Affinity Water

AFW112 PFAS business case

Raw Water Deterioration Programme

August 2024

Contents

Context of this business case

Following the submission of our business plan last year, we received an assessment of our PFAS Strategy from the DWI. Whilst they were broadly supportive of our approach, they encouraged us to submit a statutory section 19 Undertaking applied consistently across the industry. This has driven significantly additional investment requirements that we have included within this business case and our wider representation. Below we give a brief overview of the context of this case.

The Undertaking includes a requirement to progressively reduce PFAS concentrations in drinking water (e.g. through blending or treatment solutions) for all sources that fall into Tier 2:

> "For all sources that fall into Tier 2, design a proactive and systematic risk reduction strategy which shall include a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water."

Note that given the presence of PFAS within source water and uncertainty of future concentrations, to dependably "progressively reduce PFAS concentrations in drinking water", treatment will be required. We have therefore planned on this basis and included customer protection to ensure costs are returned to customers should new information emerge, and treatment no longer be required.

There are also a range of other requirements that will drive additional investment requirements, including catchment management and additional monitoring:

> "Conduct operational monitoring; sampling (and analysis) extended upstream of abstraction points into catchments and sub-catchments, and downstream through different stages of water treatment to the final water sampling location, to identify the source, concentration and fate of PFAS compounds.
>
> "Conduct risk-based, enhanced, investigatory sampling (and analysis), where PFAS are detected."
>
> "Undertake catchment characterisation and identification of PFAS sources (minimum requirements defined in DWI guidance), product usage (existing data available and data gathering), catchment modelling with analysis of weather, surface and groundwater flows, catchment walkovers, identification of high-risk locations."

Following extensive engagement with the DWI we have now submitted this signed Undertaking. PFAS is a particularly significant issue for Affinity Water. Our high proportion of ground water from high-risk catchments means we face significantly higher risk than most other companies in the industry. We have therefore already undertaken a significant amount of sampling across our region and have a higher proportion of significant detections than the wider industry, as evidenced within Figure 1, taken from the DWI annual report[1].

The number of test results from raw water PFAS monitoring

Company	Total raw water tests analysed	Results below LOD	Tier 1 - <0.01 µg/l	Tier 2 - <0.1 µg/l	Tier 3 - ≥0.1 µg/l
AFW	10,652	9,999	14	566	73
ANH	121,732	116,951	4,474	285	22
BRL	2,115	1,987	113	15	0
CAM	2,822	2,807	15	0	0
ISC	799	771	21	7	0
NES	4,136	3,704	418	14	0
PRT	4,608	4,477	119	12	0
SES	366	299	66	1	0
SEW	10,976	10,610	280	86	0
SRN	12,462	11,958	406	98	0
SST	7,627	9,684	295	59	0
SVT	2,538	2,518	20	0	0
SWB	1,739	1,730	9	0	0
TMS	1,037	728	300	9	0
UUT	5,290	4,996	271	23	0
VWP	57	57	0	0	0
WSX	1,116	1,067	43	6	0
YKS	12,403	12,195	206	2	0

Figure 1. - DWI annual report comparing PFAS sample results

This high level of risk drives the need for significant investment across the 2025-30 period, reflected within this business case. The total cost of these investments is £149m, which includes treatment at 19 'Tier 2'sites and meeting the additional requirements of the Undertaking that are not already accounted for within base allowances. We have been ambitious on cost efficiency and have taken the learning from Ofwat comments within the draft Determination to ensure we provide evidence in line with Ofwat expectation for the need, optioneering and cost efficiency.

Given the materiality of this expenditure, we have carefully considered both the bill impact and customer protection. The total bill impact of this investment is

[1] DWI Chief Inspector's report 2022.pdf

approximately +£5.20 by 2030. This is one of a number of factors impacting the bill within our representation. We have tested both customer priorities and the total bill impact. The results of this engagement are summarised below:

> Customers are aware of the emerging importance of removing PFAS from water, with 33% of customers aware and a further 33% vaguely aware of the issue. This also ranked highly (third) in customers' priorities and 63% liked our proposed solution quite, very or extremely well.
>
> When asked about the bill profile as a result of this addition to our plan and the other changes in our representations, 73% of customers thought it was a little or a lot more than they were expecting.

We have considered a range of options to best protect customers in relation to this case and proposed a PCD accordingly. We provide further detail of this analysis and the proposed mechanism within the Cost Chapter, PFAS Additional Business case sub-section of our representation.

Additional uncertainty

In addition to the investment requirements addressed within this business case, the Undertaking creates material further cost uncertainty from 2025-30, with the potential additional investment requirements for sites that *become* Tier 2 during the period.

> "Where PFAS are detected in a single final water (or downstream treated water) sample, or two or more raw water (water sampled from any point prior to the final treated water point at the water treatment works) samples in a supply system not currently listed in the annex to this Undertaking, submit a change request to the Inspectorate to add that supply system to the annex."

Whilst this Undertaking is common across the industry, given the high proportion of groundwater sites for Affinity Water and high urban and industrial density within our region, the likelihood and consequence are particularly acute for Affinity Water. We lay out further evidence regarding the nature and scale of this uncertainty and a proposed approach for managing this within appendix AFW135 – Uncertainty mechanisms for PFAS (Notified item).

Given the late stage within the price control process, materiality and uncertainty, we would welcome significant further engagement with both DWI and Ofwat ahead of the final Determination.

Summary of the business case

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) occur in fire-fighting foams and coatings for carpets and textiles, among other uses. There are multiple PFAS compounds present in some of the source waters we abstract to supply customers. This is usually the result of diffuse or point-source pollution events which took place in the past, although may also be related to ongoing activities. Where we have identified the sources of pollution, we have engaged with the relevant authorities and landowners. Despite this we have been unable to enforce aquifer remediation or to recover costs of investigations and/or treatment to date. We continue to pursue this route in parallel to our AMP8 proposed PFAS schemes.

Toxicity data is not available for many PFAS, however some PFAS, such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) (two specific compounds included within the PFAS group), have been associated with adverse effects in animal and human studies at sufficient levels of exposure. Toxicological data for other PFAS compounds is currently evolving.

In January 2021, the Drinking Water Inspectorate (DWI) published new guidance which reduced the wholesomeness value (effectively the specific Prescribed Concentration or Value (PCV)) for both PFOS and PFOA to 0.1 µg/l and in July 2022 this wholesomeness value was extended to 45 other PFAS compounds (IL03/22)[2]. The guidance also included a requirement for companies to create a risk-based approach for managing PFAS concentrations in water and introduced a three-tiered approach for PFAS concentrations. Sources are classified into 3 tiers: Tier 1 <0.01 µg/l (no foreseeable risk), Tier 2 0.01 to 0.1 µg/l (Tier 2 includes moderate and low risk) and Tier 3 >0.1 µg/l (high risk).

Further guidance was published in March 2023 (IL02/23)[3] on how to approach PFAS for long term planning and investment. In response to this guidance we submitted our PFAS Strategy[4] in June 2023 and proposed five schemes (including Ardleigh Water Treatment Works (WTWs) jointly owned and operated by Anglian Water) for investment and inclusion in the PR24 business plan submission. The five schemes identified were at treatment works that treat three of our 'high risk' PFAS sources and two of our 'medium risk' sources, these were supported by the DWI, and we accepted Regulation 28(4) Notices for one site in June 2023 and the other four in October 2023.

During November 2023 (post PR24 submission) we received an assessment of our PFAS Strategy from the DWI, while they were broadly supportive of our approach, they encouraged us to submit a statutory section 19 Undertaking. This included a requirement to undertake catchment investigation and develop options for

[2] DWI information letter IL_03-2022_PFAS_Guidance.pdf
[3] DWI Information-Letter-02_2023-1.pdf
4 ASCD_Strategy_AW1078_PFAS Strategy V1.2.docx

blending / treatment to be considered for all sources that fall into Tier 2. We also revised our PFAS Strategy accordingly.

Following this update and subsequent discussions with the DWI, we reviewed our Tier 2 site risk assessments. We identified 19 sites with sufficient PFAS compounds risk to warrant investment in AMP8. The peak licence of these 19 sites, along with the four high-risk PFAS sites already covered by the 'Raw Water Deterioration PFAS Sites' Business Case, amounts to approximately 68% of our total peak licence. This effectively discounts blending as a viable large-scale option due to the numerous conditions it imposes on several sources, leaving supplies at risk.

We also concluded that adding ion exchange to three of the four high risk sites (already covered by the 'Raw Water Deterioration PFAS Sites' Business Case[5]) and installing Granular Activated Carbon (GAC) to one of the four high risk sites would mitigate the risk of PFAS in drinking water further. The proposed AMP8 enhancement investment is aligned with the DWI requirement for all sources that fall into Tier 2, and the need to design a proactive and systematic risk reduction strategy implementing a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water, and what we have agreed to in our PFAS Statutory Undertaking AFW-2023-00013 and includes:

- GAC treatment enhancement (installation and/or GAC replacement) for 18 sites where PFAS has been detected above 0.01 µg/l in the last two years and/or detected above 0.02 µg/l since 2015,
- GAC treatment enhancement for the surface works not included in the above (Egham WTW),
- addition of ion exchange for the three high risk sites and GAC treatment at the fourth high-risk site,
- catchment management investigations in the relevant catchment areas, focussing on where most of the PFAS detections have occurred (Colne catchment)
- R&D at one of our sites to assess future treatment options and
- enhanced monitoring for all Tier 2 sites.

The requirement for this investment is

- to deliver the commitments set out in our statutory section 19 Undertaking.
- to meet the commitments set out in our Strategic Direction Statement to "Deliver what our customers need, ensuring affordability for all," which encompasses "Exceed[ing] customers' expectations for drinking water," and to "Be prepared for change and resilient to shocks and stresses".
- and to continue to provide a wholesome and resilient water supply.

[5] Raw Water Deterioration PFAS Sites.docx

Project Details

<table>
<tr><th>AMP8 Spend</th><th>2025-26</th><th>2026-27</th><th>2027-28</th><th>2028-29</th><th>2029-30</th><th>Total</th></tr>
<tr><td>Capex (£m)</td><td>34.47</td><td>34.47</td><td>34.47</td><td>34.47</td><td>7.58</td><td>145.5</td></tr>
<tr><td>Opex (£m)</td><td>0.44</td><td>0.44</td><td>0.44</td><td>0.44</td><td>1.92</td><td>3.67</td></tr>
<tr><td>Totex (£m)</td><td>34.9</td><td>34.9</td><td>34.9</td><td>34.9</td><td>9.5</td><td>149.1</td></tr>
<tr><td colspan="7">Drivers</td></tr>
<tr><td>100%</td><td colspan="6">Addressing raw water quality deterioration (grey solutions)</td></tr>
<tr><td colspan="7">Benefits</td></tr>
<tr><td colspan="7">Avoid Loss of Production Capacity (Ml/d)
Capex and Opex Savings (£m)</td></tr>
<tr><td colspan="7">Economic Analysis</td></tr>
<tr><td colspan="2">NPV Costs (£m) (2025-55)</td><td>229.87</td><td colspan="3">NPV Benefits (£m) (2025-55)</td><td>403.3</td></tr>
<tr><td colspan="2">NPV (£m) (2025-55)</td><td>173.4</td><td colspan="3">Benefit / Cost Ratio</td><td>1.75</td></tr>
<tr><td colspan="7">Six Capitals</td></tr>
</table>

Natural	Social	Financial	Manufact.	Human	Intellectual
	★ ★ ★	★	★		

Project Description

The PFAS business case is driven by the DWI statutory section 19 Undertaking. This is to secure or facilitate compliance with the wholesomeness requirement to maintain potable water quality in the context of deteriorating raw water quality conditions and a future potential further change in the wholesomeness threshold limit by the DWI. The investment will result in a further step-change in the service level provided to consumers and is therefore enhancement expenditure.

In the business case we describe a series of project in Table 1, which includes:

- addressing risk from PFAS concentrations detected at 19 "Tier 2 sites" and
- further addressing the risk from our Tier 3 sites (in addition to the treatment included in our 'Raw Water Deterioration PFAS Sites').

These projects include:

- upgrading the existing granular activated carbon (GAC) at 9 of our sites,
- installing GAC at 10 of our Tier 2 sites and 1 of our Tier 3 sites,
- installing ion exchange at three of our Tier 3 sites and upgrading the resin at the fourth Tier 3 site,
- piloting alternative PFAS treatment technologies (including waste water streams) at our Roydon WTW,
- catchment management investigations of the catchment areas where PFAS have been detected,
- and enhanced PFAS monitoring.

Table 1. Project components.

Site	New GAC	Build and Install GAC	Build and Install ion exchange	New Resin	R&D	Catchment Management	Enhanced Monitoring
Batchworth		✓				✓	✓
Broomin Green	✓					✓	✓
Chertsey	✓					✓	✓
Clay Lane	✓					✓	✓
Dover Priory		✓				✓	✓
East Hyde	✓					✓	✓
Egham	✓					✓	✓
Hart Lane (Crescent Road)	✓					✓	✓
Holmestone		✓				✓	✓
Hunton Bridge		✓				✓	✓
Iver	✓					✓	✓
Marlowes		✓				✓	✓
Mill End		✓				✓	✓
North Mymms	✓					✓	✓
Northmoor		✓				✓	✓
Roydon		✓			✓	✓	✓
Stansted		✓				✓	✓
Walton	✓					✓	✓
Walton Road		✓				✓	✓
Baldock/Bowring			✓			✓	✓
Blackford			✓			✓	✓
Holywell			✓			✓	✓
Wheathampstead		✓		✓		✓	✓
Other Sites (Gerrards Cross, Bulstrode, Digswell, Chorleywood, West Hyde, Whitehall)							✓

The costs for the above are detailed in the Table 2 below.

