention to allow us to distribute investments appropriately. The additional two WTW included in this enhancement case form the final part of our enhancement expenditure to address deteriorating raw water quality. The regulatory expectations, guidance, and request for submission of an Undertaking has changed since the business plan was first submitted, hence the inclusion of these supplementary requirements beyond our initial business plan submission. With PFAS guidance and regulatory expectations changing as further information becomes available, further investment maybe required during AMP8 and into future AMPs associated with PFAS.

3.3.2 To prevent water from entering supply that breaches the regulatory guidance provided by DWI, we are currently reducing output from affected water treatment works where possible to allow for appropriate blending of supplies to reduce the concentration of PFAS in drinking water. This short-term mitigation is

not feasible for the long-term due to the impact it has on raw water resource availability. These restrictions on raw water sources have not been considered as part of our Water Resources Management Plan (WRMP) and therefore it is vital that we return the affected WTW to their full capacity with all raw water sources available for treatment.

3.3.3 We have liaised with the Drinking Water Inspectorate (DWI) on our intentions following submission of our PFAS strategy and have consequently received letters clarifying their expectation of our plan. Copies of the letters of support can be found in the appendix of this document. We anticipate that formal legal instruments (Regulation 28 Notice, or Section 19 Undertaking) to complete this work by the end of AMP8 will be in place in 2024.

3.3.4 It is not possible to delay this investment until AMP9 because of the timeframe placed by the DWI Undertaking.

3.4 Activities to be delivered through Base

3.4.1 This enhancement case reflects activity that will deliver a step-change in service levels and satisfy new regulatory requirements. As such, it is unequivocally enhancement expenditure. To promote efficiency, where appropriate, we will make use of existing structures that would be otherwise redundant with the new technology. We have included allowance for enabling works to these structures within the enhancement claim. Further detail of the cost build-up can be found in section 6.

3.4.2 We have not included any related maintenance expenditure within this claim.

3.4.3 The installation of GAC contactors will require the acquisition of brand-new assets to be inserted into the treatment process as a new stage.

3.4.4 There will be a level of enabling work required on existing assets to allow for the installation of GAC contactors. This enabling work does not come within the remit of maintenance through base expenditure as it is exclusively intended for the installation of GAC contactors and therefore would not be carried out if the GAC contactor was not being installed. This work would not benefit the current operating processes.

3.5 Overlap with Long-Term Delivery Strategy

3.5.1 This intervention reflects the first five years of our long-term drinking water quality strategy. We have developed an adaptive plan which assesses the potential impacts of a range of drivers under differing scenarios. This includes consideration of the impact of climate change and our developing understanding of these metabolites that cause water quality issues.

3.5.2 The investment we have outlined is low regrets, since the raw water quality has deteriorated (by virtue of a new raw water contaminant being identified) beyond the design capability of the identified WTW. Additional investment is therefore crucial to achieve the level of service customers expect, alongside the level of performance we are aiming for in our long-term ambitions as outlined in Figure 1.

Figure 1: Our 2050 ambitions

Source: United Utilities Customer Priorities Report

3.6 Customer Support

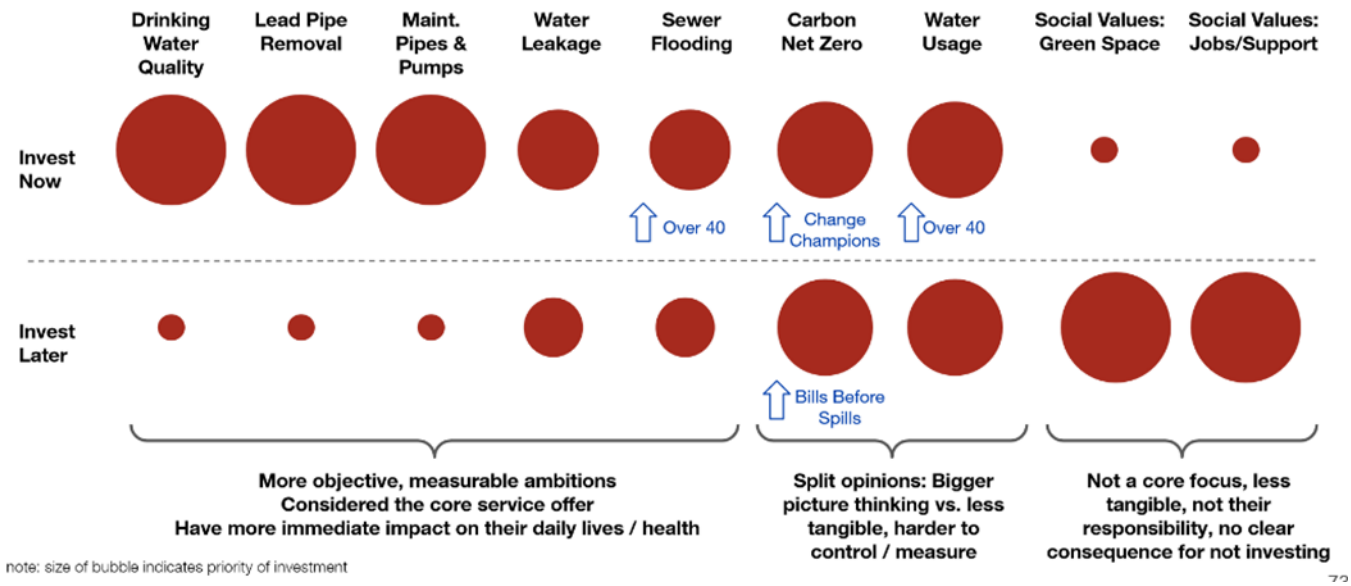
3.6.1 As part of the development of the historical and current regulatory business plans, UUW commissioned Price Waterhouse Coopers LLC (PwC) to carry out research into customer priorities.