Table 2. Cost breakdown per activity.

Activity	AMP8 Capex (£m)	AMP8 Opex (£m)	Enhanced Monitoring (£m)
Treatment			
Batchworth	6.92	0.023	0.037
Broomin Green	0.08	0.011	0.037
Chertsey	1.58	0.035	0.037
Clay Lane	3.39	0.07	0.037
Dover Priory	19.11	0.016	0.037
East Hyde	0.13	0.018	0.037
Egham	5.6	0.058	0.037
Hart Lane (Crescent Road)	0.75	0.023	0.037
Holmestone	10.72	0.016	0.037
Hunton Bridge	3.67	0.023	0.037
Iver	6.53	0.148	0.037
Marlowes	5.73	0.016	0.037
Mill End	12.13	0.044	0.037
North Mymms	0.82	0.034	0.037
Northmoor	6.17	0.023	0.037
Roydon	3.92	0.023	0.037
Stansted	3.49	0.017	0.037
Walton	1.36	0.045	0.037
Watton Road	2.06	0.017	0.037
Baldock/Bowring	10.42	0.195	0.037
Blackford	16.25	0.312	0.037
Holywell	17.83	0.32	0.037
Wheathampstead	4.38	0	0.037
Additional Monitoring			
Other Sites (Gerrards Cross, Bulstrode, Digswell, Chorleywood, West Hyde, Whitehall)			0.256
Catchment Management			
Colne Catchment Management		1.114	
River Thames Catchment Management		0.135	
Kent Catchment Management		0.035	
Other			
R&D		2.2	
Total (£m)	**149.1**		

The projects are adaptable and incorporate a level of research and development to ensure our subsequent strategies can respond to potential future changes in regulation, such as an increased range of PFAS chemicals to detect and tighter thresholds.

Project Development

Baseline Assessment

Background

PFAS are synthetic organofluorine chemical compounds that have multiple fluorine atoms attached to an alkyl chain. They include perfluorosulfonic acids such as the perfluorooctanesulfonic acid (PFOS) and perfluorocarboxylic acids such as the perfluorooctanoic acid (PFOA).

They are resistant to grease, oil, water, and heat and so they have found a large range of uses, for example, in stain and water-resistant fabrics and carpets, as well as in paints and firefighting foams, cookware, and food packaging. This is not an exhaustive list and there may be many uses of these substances that are not yet widely known. Due to the persistent nature and wide use, there are multiple PFAS compounds present in some of the source waters we abstract for supply to customers. This is usually the result of diffuse or point-source pollution events which took place in the past, although may also be related to ongoing activities.

As part of our investigation into the impact on local groundwaters of the fire-fighting foams used at Buncefield following the explosion at the fuel depot in 2005, our laboratory developed an analytical method for the detection of PFOS and PFOA. PFOS and PFOA are two well-known restricted PFAS compounds associated with adverse effects in animal and human studies at sufficient levels of exposure in water and had established guidance wholesomeness thresholds. We started our monitoring programme at the sources located around the Buncefield area and then expanded it to all our sources. Consequently, we have a good understanding of PFOS and PFOA concentrations in our source water and drinking water supplies.

Prior to 2021, the drinking water wholesomeness thresholds for PFOS and PFOA were 1.0 and 5.0 µg/l, respectively. As all the results from our source monitoring had been less than 0.4 µg/l, up until the end of 2020 our assessment of the risk from PFOS/PFOA was that it was low and manageable across all our source waters.

Toxicity data is not available for many PFAS, however some PFAS have been associated with adverse effects in animal and human studies at sufficient levels of exposure. However, as understanding of the potential impact on the environment and their toxicity of other PFAS compounds has grown, regulatory guidance has become more stringent, and a precautionary approach has been adopted. In response to this, our laboratory has continued to develop analytical methods for the wider range PFAS compounds.

In February 2022, our laboratory successfully completed the work on increasing the number of compounds detected in our PFAS analysis to include all 47 PFAS listed in the updated DWI guidance letter of July 2022 (IL 03/22). The laboratory started the validation process for the PFAS compounds used in the EU "Sum of PFAS" calculation (a subset of 20 of the listed PFAS compounds) and this has been completed and accredited in mid-2023. They will then start the validation/accreditation process for the remaining 28 PFAS compounds and expect to complete this in 2024.

In addition, during 2020 ahead of the publication of the DWI's 2021 wholesomeness value reductions, our Catchment Team were triggered to further investigate possible sources of PFAS contamination at some of our high-risk sites.

This included our Baldock Road WTW where we abstract from groundwater sources located within the Letchworth industrial area and have historically been impacted by multiple types of contamination and have been the subject of investigations and treatment schemes (blending and installation of air stripping) since the 1990s. Our investigations included groundwater sampling from previously placed investigation boreholes. Surrounding historic activities were looked at and discussed with the Environment Agency (EA) which identified a former electroplating plant with proposals for redevelopment for which we were not informed of by the Local Planning Authority (LPA).

In summer 2021 a trial consisting of progressively reducing groundwater abstractions at Baldock Road and stopping them completely for a month, whilst sampling the observation boreholes, was carried out. The results suggested the likely source of PFAS to be the former electroplating plant, which recorded PFAS at one order of magnitude higher than our source water.

Since then, we have engaged with the EA, LPA and the Landowner in the attempt to mitigate the risks and undertake some aquifer remediation. A challenge faced here is that a remediation plan had already been implemented by the landowner; the remediation addressed only the soil contamination and followed the common practice and drinking water standards of the time, which did not include PFAS. At this stage it seems that only voluntary remediation is viable for which we are continuing to liaise with all stakeholders. The landowner committed to undertake further ground investigations and an aquifer monitoring activity for contaminants trends should follow.

Our Wheathampstead WTW is another site with high risk PFAS supplies where we have been investigating the catchment area since 2017 to try to identify a link to the hexavalent Chromium (Cr VI) concentrations seen in the sources. Again, we have liaised extensively with the EA and LPA and installed five new observation boreholes. Groundwater monitoring in the catchment within those observation boreholes and other additional third-party borehole is undertaken on a regular basis. The general trend of the contaminants in the observation boreholes generally mirrors the trend observed at our abstraction boreholes. Through our investigations with the stakeholders, we have not been able to identify a single cause of the Cr VI or PFOS contamination or a point source location.

Likewise our Blackford WTW site has source waters that have shown high-risk concentrations of PFAS compounds, and we have been liaising with EA and LPA the over the last nine years regarding a development site located on the west side of the Colne Valley opposite our Blackford WTW.

In summary, we continue to pursue and explore remediation options at source with the support of relevant stakeholders, at this time no agreements are in place. Therefore, following the DWI wholesomeness limit changes in July 2022, we reviewed our risk assessments across all sources and drinking water supplies and identified five water treatment sites (WTWs) as requiring investigation: Baldock Road and Bowring in combination, Blackford, Holywell, Wheathampstead and Ardleigh WTW jointly owned and operated by Anglian Water.

Following optioneering and economic impact assessment, we recommended a number of schemes for investment and inclusion in the PR24 business plan submission, as detailed in our Appendix AFW-14b.

We also provided our PFAS strategy to DWI in June 2023 and received their response in November 2023 which included a requirement to undertake catchment investigation and develop options for blending / treatment to be considered for all sources that fall into Tier 2. We therefore conducted a further assessment of all of our sources, as detailed in the 'Data Analysis' section below and developed the business case accordingly.

Data Analysis

As part of our data analysis into the impact of PFAS compounds in our source waters and drinking water supplies the following assessment was completed.

- We conducted catchment risk assessments. These are continually maintained and updated (with a full review carried out at least every 5 years) as part of a continuous programme to ascertain potential sources of point source and diffuse pollutants within the catchment area of an abstraction. The risk assessment includes the 'source' characteristics relating to land use and inferred potential pollutants associated with the land use activity, the 'pathway' characteristics relating to the properties of the aquifer or surface water, and 'receptor' characteristics being the borehole or surface water intake including an analysis of water quality seen at the receptor.
- We reviewed the extended suite of PFAS compounds, full details are included in PFAS Review 2024 'What PFAS compounds do we see where?'[6]
- Confirmed PFAS Tier score – historical and past two years.
- Reviewed historical PFOS and PFOA results and trends to help establish trend data.
- Prioritised highest to lowest PFAS compounds detections and cross check mean and maximum values DWI PFAS 47.
- Following the further update in guidance from the DWI during August 2024[7] which includes the expectation to consider the effect of combined concentrations of the PFAS chemicals, we validated our data analysis and

[6] PFAS Strategy – What PFAS compounds do we see where FINAL.docx
[7] DWI_PFAS-Guidance_Aug-2024_FINAL-2.pdf

included a review of the sum of PFAS concentration detected in samples taken since monitoring began in February 2022. This showed no additional sites were at risk at this stage of falling into Tier 2 or 3.

Our initial review of the extended suite of PFAS compounds identified 65 sources with positive detections of PFAS compounds greater than 0.01 µg/l (excluding our Tier 3 PFAS sites sources). These supply 26 Water Treatment Works. Two WTW Bow Bridge and Periwinkle Lane are no longer in supply due to sustainability reductions, and three sources supplying three of our WTW are due to have licences revoked (Runley Wood Chalk 3 end of 2024, Redbourne and Friars Wash during AMP8). Grafham import and Ardleigh WTW are not included in this review as both supplies have been assessed by Anglian Water.

We further analysed the data and identified 19 sites where PFAS had been detected above 0.01 µg/l in the last two years (2022-2023) and/or above 0.02 µg/l since 2015 and/or is a surface works, as shown in Table 3 below.

The peak licence of these 19 sites plus the four risk PFAS sites already covered by the 'Raw Water Deterioration PFAS Sites' Business Case amounts to approximately 68% of our total peak licence.

Table 3. Short Listed Sites.

WTW	Sources	Catchment	Tier 2	Sites detected in last 2 yrs and/or = or >0.02µg/l ever	Surface Works
Batchworth	Batchworth Raw 2,3,4	Colne	Y	Y	
Broomin Green	Broomin Green Raw 1 & 2	Lee	Y	Y	
Chertsey	River Thames (Chertsey Intake) & Abbeymeads Raw 1, 2, 3 & 4	Thames	Y	Y	Y
Clay Lane	Berrygrove Raw 1, 2 & 3; Bricket Wood Raw 1 & 2; Bushey Hall Raw & Well; Bushey Raw 4; Eastbury Raw 1, 2 & 3; Netherwild Raw 1,2 & 3; Tolpits Lane Raw 1 & 2; Wall Hall Raw 1 & 2.	Colne (Herts) & Ver	Y	Y	
Dover Priory	Dover Priory Raw & Cow Lane Raw	Dour	Y	Y	
East Hyde	East Hyde Raw 3	Lee Upper	Y	Y	
Egham	River Thames (Egham Intake)	Thames	Y	N	Y
Hart Lane	Crescent Road Raw 4, 5 & 6	Lee Upper	Y	Y	
Holmestone	Holmestone Raw	Dour	Y	Y	
Hunton Bridge	Hunton Bridge Raw 2 & 4	Colne	Y	Y	
Iver	River Thames (Sunnymeads Intake)	Thames	Y	Y	Y
Marlowes	Marlowes Raw 3 & 4	Colne	Y	Y	
Mill End	Mill End Raw 2, 4 & 5 Springwell R2, 3	Colne	Y	Y	
North Mymms	Essendon Raw, North Mymms Raw, Roestock Raw & Tyttenhanger Raw	Colne & Lee Upper	Y	Y	
Northmoor	Northmoor Raw 1, 2 & 3	Colne	Y	Y	
Roydon	Roydon Raw 1 & 3	Lee Upper	Y	Y	
Stansted	Stansted Raw 1 & 2	Lee Upper	Y	Y	
Walton	River Thames (Walton Intake) & Walton Well	Thames	Y	Y	Y
Watton Road	Watton Road Raw 1 & 2	Lee Upper	Y	Y	

Uncertainty of Measurement and Limit of Quantification (LoQ)

The 2018 amendment water regulations include a minimum performance characteristic termed 'Uncertainty of Measurement' for parameters listed in the new Table A3 of Schedule 5 - Minimum performance characteristic 'uncertainty of measurement. This requires companies ensure that uncertainty of measurement and limit of quantification are calculated and appropriately accredited. For the purposes of this review where a result has been recorded as less than the LoQ a 'zero' value has been used where graphs have been used to interpret results and trends. It should be noted that the LoQ for some of the PFAS compounds are higher than the limit of detection (the previous reportable limit used) and this may falsely indicate that the compound is no longer at the lower concentrations that were previously reported where the LoQ has increased.

1. Batchworth WTW

Batchworth WTW is located centrally to the town of Rickmansworth, Hertfordshire. Raw water is supplied from three unconfined chalk boreholes. The catchment is a mixture of urban and rural areas. Water from some of the sources on occasions shows elevated turbidity and PFAS compounds have been detected. Treatment at the site includes validated ultra-violet (UV) irradiation followed by chlorination with contact for disinfection, which would not be effective for directly removing PFAS compounds.