3.6.2 The customer research identified drinking water quality as a priority ambition for most customers, with many seeing it as a core service offer and basic human need. Additionally, customer research prepared by Impact for UUW's customer priorities has shown safe clean drinking water to be ranked highest out of all our priorities for AMP8 and beyond[3]. A sufficient and reliable supply of safe clean drinking water is intrinsically linked to good public health and customer confidence in water supplies.

3.6.3 In the PwC facilitated research, customers were shown UUW plans in different thematic areas, they were asked to comment on those plans and were given a range of spend and delivery profiles to choose from. Customers were offered three spend profile options, from deferred investment resulting in ageing assets, to moderate investment focussing on long life asset replacement/maintenance, to accelerated investment. Customers indicated that they want to see more urgent investment in 'core services' that have more immediate impact on lives/health (Figure 2).

[3] https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/p143-customer-priorities-2021/final-report.pdf

Figure 2: Customer preference for timeliness of investments



Source: Long Term Delivery Strategy Ambition Testing Report

3.6.4 We consider it is appropriate for customers to fund this enhancement as it is intrinsically aligned to their highest priority of safe clean drinking water out of all our priorities for AMP8 and beyond. This work will enable an enhanced level of treatment which will meet the regulatory requirements associated with PFAS concentration in drinking water.

3.7 Factors Outside of Management Control

3.7.1 Whilst Catchment management and working with landowners will prevent new point-sources of PFAS being introduced to our water sources, it does not solve the legacy issues of historic discharges from industrial or commercial activity in the vicinity of our water sources. The chemical properties of PFAS mean that is it not possible to employ catchment solutions or management to remove PFAS from the raw water sources. It is known that PFAS do not biodegrade in the environment, and it is understood that the substances cannot be removed without specific treatment processes. Ongoing research provides evidence to suggest that PFAS can be removed through treatment with activated carbon.

4. Best option for customers

4.1 Introduction

4.1.1 PFAS are not removed with conventional treatment, therefore it is necessary that additional treatment solutions are installed at the affected WTW. We are committed to finding the most robust, no regrets solution to this problem.

4.2 Options Review

4.2.1 We have made use of industry research and knowledge sharing as well as understanding of PFAS occurrences in raw water sources to develop the most appropriate suite of options to address this risk, details of which can be found in Table 3.

4.2.2 Monitoring for PFAS is a new requirement of Water Companies, introduced by the DWI in AMP7. This results in there being limited case studies of practical applications of water treatment technologies specifically designed to reduce PFAS concentration. Treatment with activated carbon is the most studied technology and is widely regarded as the most mature technology available for drinking water treatment.

4.2.3 There is still no known solution to eliminate PFAS from the raw water at the source. It is therefore necessary to upgrade the treatment capability at the relevant WTW where PFAS pose the largest risk to water quality and water sufficiency, so that UUW can continue the provision of wholesome water.

Table 3: Options considered to address PFAS

Option	Rationale	Select/Reject	Reason
Continue with current practice	Least cost option for customers.	Reject	Does not meet the regulatory requirements or Undertakings.
Catchment interventions to reduce PFAS input	Our PFAS strategy is to prevent new sources of PFAS from entering water courses that will remain indefinitely.	Select (DWSP)	While this activity will limit the introduction of new sources of PFAS to our water sources, PFAS do not biodegrade and therefore the historic sources of PFAS will continue to be present in raw water.
Grey solutions	Robust, permanent, solutions to effectively treat taste and odour compounds.	Select	Long-term, high-utilisation solutions that are proven to resolve the issue.
Introduce or build new sources	Creating new sources or introducing new groundwater sources could ensure that there is no PFAS present in the raw water sources.	Reject	The cost associated with this would be extremely high and is not guaranteed to work as PFAS is ubiquitous.
Delay investment until AMP9	Continue to manage the risk using current practices until AMP9 so as to not contribute towards large AMP8 investment programme.	Reject	We have a statutory obligation to complete this work in AMP8.

Source: UUW options development report

4.2.4 We have a statutory obligation to make the necessary upgrades to the nominated WTW which requires enhancement investment to meet the requirements of the Undertaking. The necessary upgrades are beyond conventional treatment processes and therefore should not be considered as base maintenance activities.

4.2.5 Activated carbon has largely been accepted as the most mature technology to treat PFAS, when considering all the available information. We have therefore reviewed the technically feasible applications of activated carbon at the named WTW to achieve the PFAS requirements. Activated carbon can be utilised in two forms – powder activated carbon (PAC) added directly to the water or granular activated carbon (GAC) either as rapid gravity filter media or in containerised pressure vessels known as contactors. The application of PAC is only possible in a conventional three-stage treatment process, and not at single-stage works, such as Royal Oak WTW.

4.2.6 We undertook a desktop assessment of the available applications of activated carbon at Wickenhall WTW which resulted in the elimination of PAC and GAC as rapid gravity filter media for the following reasons:

- PAC dosing is limited and can have an adverse effect on downstream treatment processes, such as elevated turbidity leading to plant shutdowns on account of the critical disinfection parameters not being met.
- PAC dosing would result in concentrated PFAS in water treatment sludges that are disposed of *via* a sewer connection to Rochdale wastewater treatment works (WwTW). This means that we would be transferring the PFAS contamination to the WwTW where it could ultimately end up back into the natural environment.
- GAC as rapid gravity filter media would fail to meet the required contact time to achieve PFAS removal to below tier 1.

4.2.7 After carefully considering all options, we determined that GAC is the best value option for customers over PAC at Wickenhall WTW, as it is the more efficient technology and does not threaten the resilience of supplies, whilst providing the required removal of PFAS.

4.2.8 We have evaluated the available information on the best solution for customers at and determined that a robust solution, such as installing GAC contactors, is required. GAC contactors do not have an adverse impact on the downstream process or result in reductions in plant throughput, meaning that the resilience of the supply system is retained. A GAC contactor provides a permanent and continual solution for the removal of PFAS.

4.2.9 At Royal Oak WTW, a groundwater site combining raw water from six boreholes with conjunctive daily abstraction limits of 44 Ml/d. Due to the nature of Royal Oak WTW being a groundwater site, the only viable option for PFAS treatment is through GAC contactor installation. We assessed the site set up and source blending locations to determine the most efficient locations for GAC contactor installation.

4.2.10 Our assessment identified that GAC contactor installation at the three affected boreholes (Abrams Farm, Springfield and Whitegates) with a combined daily abstraction licence volume of 25.092 Ml/d would be more cost effective and efficient than installing a GAC contactor process to treat the combined flow of up to 44 Ml/d at Royal Oak WTW. This is due to the need for fewer GAC contactors in total which have the largest capex contribution in the cost estimate.

4.2.11 We will continue catchment risk assessments to identify potential sources of PFAS making their way into our source waters. We are participating in the UKWIR led Chemical Investigations Programme (CIP), which brings together the water and wastewater companies in England and Wales with the various regulators in a collaborative programme of research into current and emerging legislation on substances in the water environment. The AMP8 CIP4 will include research into a range of chemicals including further sampling on various PFAS and investigations into PFOS at 13 Wastewater Treatment Works (WwTW) and the associated catchments. This investigation will look at likely catchment inputs as well as sampling upstream and downstream of the works, the influent and effluent.

4.2.12 Our WINEP submission also includes a proposed programme of enhanced sludge quality surveillance for PFOS at five sludge treatment sites at co-located WwTW to enable us to better understand the fate and transport of PFOS.

4.2.13 We are actively participating in working groups led by external organisations to keep up to date with the latest developments in this field, these include:

- UK Water Industry Research (UKWIR) working group, assessing the potential for emerging contaminants and other research projects to understand the risks emerging from PFAS
- Construction Industry Research and Information Association (CIRA) steering group focussed on the development of best practise guidance in relation to PFAS in the soil and water environment
- Isle Utilities steering group provides an opportunity to explore and assess new and emerging technologies to detect and treat PFAS, and how to dispose of PFAS contaminated waste from some of these processes.

4.2.14 By advancing our understanding of the ways to investigate PFAS risks and treat PFAS, we will be able to apply targeted and potentially innovative ways of working on our catchment land to improve, or at least stabilise, the quality of the raw water.

4.3 Cost-Benefit Appraisal

4.3.1 Our balanced options review enabled us to determine that engineered, grey solutions was the most robust and reliable option. Following this, a desktop assessment of plausible solutions was undertaken which resulted in two options for Wickenhall WTW and one option for Royal Oak WTW being scoped and cost estimated (more detail on the cost estimating process is found in section 5). Brief details of the options put forward and the rationale for which option was chosen is included in Table 4.

4.3.2 Our claim is valued at £49.075m; this includes installation of GAC contactors and supporting assets at the affected boreholes at Royal Oak WTW and installation of GAC contactors at Wickenhall WTW, which is currently a conventional three-stage surface water treatment works.

Table 4: Solutions identified by WTW

Location	Option 1	Option 1 Capex	Option 2	Option 2 Capex	Preferred Solution	Rationale
Royal Oak WTW	GAC Contactor Installation	£27,364,241	n/a	n/a	1	Only one feasible solution
Wickenhall WTW	GAC Contactor Installation	£21,245,120	Permanent PAC Dosing	£2,124,008	1	More robust. and environmentally beneficial solution

Source: UUW options development report

4.3.3 We recognise that the more expensive option has been selected for Wickenhall WTW, however the operational limitations associated with PAC dosing have led us to this decision. GAC contactors are the more robust solution which are more likely to achieve the required PFAS removal without adjusting the current plant operating mode. For example, to achieve the necessary contact time with PAC to achieve PFAS removal, plant flows may need to be altered to accommodate this as dosing higher levels of PAC could impact the through process turbidity, which is unacceptable for disinfection.