PFOS concentrations in borehole 3 and 4 sources are generally below 0.01µg/l and have shown a declining trend over the last decade, positive detections have been seen in borehole 2 with an average PFOS concentrations of 0.011µg/l, however the trend does appear to be gradually increasing as shown in Figure 2 PFOA concentrations were last detected in two of the sources over a decade ago and have since been less than the LoQ, as shown Figure 3 below. No other PFAS compounds have been detected >LoQ in the source waters.

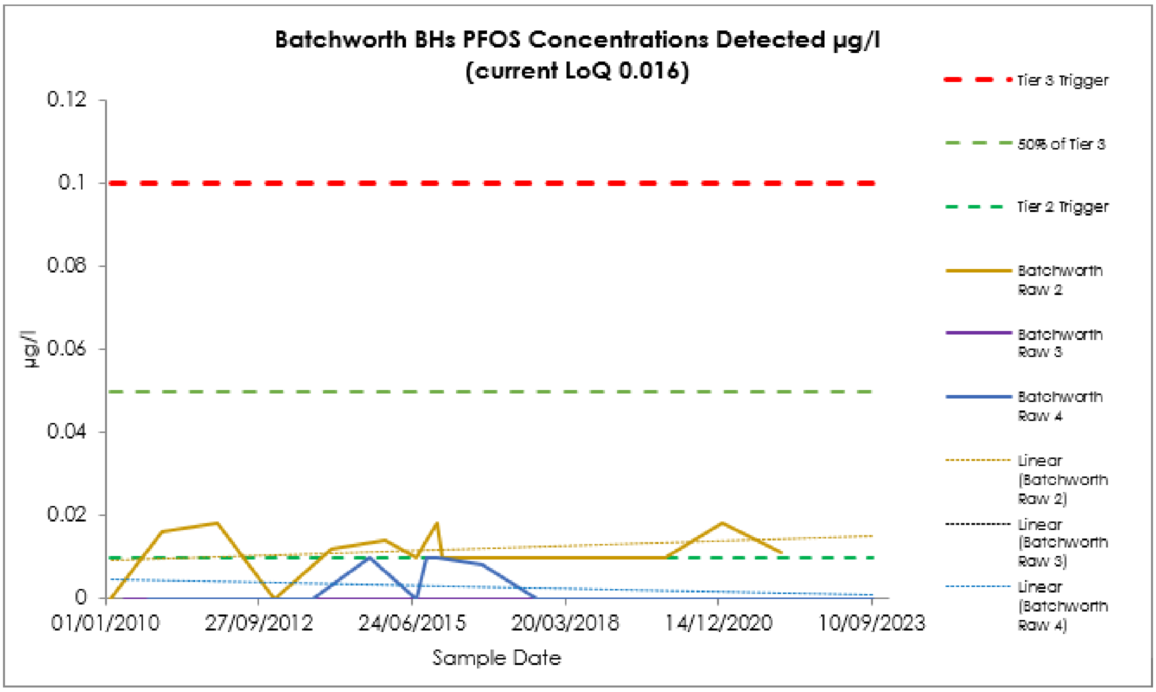

Figure 2. Batchworth BHs PFOS Concentrations Detected µg/l

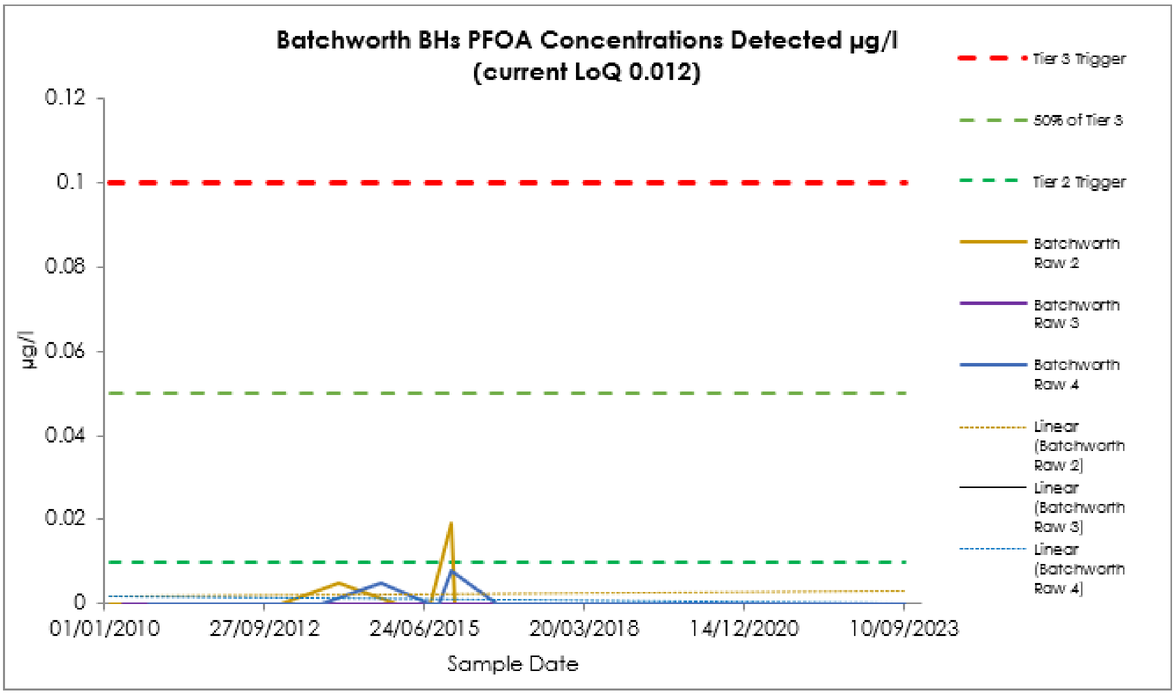

Figure 3. Batchworth BHs PFOA Concentrations Detected µg/l

We have two sets of the full PFAS analysis suite taken from Batchworth final water in June 2022 and March 2024 which both showed all PFAS results <LoQ. Given the historic PFAS analytic data trends it is unlikely water leaving Batchworth WTW will be at risk of entering Tier 3 PFAS concentrations. We will continue with enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. However, as we have detected PFOS concentrations in the raw waters, in order to reduce the risk of any PFAS being in the final water above 0.01 µg/l then PFAS treatment will be needed.

2. Broomin Green WTW

Broomin Green WTW is located in Stevenage, Hertfordshire and shares the site with one of our area offices. Raw water is supplied from two unconfined chalk boreholes. The catchment is a mixture of residential and industrial areas. Consequently, water from the source contains elevated concentrations of pesticides including Atrazine, Bromacil, & Diuron and PFAS compounds have also been detected.

PFOS concentrations are generally above 0.01µg/l and have shown a decreasing trend over the last decade, as shown in Figure 4. PFOA concentrations have been declining over the last the decade, as shown in Figure 5 below. One other PFAS (PFHxS) compound has been detected >LoQ in the source waters.

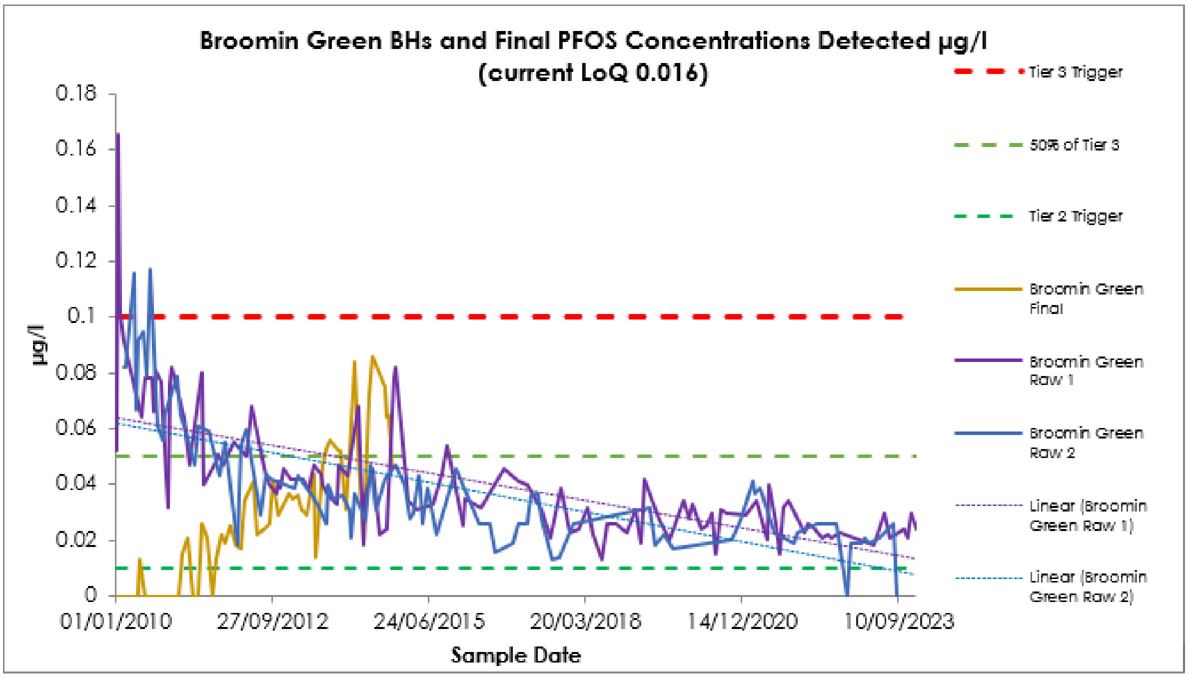

Figure 4. Broomin Green BHs and Final PFOS Concentrations Detected µg/l.

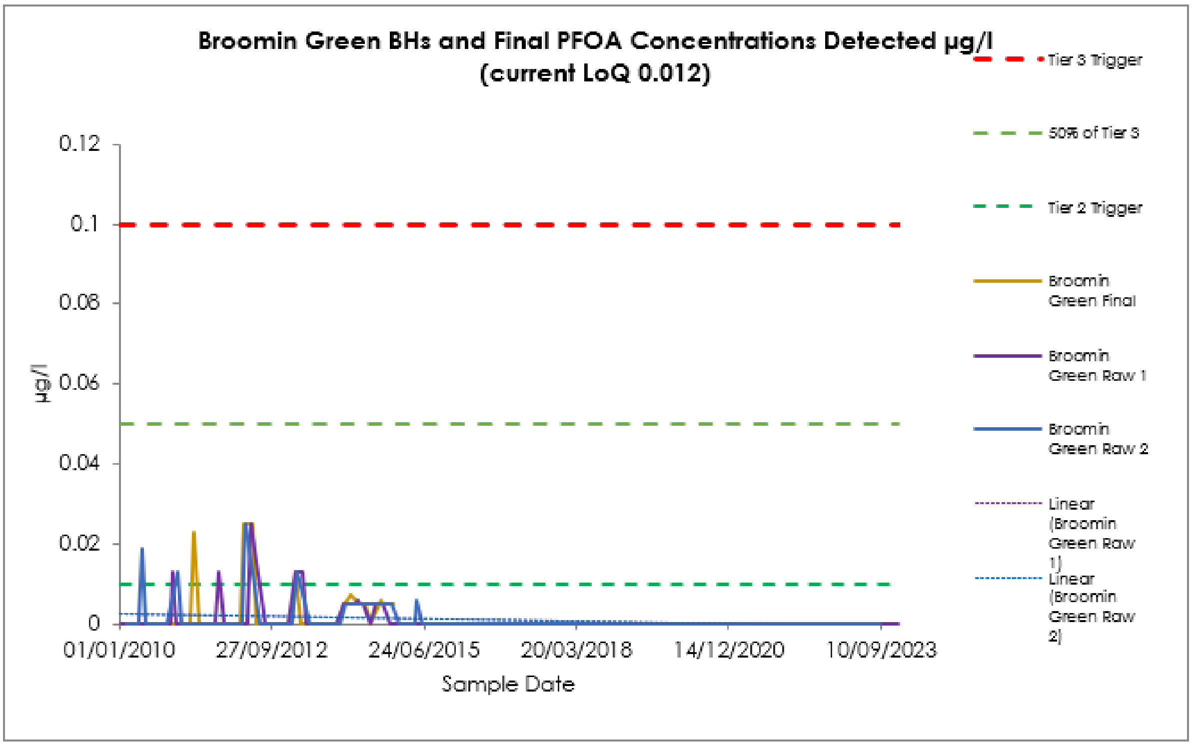

Figure 5. Broomin Green BHs and Final PFOA Concentrations Detected µg/l.

PFHxS is another PFAS compounds detected at Broomin Green sources at low concentrations around 0.01 µg/l as shown in Figure 6 below.