4.3.4 Additionally, the choice of GAC contactors over PAC dosing removes the risk of transferring concentrated PFAS sludge downstream to Rochdale WwTW where the PFAS could ultimately end up being released back into the environment.

4.3.5 GAC contactors are containerised pressure vessels, sized according to the contact time required for contaminant removal.

4.3.6 We anticipate that the following benefits will be realised by both UUW and consumers by completing this series of investments:

- Maintained public confidence in water supplies by reducing PFAS concentration in drinking water;

- Compliance with regulatory requirements with respect to PFAS based on current knowledge, data and guidance.
- Continued provision of safe, clean drinking water that meets customer standards.

4.3.7 A technical submission was made to the DWI in June 2024, illustrating the factors that have led to our decision and the rationale for the proposed upgrades at each of the named sites. The submission demonstrates that the presence of PFAS in the raw water sources to the named WTW pose a risk to drinking water quality and the most appropriate next course of action is to install robust, permanent, treatment solutions.

4.3.8 Following the technical submission, we have received letters of support from the DWI for the two PFAS schemes at Royal Oak WTW and Wickenhall WTW. Copies of these letters can be found in the appendices of this document.

4.4 Best Value Analysis

4.4.1 Our approach to delivering best value is robust and consistent across all of our enhancement cases. Our approach uses a rich mix of metrics to help us drive value and efficiency in developing our business plan. Consistency of the approach is driven through our PR24 Value Tool which allows us to quantify and value environmental and social benefits, costs and risks. For more detail on this approach please see 'Our approach to deliver best value totex'.

4.5 Quantified Impact of the Proposed Options

4.5.1 Whilst the completion of this work does not relate to a specific performance commitment, we have a statutory obligation to complete this work and comply with new regulatory requirements.

4.6 Cost and Benefit Delivery Uncertainty Mitigation

4.6.1 The proposed solutions will all have a high utilisation rate due to the continuous risk posed by PFAS in the raw water sources. Concentrations of PFAS have been shown to remain constant in the raw water sources, however, could increase significantly if an additional source of PFAS is released into the environment.

4.6.2 There is evidence pertaining to the fact that PFAS are not biodegradable in the environment, therefore the existing concentrations will not reduce over time[4]. Research suggests that PFAS can be removed during treatment by activated carbon, a proven technique for removing organic contaminants such as pesticides or taste and odour compounds.

4.6.3 As knowledge pertaining to PFAS exposure and toxicity evolves, as well as the most effective methods for tracing and removing PFAS from drinking water supplies, we anticipate future changes to regulations resulting in additional duties of Water Companies. Research is underway to fully understand the mechanisms of PFAS toxicity which could be used to inform whether international health-based guideline values can be established. With these anticipated developments, we think it is likely that requirements, such as catchment investigations or modelling and increased sampling and analytical capability will be introduced before the next periodic review.

[4] Goldenman, G. et al., 2017. Study for the strategy for a non-toxic environment of the 7th EAP. Sub-study d: Very Persistent Chemicals. Milieu Ltd, Brussels, 123 p.

5. Cost efficiency

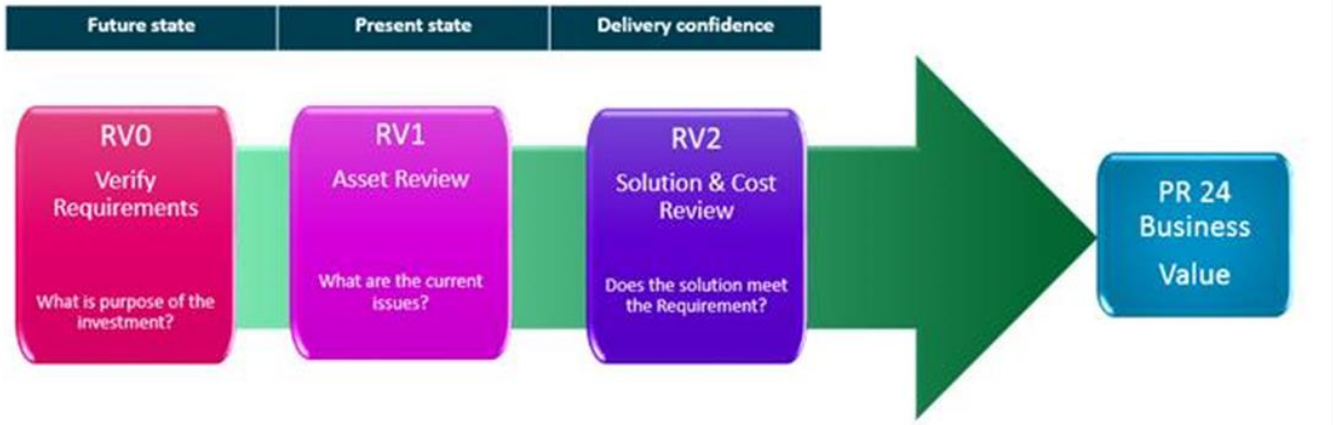
5.1 Introduction

5.1.1 To ensure robust and efficient costs in our programme we have used an estimating approach based on data collected over a number of AMPs (AMP3 to AMP7) updated to reflect present market conditions under which we and the UK Water Industry are operating. Mott Macdonald provide us and other UK water and sewerage companies with an estimating service, which allows them to provide a benchmarked approach to our PR24 capital cost estimates.