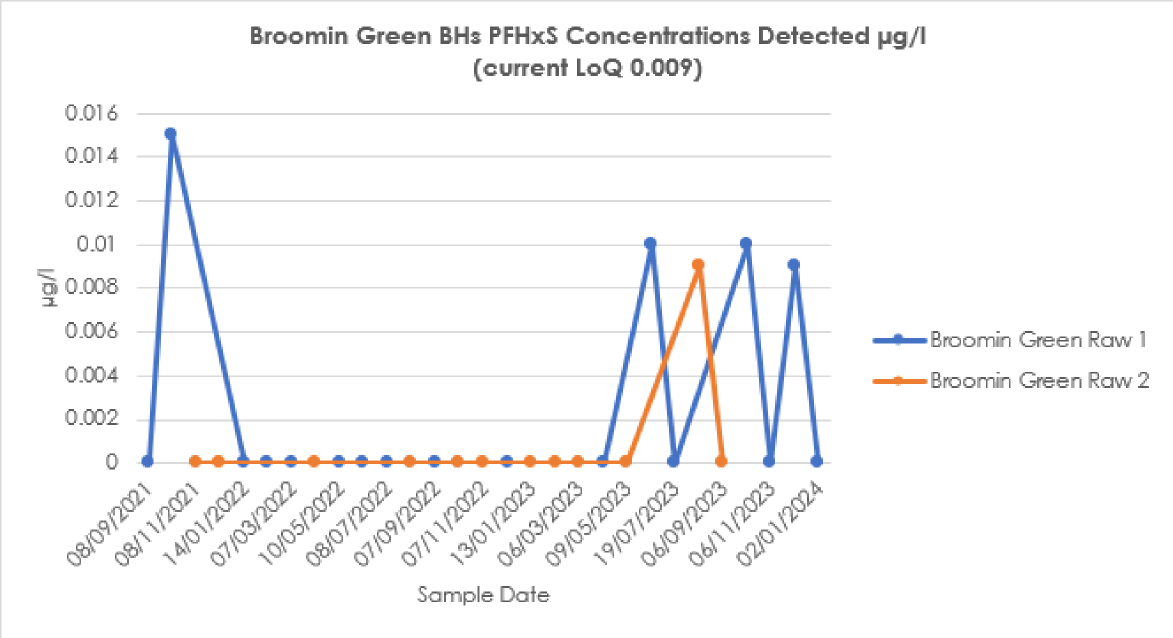

Figure 6. Broomin Green BHs PFHxS Concentrations Detected µg/l.

The treatment process which would be expected to remove PFAS compounds at Broomin Green is GAC, and we do see a reduction in PFOS concentrations following replacement of GAC media for a short period. Given the historic PFAS detections and the high-risk nature of the catchment, it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

3. Chertsey WTW

Chertsey WTW is located near Chertsey town in Surrey. Raw water is comprised of surface water from the River Thames and groundwater from Abbeymead Wells 1, 2 & 3 (and well field 4 which is currently out of supply). The Thames catchment contains heavily urbanised areas in the east and northern parts while the western parts of the catchment are predominantly rural. As a result, water quality is an ongoing challenge in the Thames, including pollution from sewage treatment works, and significant challenges from agricultural pollution and urban runoff.

Despite this the concentration of both PFOA and PFOS detected in the River Thames have shown decreasing trends over the last decade as shown in Figure 7 and Figure 8, and none of the extended suite of PFAS compounds have been detected since monitoring began approximately two years ago.

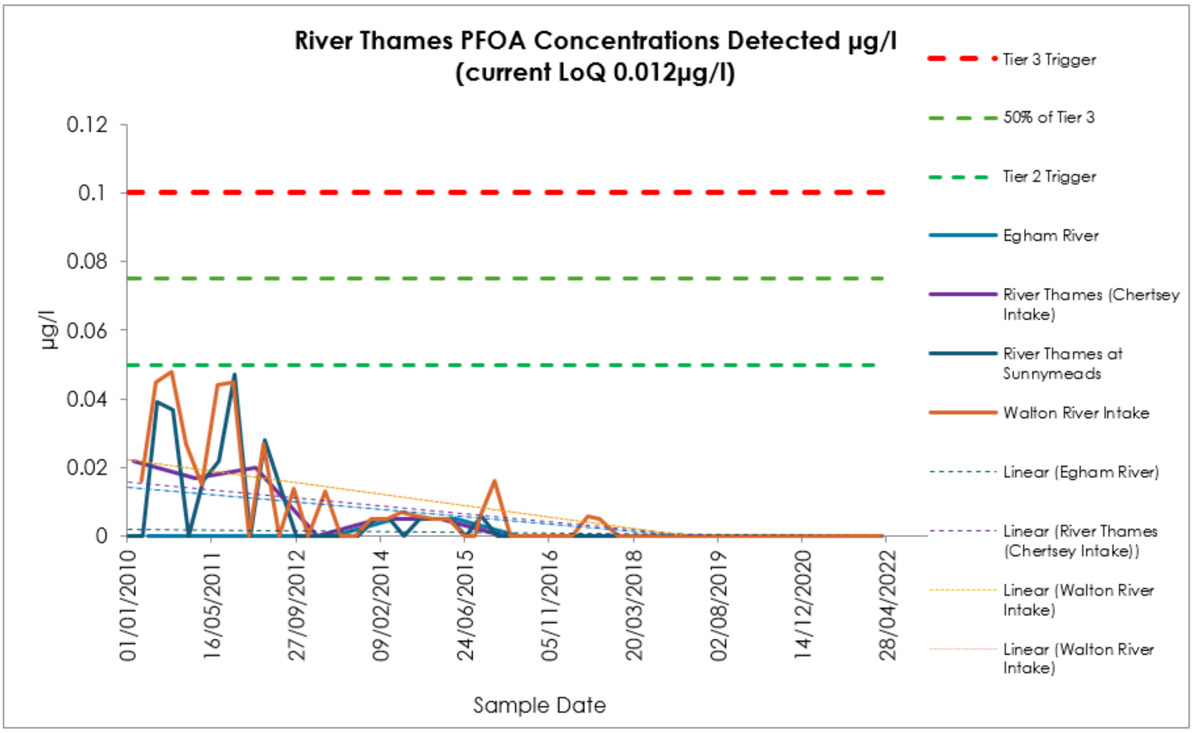

Figure 7. River Thames PFOA concentrations detected µg/l.

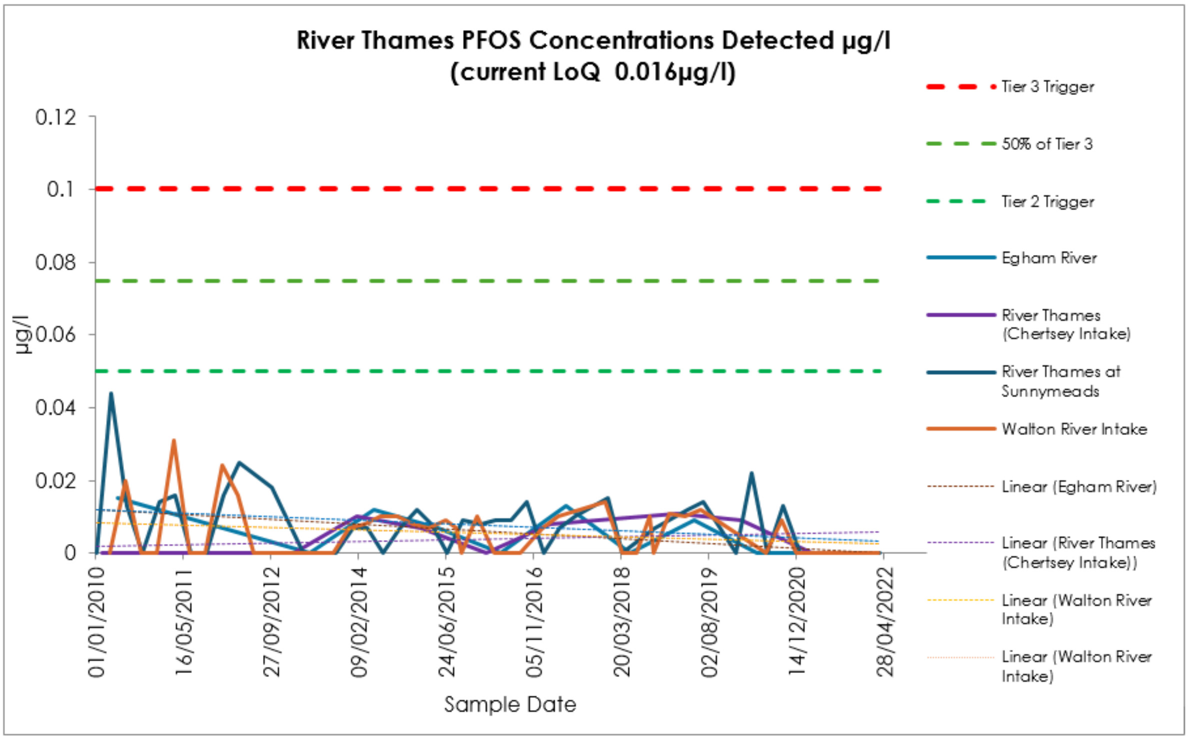

Figure 8. River Thames PFOS concentrations detected µg/l.

However, as mentioned earlier Chertsey WTW is also supplied by Abbeymeads Wells a separate source stream that is treated by membrane filtration before combining with the river water stream at the interozone treatment stage and contributes to approximately 38% of licenced output from the WTW. In addition, if there is reason to stop abstraction from the river stream, the Abbeymead wells can contribute to 100% of the supply raw water.

PFOS concentrations at the combined membrane inlet are relatively stable at 0.012 µg/l and most recent results are <LoQ of 0.016µg/l, as shown in Figure 9 below. PFOA have shown decreasing trends over the last decade as shown in Figure 10. Chertsey membrane plant inlet has shown a single sample result taken on 02/01/2024 with a PFBS concentration of 0.025µg/l, 10 samples taken for PFBS have shown results <LoQ 0.010 µg/l up until 19/04/2022 and <LoQ of 0.009 µg/l since then.

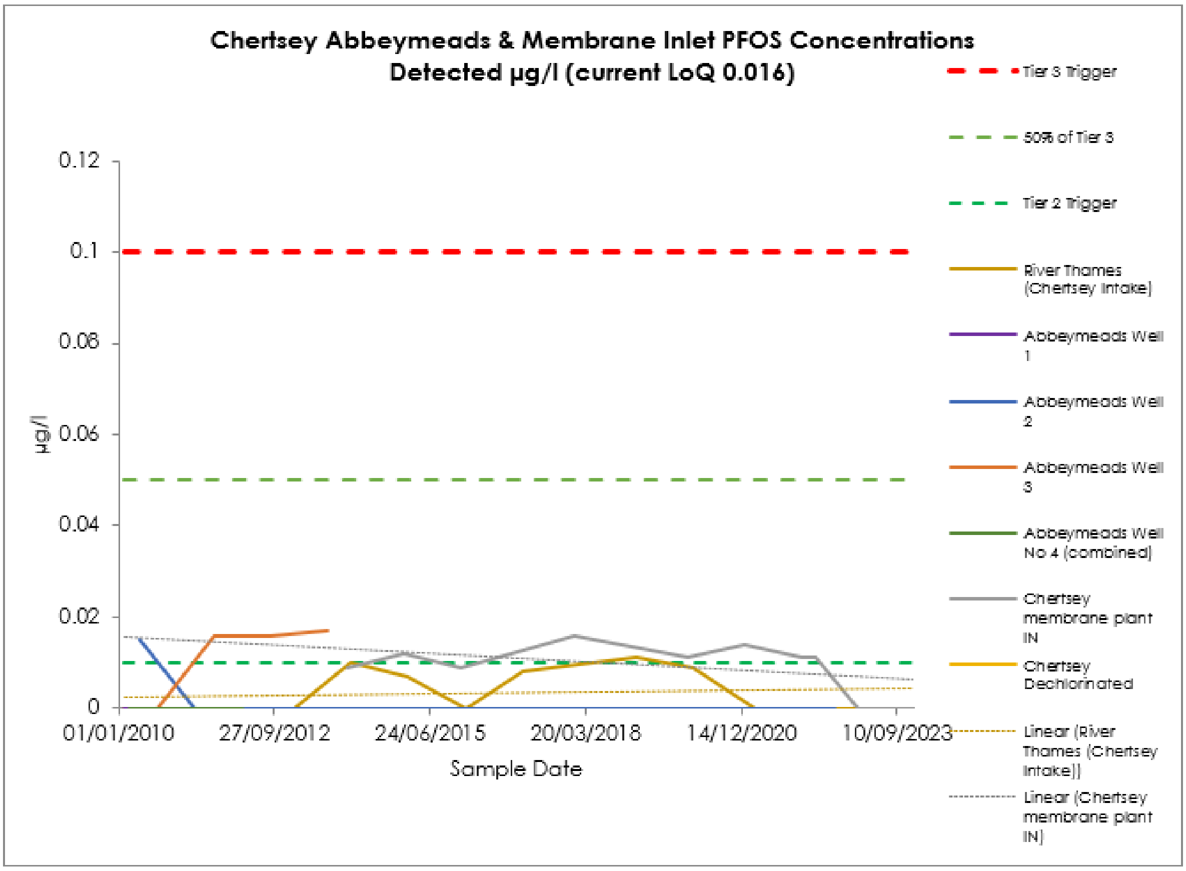

Figure 9. Chertsey Abbeymeads & Membrane Inlet PFOS Concentrations Detected µg/l.