5.2 Options Development

5.2.1 PR24 options development followed the fundamental principles of UUW defined value management process. Risk and Value for PR24 (RV) was a three-stage process (Figure 3), aimed at positively challenging our projects to ensure we have sufficient evidence behind decisions. It provides United Utilities with confidence that they are proposing the right projects for the AMP8 Programme and therefore managing and maximising the value for their customers from their investments. It ensures that the organisation adopts the correct approach to option identification, development and selection to maximise the realisation of benefits associated with these investments.

Figure 3: PR24 Risk and Value process



5.2.2 Once the requirements had been clearly verified RV1 was completed in order to understand the current asset condition and performance. Without this understanding there is significant risk that proposed solutions will fail to deliver the value intended and may even fail to satisfy the requirements. This initial baselining was essential in order to allow identification of possible options against the generic high level solutions (GHLS).

5.2.3 Options to address PR24 requirements passed through a series of stages before the agreed solution was confirmed, from an initial 'un-constrained' list of options through to confirmation of the defined and estimated scope associated with a preferred solution.

5.2.4 Within the options development process, un-constrained options were identified against a list of GHLS categories (Table 5). If un-constrained options were deemed viable then additional screening was carried out to identify 'constrained' options, with further screening taking place to refine the feasible solutions and determine those to be progressed to detailed scope development and estimating. In developing feasible options the engineer will always have taken which solution could represent the best value to the customer into consideration.

Table 5: Generic High Level Solutions

GHLS	Description
Monitor & Respond	Accept risk with agreed contingency plan
Operational Intervention	Solve need by identifying targeted maintenance to restore performance
Optimise Asset	Solve need by improving performance of existing equipment
Partnership	Solving need by assistance of third parties, i.e. assisting farmers reduce pollution of watercourses
Refurbish Asset	Major asset refurbishment to restore asset life and performance
Replacement	Replace asset(s) on like for like basis
New Asset	Build new asset when all other options are not possible (this could be a NBS)
Integrated Approach	Integrated solution across asset boundaries e.g. network, process, bio-resources or catchment level solutions. An integrated solution is a systems thinking response and could be a combination of the above solution types.
Combination of generic high level solutions	Example - SuDS and a storage tank to address CSOs

5.2.5 Should a refurbishment, replacement or new asset solution be identified, a number of design tools were used to develop the requirement through to an estimated solution. Base design data was gathered from United Utilities' corporate systems to inform the design, including flow, quality and treatment performance data. In the majority of cases a 2050 design forecast was used, the exception being when there was a high level of uncertainty in the design forecast thus ensuring the most efficient design for the future.

5.2.6 For each requirement, options were identified and screened using the GHLS approach. Identification of options was more bespoke for water projects and was based on use of expert judgement based on past experience of similar schemes.

5.2.7 A detailed engineered design was then developed for all the feasible solutions identified during this screening process in order to provide comprehensive cost and carbon data.

5.2.8 It was at this stage that the options were assessed for deliverability. A review was undertaken by the Planning, Land and Environmental Team, Ground Engineering and United Utilities' Construction Services which allowed identification of risks and potential mitigation measures. This will have improved the cost accuracy associated with implementing the PR24 solution, it allowed elimination of options which are not deliverable thereby confirming feasibility. This included an assessment of the likely delivery route (including Direct Procurement for Customers) which was then used as the basis for the Contractor add-ons in the cost estimate.

5.3 Innovation

5.3.1 Throughout AMP7 United Utilities' has taken learning from AMP6 innovation roll out (such as that demonstrated with Nereda and Typhon) to deliver a new Technology Approval Process. This process identifies opportunities for innovative technologies and nature based solutions and provides a methodical approach to due diligence, innovation risk identification and mitigation planning. The approved technologies/solutions include:

- Those we have identified ourselves;
- Those suggested by our construction partners;
- Those identified by other WASCs but not yet progressed by United Utilities in AMP7 i.e. I-PHYC Algal bioreactors; and
- Global innovation insights such as that secured through our engineering service provider Jacobs and other consultants such as Stantec.

5.3.2 Our Technology Approval Process has allowed us to progress technologies into approval without the need to trial, for example the Mobile Organic Biofilm technology approved and now in detailed design and construction for our Macclesfield AMP7 scheme. This approach highlights United Utilities' credentials as a fast adopter of new technology but with deeper awareness of the inevitable innovation risks that need to be managed.

5.3.3 To develop our PR24 submission we have incorporated the technologies that have now secured 'Approved' status into our Process Decision Support Tool which was used to identify innovation opportunities by driver and site details. Where these innovation opportunities present the best value solutions they have been selected to be taken forward as the preferred solution. If the value of these novel and less well understood solutions cannot be determined with sufficient certainty they have been identified as an opportunity for United Utilities to pursue in the period between submission and delivery. Alongside this we will continue to review those innovations/solutions not yet approved but relevant to AMP8 drivers and progress these through our Technology Approval Process and, where truly necessary, deliver specific Innovation trials deemed. We believe this sets United Utilities in good standing in terms of understanding the key opportunities that innovation can deliver within our PR24 submission and will allow for further efficiency driven by our Innovation programme.

5.4 Options selection

5.4.1 The water sector is moving towards a 'best value' approach, promoted by the regulators, with a best value option being one which drives the best outcomes for the environment, society, customers and United Utilities over the long-term.

5.4.2 The value associated with the various options was assessed using the value assessment tool developed by United Utilities specifically for this purpose. This tool lists intervention type and pulls through the associated benefits and value. It assesses value against a number of benefits including all the wider environmental outcomes. The benefits were drawn from the MyRisk Risk Breakdown Structure (RBS), currently widely used in United Utilities.

5.4.3 The inputs to the value tool included costs (capex, opex and whole life), carbon (embedded, operation and whole life), data on biodiversity plus risks and benefits as described above. The outputs from the tool included a cost benefit analysis and allowed the selection of the preferred solution based on the comparison of value between the various options (RV2). The option selected was therefore that which provides the best value to customers.

5.5 GAC Market Conditions

5.5.1 A significant driver of cost for each of the schemes named within this enhancement case is the price of carbon which is related to specifics such as coal, energy and exchange rates. Coal prices are dependent on the world demand and trade in coal which in turn depends on the availability and supply of oil and gas. Recent volatility in the global energy market due to factors such as the conflict in the Ukraine resulted in a sharp increase in coal prices in 2022.

5.5.2 Between 01 February 2022 and 01 January 2023, the cost of virgin carbon increased by 11%. While we have worked with suppliers to mitigate these increasing prices, global factors have a significant impact on the cost which are not possible to control locally.

5.6 Cost Estimate Build-Up

5.6.1 A detailed breakdown of the individual construction elements and their contribution to capex is displayed in Table 6**.**

Table 6: Construction Costs

Detail	Cost
Civil New (Q) - Elements / BUE Work	£21,034,576
Mech New (Q) - Elements / BUE Work	£17,591,867
Elec New (Q) - Elements / BUE Work	£4,154,669
ICA New (Q) - Elements / BUE Work	£2,914,701
Civil Refurbishment (R) - Elements (BUE Only)	£305,303
Mech Refurbishment (R) - Elements (BUE Only)	£54,365
Elec Refurbishment (R) - Elements (BUE Only)	£28,065
ICA Refurbishment (R) - Elements (BUE Only)	£19,689
Service Ducting	£333,417
Connections and Tie ins	£256,467
Surface and Foul Drainage	£271,437
Service Diversions	£185,285
Prime Contractors Surveys	£93,972
Landscaping	£748,567
Enabling Works	£616,981
Total Capital Expenditure	**£48,609,361**
Operating Expenditure	£465,794
Totex	**£49,075,155**

5.7 Ensuring our costs are robust

5.7.1 UUW put in place a robust process to identify, scope and cost all solutions proposed within our business plan. This process is set out in detail in October's main business plan submission[5] along with supporting supplementary documents[6].

5.7.2 This process was subject to third party assurance during the development of our business plan. Full details of UUW's approach to assuring our business plan was set out in our October submission[7]. As set out within this submission, a number of third party organisations were involved in providing assurance including Deloitte, PWC and Faithful & Gould.

5.7.3 UUW's Board provided assurance that the solution development process underpinning our plan was appropriate, included extensive optioneering and that resulting expenditure forecasts were robust and efficient[8].

5.7.4 The scope and associated costs set out within this enhancement case have been developed using the same process described and assured in the above documents. This enhancement case has also set out specific evidence to support the unique aspects of this particular investment proposed. As such, we consider this to represent compelling evidence that the forecasted costs set out within this case are robust and efficient.

[5] UUW (2023) *UUW08: Delivering at efficient cost.* Available here:
https://www.unitedutilities.com/globalassets/z_corporate-site/pr24/main-documents/uuw08.pdf

[6] UUW (2023) UUW45: Our approach to best value totex. Available here:
https://www.unitedutilities.com/globalassets/z_corporate-site/pr24/supplementary-documents/uuw45.pdf

[7] UUW (2023) *UUW76: Confidence and assurance of the submission*. Available here:
https://www.unitedutilities.com/globalassets/z_corporate-site/pr24/supplementary-documents/uuw76.pdf

[8] UUW (2023) *UUW11: Board Assurance Statement*. Available here:
https://www.unitedutilities.com/globalassets/z_corporate-site/pr24/main-documents/uuw11.pdf

5.8 Benchmarking UUW's capital costs

5.8.1 In July 2024 United Utilities commissioned Mott MacDonald to carry out a benchmarking exercise of United Utilities major capital construction costs.