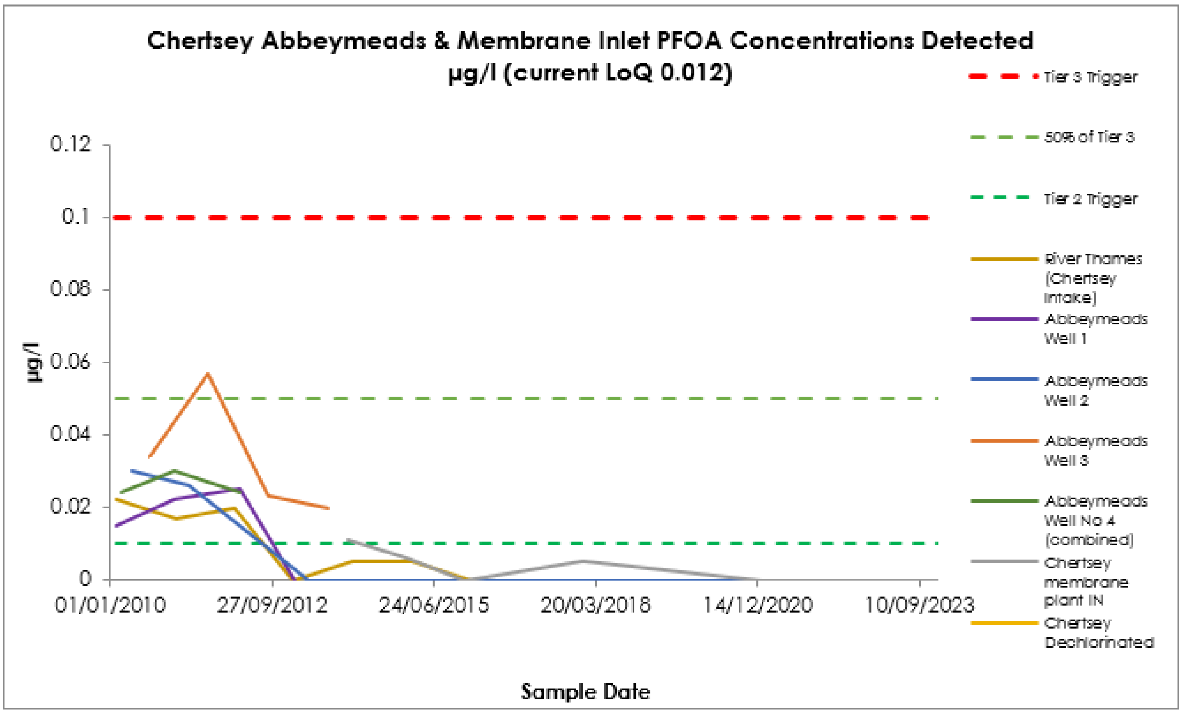

Figure 10. Chertsey Abbeymeads & Membrane Inlet PFOA Concentrations Detected µg/l.

We have one set of the full PFAS analysis suite taken from Chertsey final water in February 2023 which showed all PFAS results <LoQ. The treatment process which would be expected to remove PFAS compounds at Chertsey is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTWs. Given the historic PFAS detections in the well water sources, the high-risk nature of the catchment and recent detection of PFBS it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

4. Clay Lane WTW

Clay Lane WTW is supplied from eight borehole sites located in and around the Watford area, along the Colne Valley in Hertfordshire - Bricketwood, Berrygrove, Eastbury, Bushey Hall, Netherwild, Bushey, Wall Hall & Tolpits Lane. All water is sourced from a karstic aquifer. The catchment is approximately 50% urban, 50% rural with historic and current landfill sites. Main roads running through the catchment are the M1 and M25 motorways, an oil line runs through the north of the catchment.

Consequently, water from some of the sources contains elevated concentrations of PFAS compounds, nitrite, nitrate, sum of tri- and tetra-chloroethene (TCE), manganese, pesticides, and elevated turbidity.

There are two treatment streams at Clay Lane WTW: the 27" stream (Inlet 1) and the 36" stream (Inlet 2). The 27" stream is predominantly comprised of Bricketwood, Berrygrove, Bushey Hall, Netherwild, Bushey & Wall Hall raw water sources. The 36" stream is predominantly comprised of Berrygrove, Eastbury, Bushey Hall, Bushey & Tolpits Lane raw water sources. Blending of the source waters and the current treatment processes at the WTW which comprise of GAC filtration, chlorination, disinfection by ultrafiltration membrane and orthophosphate dosing for plumbosolvency control in the final water manage the raw water challenges to ensure wholesomeness of final drinking water to current guidance values.

The pie chart below Figure 11 shows the different PFAS compounds detected in the source water and the maximum concentration. Seven different PFAS compounds have been detected, PFOS has been observed at the highest concentrations and most frequently.

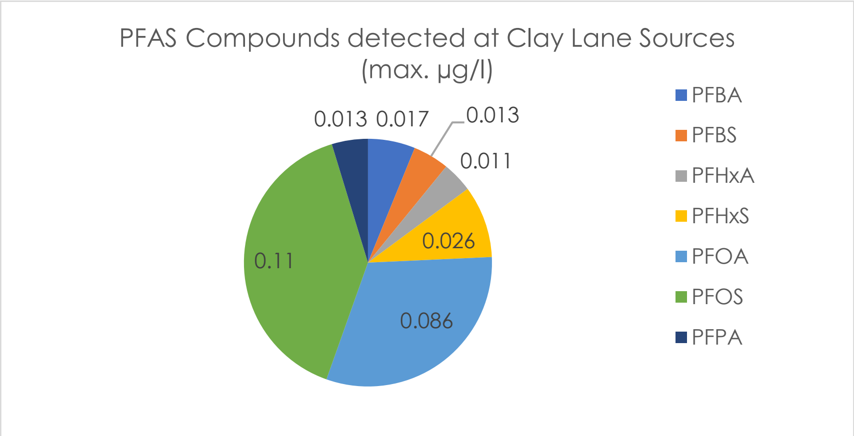

Figure 11. PFAS Compounds detected at Clay Lane Sources (max. µg/l)

Table 4. below summaries where the PFAS compounds have been detected at the sources and Figure 12 shows the PFOS concentrations detected in the source waters since 2010.

Table 4. PFAS compounds detected in Clay Lane sources.

PFAS Compound	Current LoQ	Details of Sources	Group
PFBA Perfluorobutanoic Acid CAS: 375-22-4	0.009	Tolpits Lane Raw 1 (single detection) of 0.017µg/l in June 2023.	Short-chain Perfluoroalkyl carboxylic acids (PFCA)
PFBS Perfluorobutanesulfonic acid CAS: 375-73-5	0.009	One or two detections have been seen at Tolpits Lane Raw 1.	Short-chain Perfluoroalkyl sulfonic acids (PFSA)
PFHxA Perfluorohexanoic acid CAS: 307-24-4	0.008	Detections at Berrygrove Raw 2 and 3, Tolpits Lane Raw 1 and 2,	Short-chain Perfluoroalkyl carboxylic acids (PFCA)
PFHxS Perfluorohexanesulfonic acid CAS: 355-46-4	0.009	Detected at Tolpits Lane Raw 1 and 2, Bushey Ps 4 Well, Eastbury Raw 1, 2 and 3.	Long-chain Perfluoroalkyl sulfonic acids (PFSA)
PFPA (PFPeA) Perfluoropentanoic acid CAS: 2706-90-3	0.009	Regularly detected Berrygrove Raw 2 and 3 up to a concentration of 0.013µg/l (single positive result from Raw 1). Less frequent detections at Tolpits Lane Raw 1and 2.	Short-chain Perfluoroalkyl carboxylic acids (PFCA)
PFOA Perfluorooctanoic Acid CAS: 335-67-1	0.012	Historically detected at Tolpits Lane Raw 1 and 2, Bushey Hall, Berrygrove Raw 3, Bricketwood Raw 1. and Netherwild Well.	Long chain Perfluoroalkyl carboxylic acids (PFCA)
PFOS Perfluorooctane Sulfonate CAS: 1763-23-1	0.016	Detected in all sources see Figure 12.	Long-chain Perfluoroalkyl sulfonic acids (PFSA)

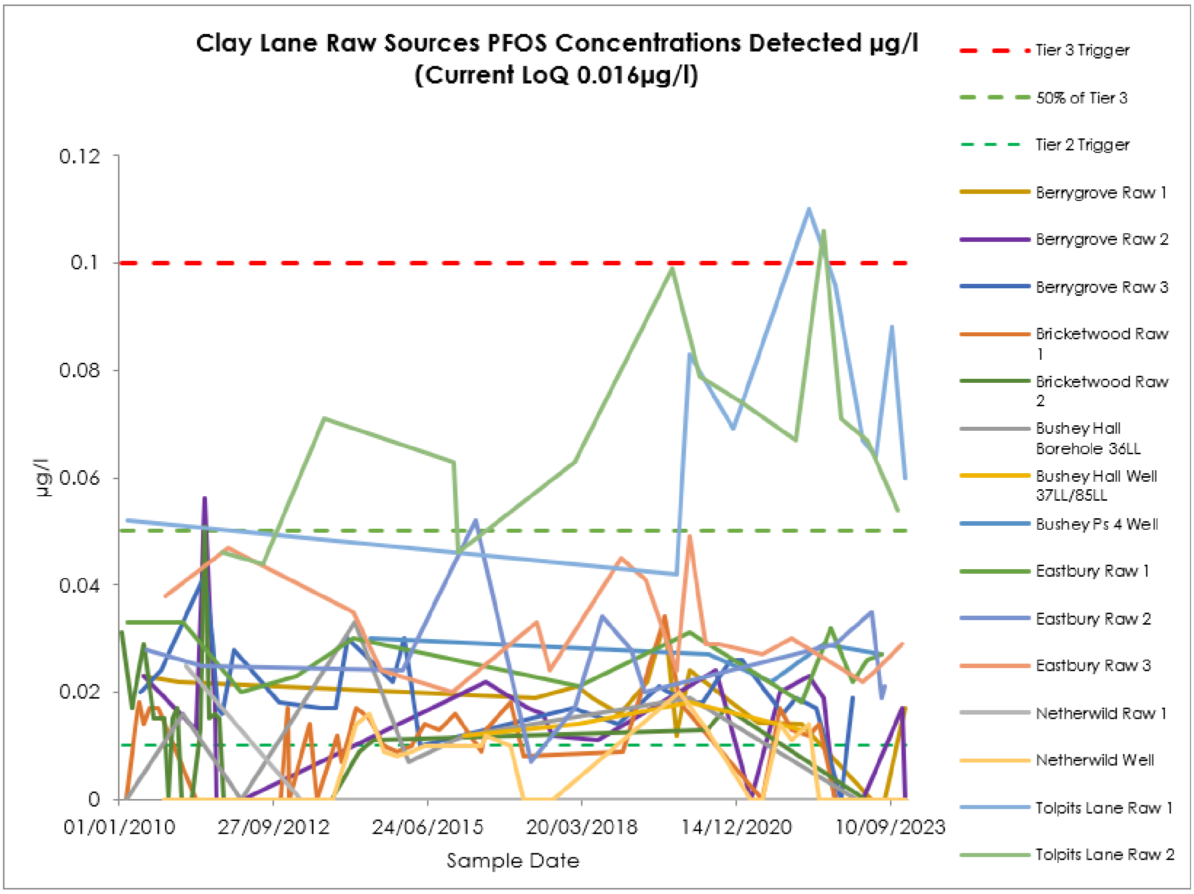

Figure 12. Clay Lane Raw Sources PFOS Concentrations Detected µg/l

While blending of source waters ensures the concentration of PFAS in the final is less than 0.1 µg/l (Tier 3), PFOS in the Tier 2 concentrations are seen in the incoming and final water, lower concentrations of PFOA are also detected in the incoming water but no detections have been seen in the final water, as shown by the graphs below Figure 13 and Figure 14. Concentrations of PFOS are relatively stable at about 0.02µg/l, two sample results showed concentrations >0.05µg/l (i.e. high Tier 2), 0.052µg/l (19/07/2017) and 0.06µg/l (17/09/2019) in Clay Lane Inlet 2. PFOS trends seen over the last decade are gradually increasing (note no samples were collected from these samples points in 2023).

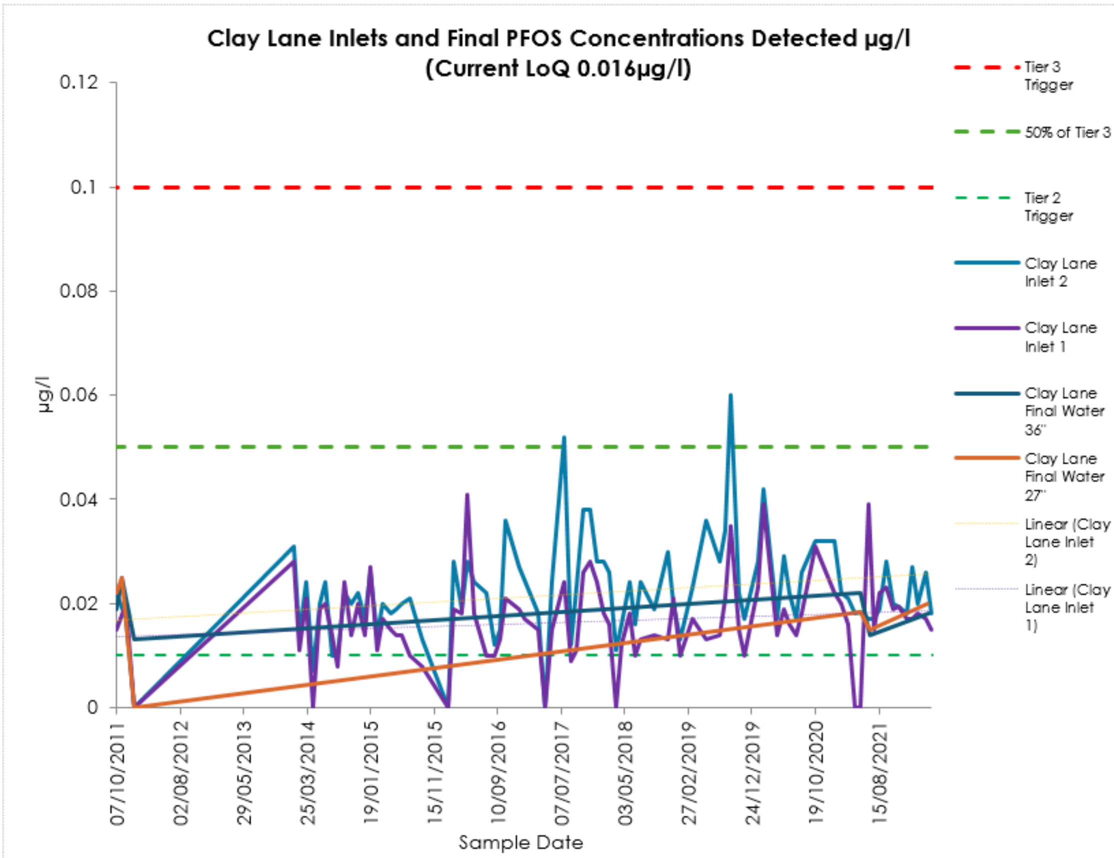

Figure 13. Clay Lane Inlets and Final PFOS Concentrations Detected µg/l.