5.8.2 The benchmarking of costs between companies is a challenging task, as such costs are often commercially sensitive, and are not readily shared. The sharing of out-turn costs could affect market competition between contractors and suppliers.

5.8.3 Mott MacDonald provide engineering and capital delivery services to three UK water and waste water companies, and were able to determine the costs incurred by those companies in the delivery of their major capital programme. United Utilities costs were compared to the other two water and waste water companies (whose identity was not revealed to United Utilities, and who were referred to as "Benchmark 1" and Benchmark 2") and the outcome of this comparison was shared.

5.8.4 United Utilities provided cost breakdowns for high value construction projects, for use in the benchmarking exercise. The comparable project costs included elements such as materials, construction costs, and so on.

5.8.5 The benchmarking exercise found that all companies were most expensive for some line items, and least expensive for other line items.

5.8.6 When comparing all of the most expensive line items from across the three companies, and all of the least expensive line items (the max of maxs, and min of mins), United Utilities costs were 18% below the max of max, and 19% above the min of mins.

5.8.7 Looking at overall average costs, United Utilities was 2% above Benchmark 1 costs, and 3% below Benchmark 2 costs, with an average variance of 1%.

5.8.8 This indicates that United Utilities costs are comparable to other companies in the sector, and that we are not high cost outliers. We will continue to work with contractors and partners to secure cost efficiencies as we move into the delivery phase of the programme (see Appendix 1 for details of our approach to capital investment).

6. Customer protection

6.1 Introduction

6.1.1 It is important that customers have confidence that we will deliver the enhancement schemes that get reflected in our PR24 final determinations and they are suitably protected in the event of non-delivery, or if there are material changes to deliverables (including changes to dates), which leads to a change in cost (including changes in the timing of required expenditure). Ofwat proposes that, if companies fail to deliver or are late delivering improvements to customers, then price control deliverables (PCDs) should, where appropriate, be used to compensate customers. In our PR24 *Chapter 8 – Delivering at Efficient Cost, section 8.8.9* we have proposed an approach to PCDs that aims to provide customer protection, such that customers are fairly compensated for non-delivery (such as due to a change in regulatory requirements) or late delivery (including as a result of a change to a regulatory date), between PCDs, any related ODI underperformance payments, and cost sharing arrangements.

6.2 Price Control Deliverable

6.2.1 Our response to draft determination includes a re-designed Raw Water Deterioration PCD for all enhancement schemes included under this driver. The schemes named within this additional PFAS enhancement are included in the Raw Water Deterioration PCD, in DD representation document *UUWR_35 - Raw water quality deterioration*.

6.2.2 We deem it appropriate to include the two new legal instruments (Notices), UUT-2024-00002 Royal Oak WTW PFAS and UUT-2024-00003 Wickenhall WTW PFAS in the PCD deliverables for this enhancement case.

6.2.3 The Company wide PFAS strategy Undertaking does not have any associated enhancement deliverables and therefore does not fall under the remit of a PCD. Through the inclusion of the site-specific Notices at WTW named in this enhancement case in the PCD, customer investment is protected from non-delivery.

Appendix A

Drinking Water Inspectorate
Ground Floor, SW
Seacole Building
2 Marsham Street
London
SW1P 4DF
Enquiries: 0330 041 6501
E-mail: DWI.Enforcement@defra.gov.uk
DWI Website: www.dwi.gov.uk

DWI reference: UUT9

22 August 2024

Mr Grant Batty
Water Treatment Director
United Utilities Water Ltd
1st Floor, Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

Dear Mr Batty

Periodic Review 2024: United Utilities Water Ltd

DWI Scheme reference: UUT9 - Royal Oak - PFAS

Final Decision Letter – Support Proposed Scheme

The Inspectorate has completed its detailed assessment of the scheme proposed by United Utilities Water Ltd to install granular activated carbon (GAC) at the sources supplying Royal Oak Water Treatment Works, to mitigate PFAS risks for drinking water quality reasons. This was a late submission, received by the Inspectorate on 14 June 2024. A summary of the outcome of our assessment of this scheme is attached.

The detailed assessment considered the outcome of the risk assessment report(s) dated 20 September 2022, that was submitted to the Inspectorate as required by regulation 28(1) of the Water Supply (Water Quality) Regulations 2016 (as amended) for Royal Oak Water Treatment Works (and associated assets as applicable).

Based on the information submitted by the company, the Inspectorate **supports** the need for this scheme, for water quality reasons, and the supported scheme shall be included by the company in its AMP8 plan, subject to the caveats listed in the attachment.

A draft regulation 28(4) notice, UUT-2024-00002 AMP8 Royal Oak PFAS, has been received from the company and is being finalised.

I am copying this letter to

- Paul Martin, Ofwat;
- Simon Harrow, Ofwat;
- Richard Thompson and Anne Dacey, Environment Agency;
- Karen Gibbs, CCWater.