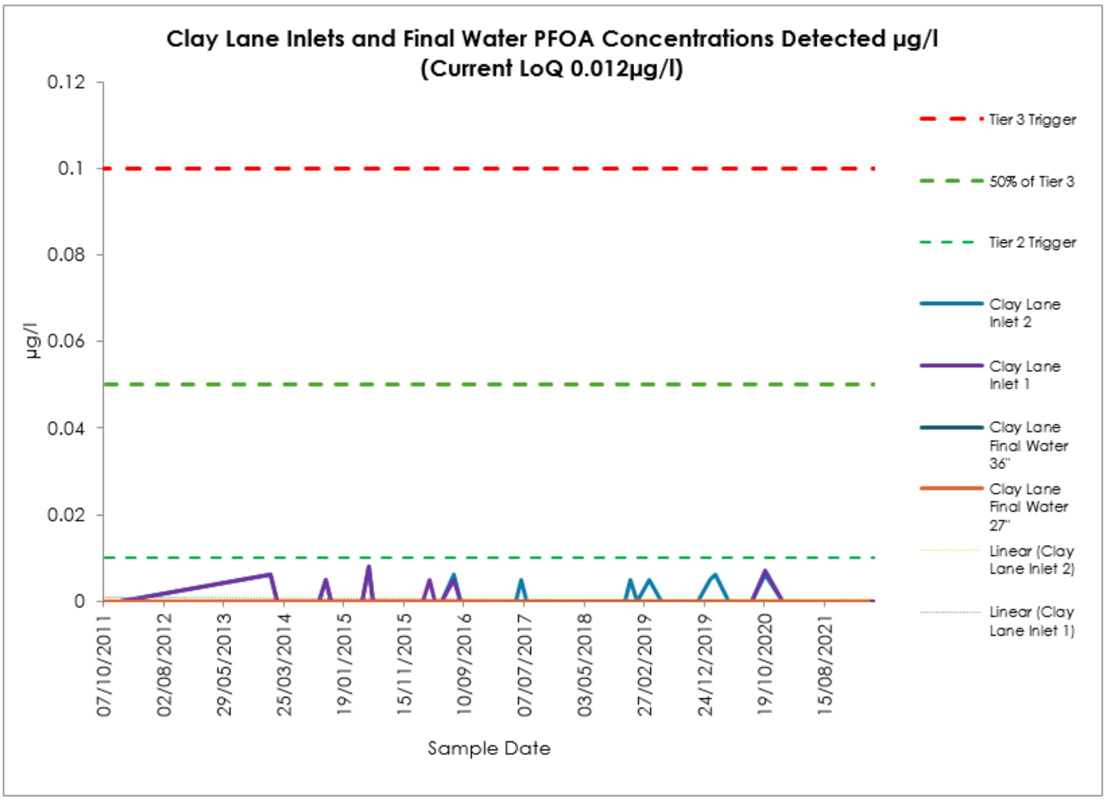

Figure 14. Clay Lane Inlets and Final PFOA Concentrations Detected µg/l.

Clay Lane Inlets and Final PFOA Concentrations Detected µg/l. The treatment process which would be expected to remove PFOS at Clay Lane is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTW. Blending of the source waters ensures concentrations are less than 0.1 µg/l, but with the concentration of PFOS showing an increasing trend and the drive to reduce PFAS concentrations further it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

5. Dover Priory WTW

Dover Priory WTW is located in a suburban area central to Dover, immediately adjacent to the railway station and maintenance yard. Raw water is supplied from an unconfined chalk well, and an unconfined chalk offsite borehole (Cow Lane). The catchment for Dover Priory is mainly urban with residential, schools, an industrial area, a railway, with some conservation, while for Cow Lane the catchment is mainly rural with arable farming and conservation areas. Water from the Cow Lane source shows elevated turbidity on occasions and PFAS compounds have been detected in the Dover Priory source. Cartridge filtration have been installed at the Cow lane source to mitigate turbidity and treatment at Dover Priory includes validated UV irradiation followed by chlorination, which would not be effective for directly removing PFAS compounds.

PFOS concentrations in Dover Priory raw are now generally below 0.01µg/l and have shown a declining trend over the last decade as shown in Figure 15. PFOA concentrations have also been declining over the last the decade, as shown in Figure 16 below. No other PFAS compounds have been detected >LoQ in the source waters. A single sample has been taken from Cow Lane raw source in 2022, which showed no PFAS compounds.

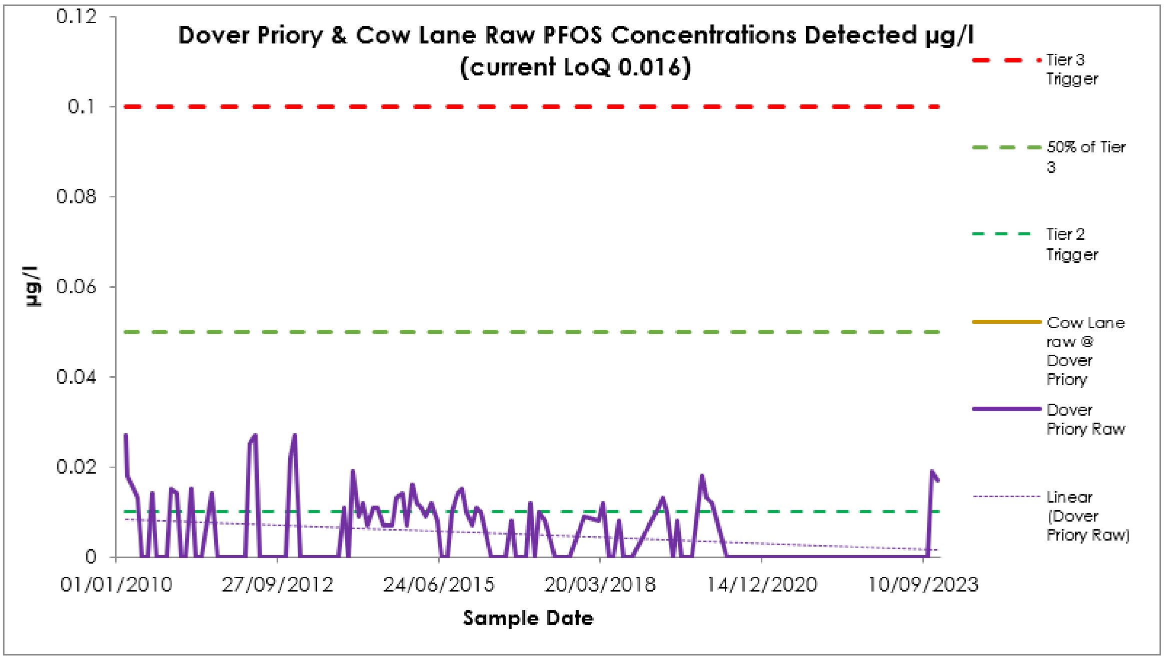

Figure 15. Dover Priory & Cow Lane Raw PFOS Concentrations Detected µg/l.

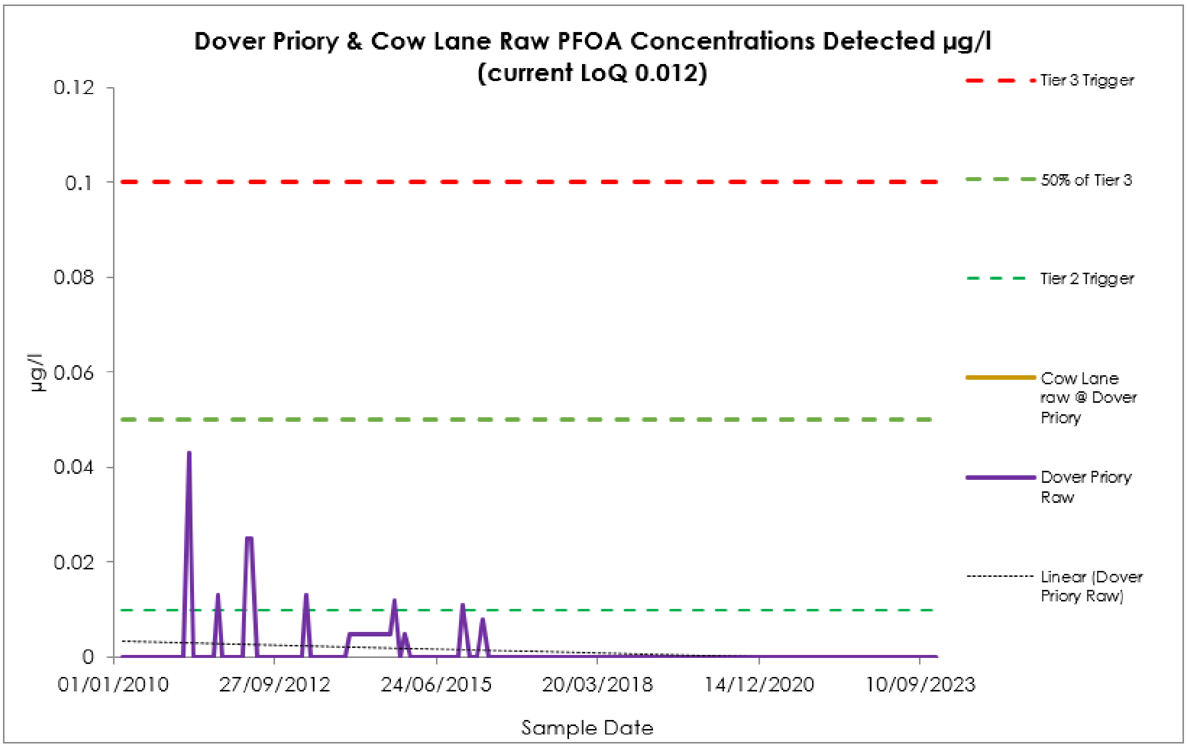

Figure 16. Dover Priory & Cow Lane Raw PFOA Concentrations Detected µg/l.

Given the historic PFAS analytic data trends appears to be on a decreasing trend and the blending of source waters, it is unlikely water leaving Dover Priory WTW will be at risk of entering Tier 3 PFAS concentrations. We will continue with enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. However, given the recent detection in of PFOS at 0.019 µg/l in November 2023, in order to reduce the risk of any PFAS being in the final water above 0.01 µg/l then PFAS treatment will be needed.

6. East Hyde WTW

East Hyde WTW is located approximately 4.5 miles south east from the centre of Luton, Bedfordshire. Raw water is supplied from a single unconfined chalk borehole. The catchment is semi-rural, consisting of arable farming and small clusters of residential housing. Consequently, water from the source contains elevated concentrations the pesticides Atrazine & Diuron and of PFAS compounds have been detected.

PFOS concentrations are generally above 0.01µg/l and have shown an increasing trend over the last decade as shown in Figure 17. PFOA concentrations have been declining over the last the decade, as shown in Figure 18 below. No other PFAS compounds have been detected >LoQ in the source waters.