Yours sincerely

Nicholas Adjei

Deputy Chief Inspector, on behalf of the Secretary of State for Environment, Food and Rural Affairs

Cc Robin Halford-Maw, United Utilities Water Ltd
Cc Simon Benton, Principal Inspector (Enforcement), Drinking Water Inspectorate
Cc Amy Jeffrey, Company Liaison Inspector, Drinking Water Inspectorate
Cc Ashleigh Parker, Principal Inspector, Drinking Water Inspectorate

Periodic Review 2024: Late Submission Scheme

Summary of DWI Assessment – Supported

Water Company Name: United Utilities Water Ltd

DWI Scheme Reference: UUT9

Scheme Name: Royal Oak PFAS

Proposal:

Installation of Granular Activated Carbon (GAC) at the sources supplying Royal Oak Water Treatment Works.

Supporting Evidence:

Risks described in the formal PR24 submission and accompanying regulation 28(1) risk assessments, provided to the Drinking Water Inspectorate.

Conclusion:

The Drinking Water Inspectorate supports the delivery of this scheme in order to secure or maintain drinking water quality.

Caveats: None

Timescale: 31/01/2031

Estimated Cost: CAPEX: £26,955k, Annual OPEX: £1,448k

Legal Instrument Required: Regulation 28(4) Notice

Comment:

The Inspectorate has no role in determining proportional allocation of expenditure. Where technical support from the Inspectorate is given, this should not be taken by the company to imply that the scheme will be partially or wholly funded as a Quality item. We note that it is late in the Price Review process, with Ofwat publish its draft determinations on 11 July 2024.

Drinking Water Inspectorate
Ground Floor, SW
Seacole Building
2 Marsham Street
London
SW1P 4DF
Enquiries: 0330 041 6501
E-mail: DWI.Enforcement@defra.gov.uk
DWI Website: www.dwi.gov.uk

DWI reference: UUT10

24 June 2024

Mr Grant Batty
Water Treatment Director
United Utilities Water Ltd
1st Floor, Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

Dear Mr Batty

Periodic Review 2024: United Utilities Water Ltd

DWI Scheme reference: UUT10 - Wickenhall - PFAS

Final Decision Letter – Support Proposed Scheme

The Inspectorate has completed its detailed assessment of the scheme proposed by United Utilities Water Ltd to install granular activated carbon (GAC) at Wickenhall Water Treatment Works, to mitigate PFAS risks for drinking water quality reasons. This was a late submission, received by the Inspectorate on 14 June 2024. A summary of the outcome of our assessment of this scheme is attached.

The detailed assessment considered the outcome of the risk assessment report(s) dated 16 February 2023, that was submitted to the Inspectorate as required by regulation 28(1) of the Water Supply (Water Quality) Regulations 2016 (as amended) for Wickenhall Water Treatment Works (and associated assets as applicable).

Based on the information submitted by the company, the Inspectorate **supports** the need for this scheme, for water quality reasons, and the supported scheme shall be included by the company in its AMP8 plan, subject to the caveats listed in the attachment.

Consequently, a blank regulation 28(4) notice template has been attached to this letter for the Company's review. I would be grateful if the company could add measures as appropriate, to this template and submit the completed template to DWI.Enforcement@defra.gov.uk by 26 July 2024.

I am copying this letter to

- Paul Martin, Ofwat;
- Simon Harrow, Ofwat;
- Richard Thompson and Anne Dacey, Environment Agency;
- Karen Gibbs, CCWater.

Yours sincerely

Nicholas Adjei

Deputy Chief Inspector, on behalf of the Secretary of State for Environment, Food and Rural Affairs

Cc Scott Fell, United Utilities Water Ltd
Cc Simon Benton, Principal Inspector (Enforcement), Drinking Water Inspectorate
Cc Amy Jeffrey, Company Liaison Inspector, Drinking Water Inspectorate
Cc Ashleigh Parker, Principal Inspector, Drinking Water Inspectorate

Periodic Review 2024: Late Submission Scheme

Summary of DWI Assessment – Supported

Water Company Name: United Utilities Water Ltd

DWI Scheme Reference: UUT10

Scheme Name: Wickenhall PFAS

Proposal:

Installation of Granular Activated Carbon (GAC) at Wickenhall Water Treatment Works.

Supporting Evidence:

Risks described in the formal PR24 submission and accompanying regulation 28(1) risk assessments, provided to the Drinking Water Inspectorate.

Conclusion:

The Drinking Water Inspectorate supports the delivery of this scheme in order to secure or maintain drinking water quality.

Caveats: None

Timescale: 31/03/2030

Estimated Cost: CAPEX: £20,928k, Annual OPEX: £1,075k

Legal Instrument Required: Regulation 28(4) Notice

Comment:

The Inspectorate has no role in determining proportional allocation of expenditure. Where technical support from the Inspectorate is given, this should not be taken by the company to imply that the scheme will be partially or wholly funded as a Quality item. We note that it is late in the Price Review process, with Ofwat due to publish its draft determinations on 11 July 2024.

United Utilities Water Limited
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unitedutilities.com

United Utilities

Water for the North West