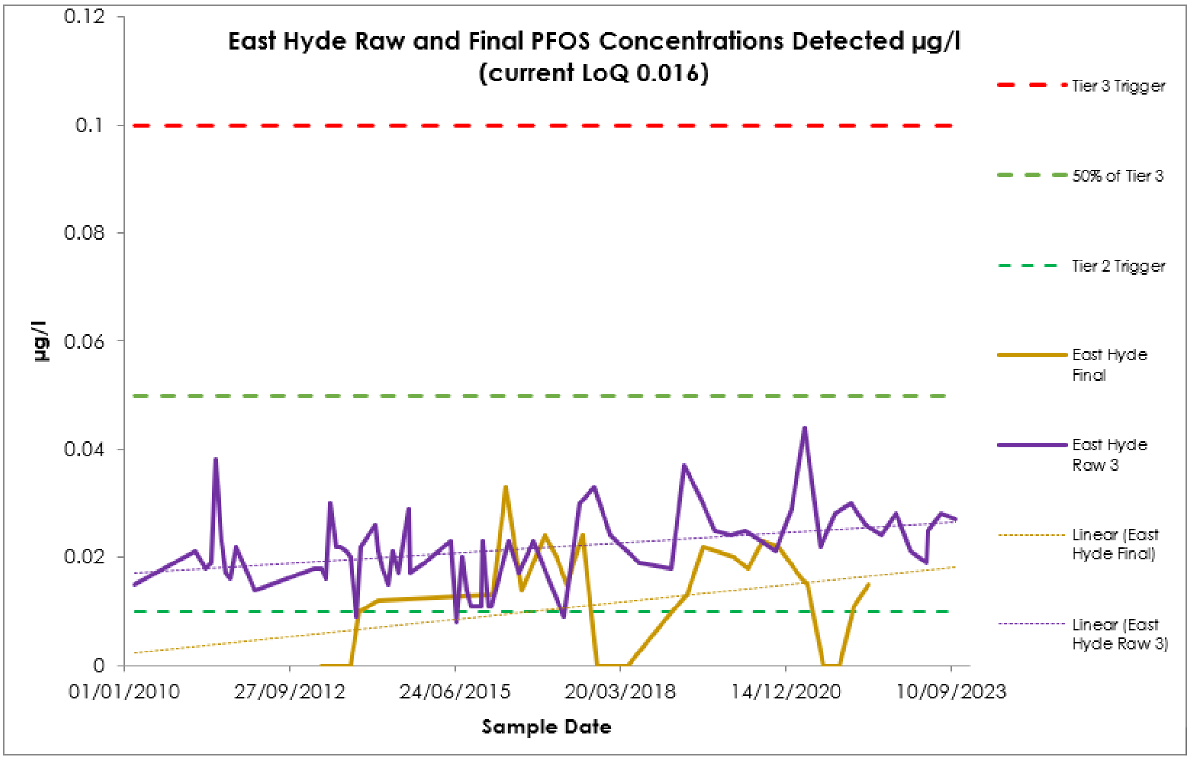

Figure 17. East Hyde Raw and Final PFOS Concentrations Detected µg/l.

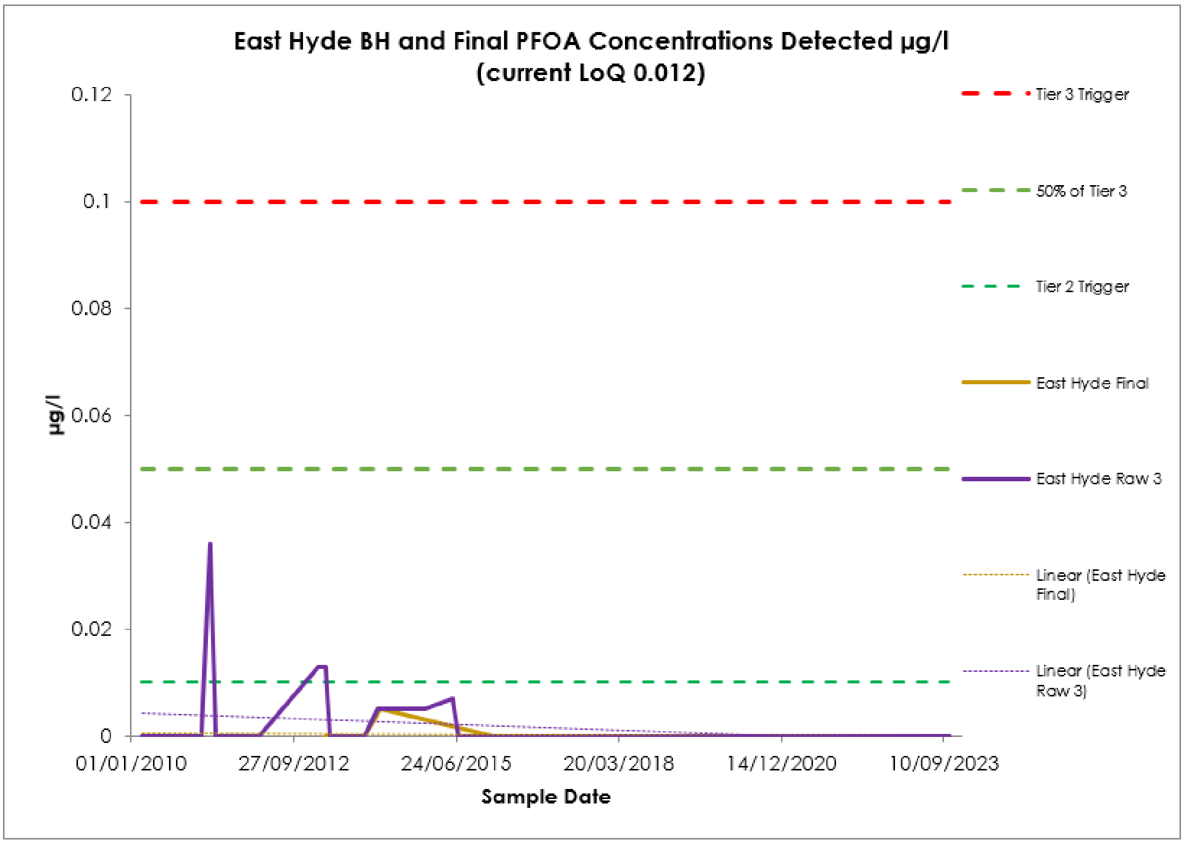

Figure 18. East Hyde BH and Final PFOA Concentrations Detected µg/l.

The treatment process which would be expected to remove PFAS compounds at East Hyde is GAC, and we do see a reduction in PFOS concentrations following replacement of GAC media for a short period. Given the historic PFAS detections and the high-risk nature of the catchment, it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

7. Egham WTW

Egham WTW is located near Staines-Upon-Thames, Middlesex, raw water is supplied from the River Thames. The Thames catchment contains heavily urbanised areas in the east and northern parts while the western parts of the catchment are predominantly rural. As a result, water quality is an ongoing challenge in the Thames, including pollution from sewage treatment works, and significant challenges from agricultural pollution and urban runoff.

Despite this the concentration of PFOS detected in the River Thames at our Egham intake have shown decreasing trends over the last decade as shown in Figure 19 below, and none of the extended suite of PFAS compounds have been detected since monitoring began approximately two years ago. Despite this trend, we believe the risk of detectable concentrations of PFAS being present in the River Thames remains high because of the wide range of industrial discharges into the River and its tributaries.

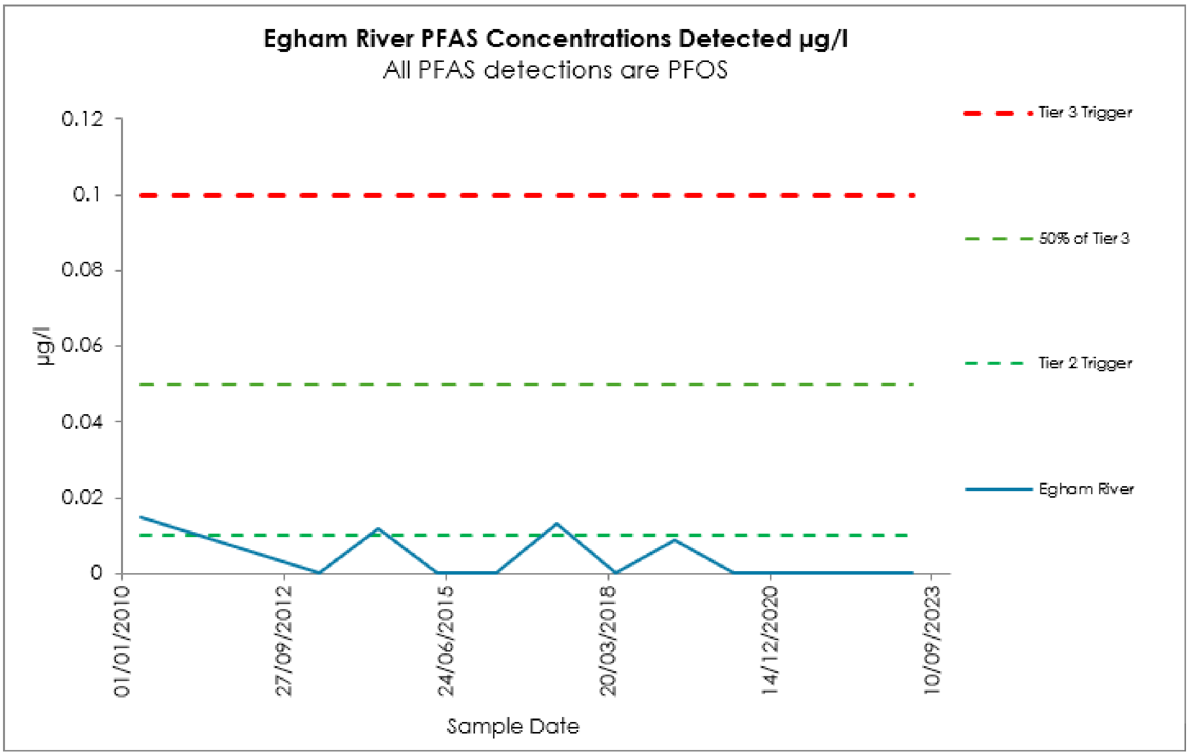

Figure 19. Egham River PFAS Concentrations Detected µg/l (all PFAS detections are PFOS).

The treatment process which would be expected to remove PFAS compounds at Egham is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTWs. Given the historic PFAS detections sources, the high-risk nature of the catchment, it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

8. Hart Lane WTW (Crescent Road)

Hart Lane WTW is located to the North of Luton town centre in Bedfordshire. Raw water is supplied from three unconfined chalk boreholes located approximately a mile from the site at Crescent Road. The catchment is mainly urban with a combination of residential and industrial land use. Consequently, water from the sources contains elevated concentrations of Cr VI, nitrate and PFAS compounds have been detected.

PFOS concentrations in the sources are now generally above 0.01µg/l, showing a recent average of 0.013µg/l and peak of 0.024µg/l in borehole 6. The trends are gradually increasing as shown in Figure 20. PFOA concentrations were last detected in the sources over a decade ago and are now generally less than the LoQ, as shown in Figure 21 below.

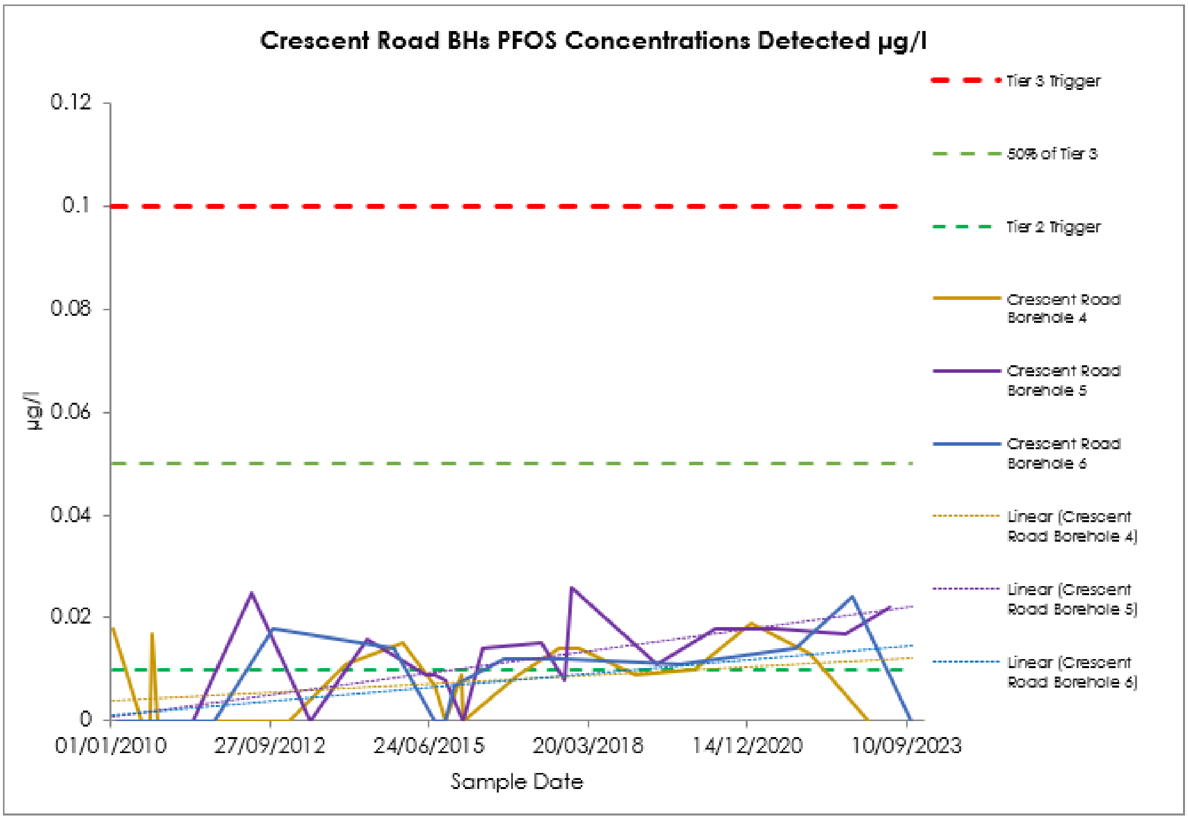

Figure 20. Crescent Road BHs PFOS Concentrations Detected µg/l.

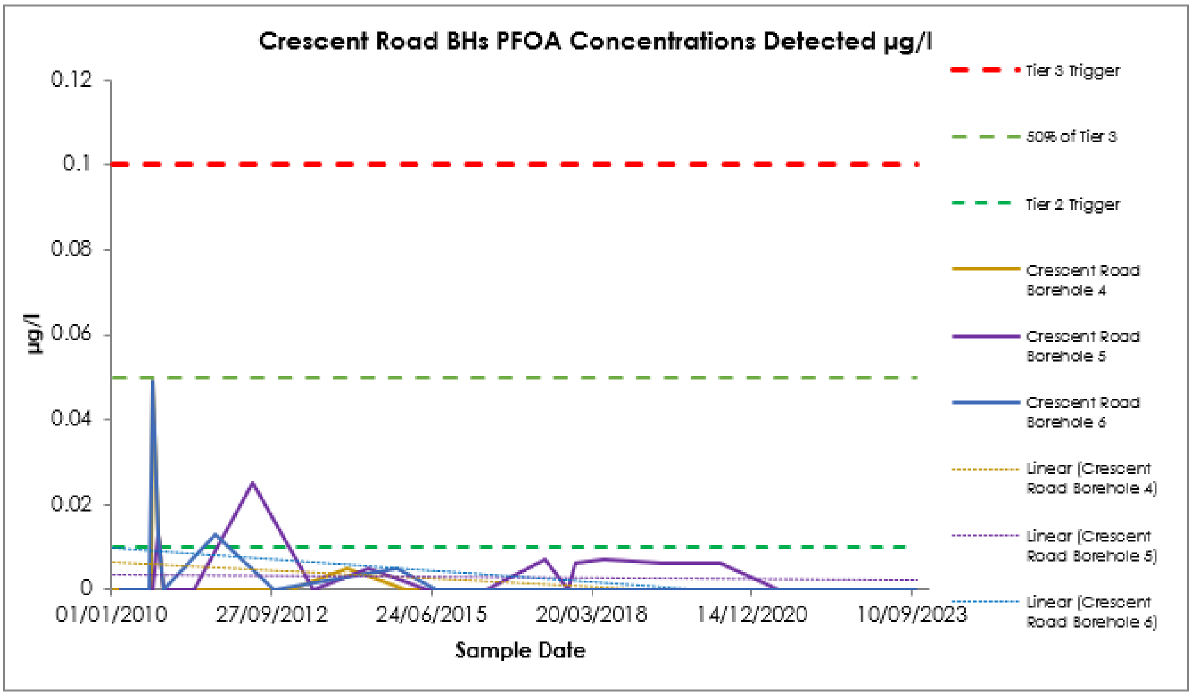

Figure 21. Crescent Road BHs PFOA Concentrations Detected µg/l.

One of the extended suites of PFAS compounds have been detected in the source water since monitoring began approximately two years ago.

Perfluorohexanesulfonic acid (PFHxS) has been detected in a sample taken from Crescent Road Borehole 5 on 01/06/2023 showing a concentration of 0.01µg/l.

Due to the elevated nitrate concentration in Crescent Road source, the treated water is blended with treated water imported from Whitehill Reservoir, before filling the on-site storage installations (Hart Lane Service Reservoir No. 2, Reservoir No. 3, Reservoir No. 4 and Hart Lane Water Tower). The imported water that feeds Whitehill Reservoir is from our Anglian Water Grafham import, the catchment for which has been assessed as a very high-risk PFAS hazard due to the due to the nature of their large catchments and the number of potential contamination sources.

Grafham WTW Import

Grafham has been assessed as a very high-risk in Anglian Water's Surface Water Risk Assessments due to the nature of the large catchment and the number of potential contamination sources.

All PFAS compounds sample results above the LOQ for Grafham Raw water from 5 November 2021 to 1 March 2023 are displayed in the Figure 22 below. PFPeA and PFHXA have been detected above 10ng/l (0.01µg/l).

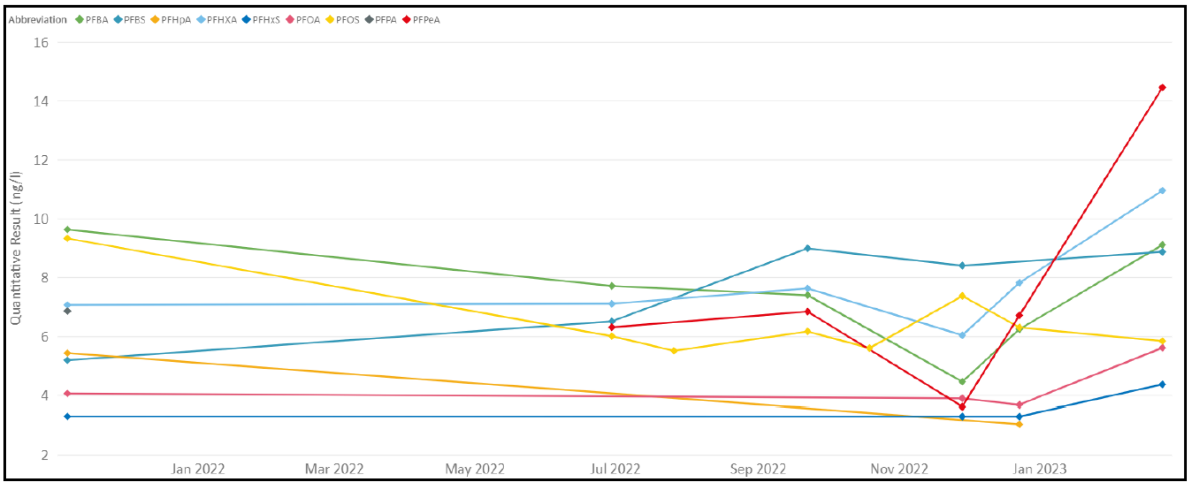

Figure 22. PFAS compounds sample results above the LOQ for Grafham Raw water from 5 November 2021 to 1 March 2023

All PFAS compounds sample results above the LOQ for Grafham Final water from 1st February 2021 to 1st March 2023 are displayed in Figure 23 below. Currently there is one PFOS result of 17.10 ng/l (0.01710µg/l) and one PFBS results of 10.21 ng/l (0.01021µg/l) which have triggered Tier 2 and all other PFAS compounds are below 10 ng/l (0.01µg/l).

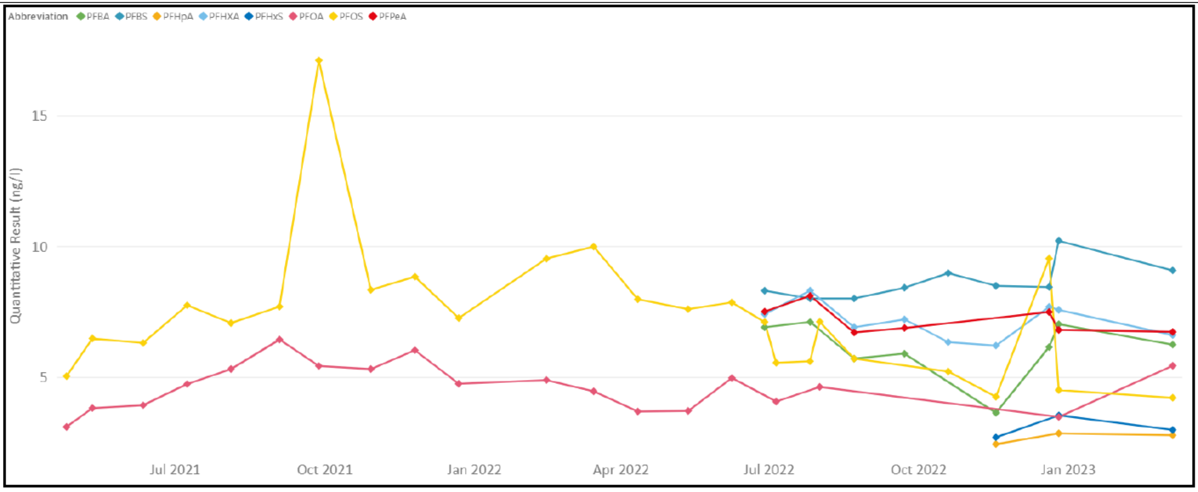

Figure 23. PFAS compounds sample results above the LOQ for Grafham Final water from 1st February 2021 to 1st March 2023

Grafham PFOS (raw and final water)

Sample results above from Grafham raw water into the works (W01GTW1CD) and Grafham Final (W01GTW1CN) for PFOS are in Figure 24 below. Currently there is one PFOS sample result greater than 10 ng/l (0.01µg/l) at Grafham final water.

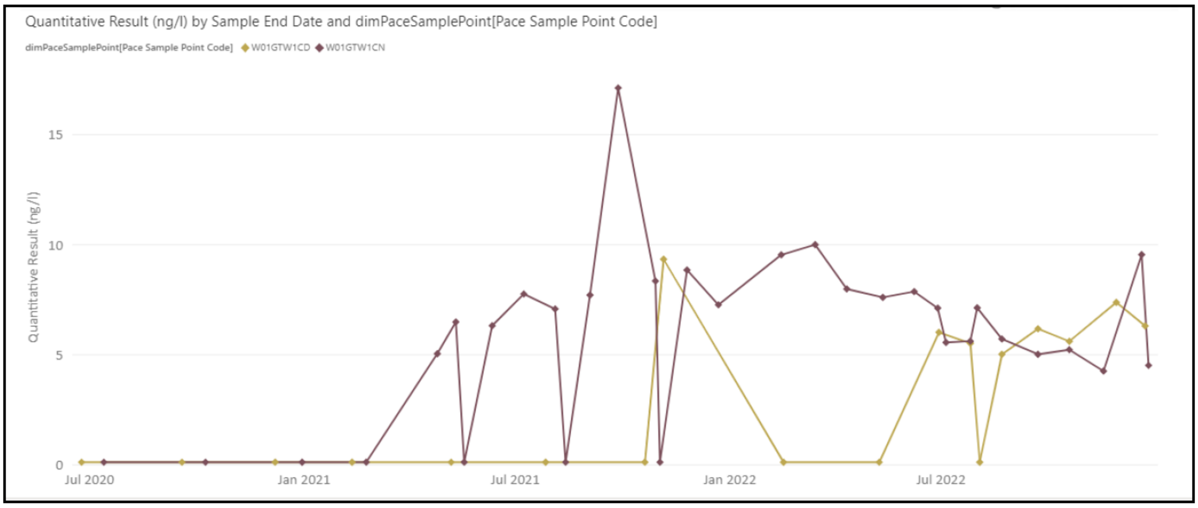

Figure 24. Grafham raw water into the works (W01GTW1CD) and Grafham Final (W01GTW1CN) for PFOS

Grafham PFBS (raw and final water)

Sample results from Grafham raw water into the works (W01GTW1CD) and Grafham Final (W01GTW1CN) for PFBS are in Figure 25 below. Currently there is one PFBS sample result greater than 10 ng/l (0.01µg/l) at Grafham final water.

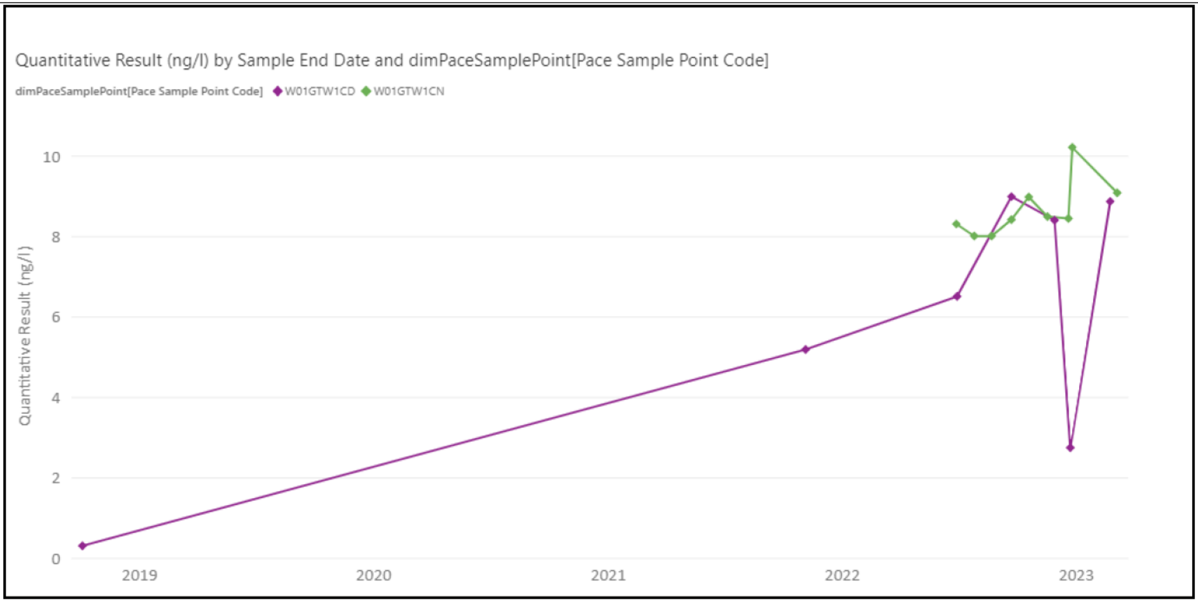

Figure 25. Sample results from Grafham raw water into the works (W01GTW1CD) and Grafham Final (W01GTW1CN) for PFBS

We only have one set of the full PFAS analysis suite taken from Crescent Road final water in January 2024 which showed all results <LoQ. The treatment process which would be expected to remove PFAS compounds at Crescent Road is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTWs. Given the historic PFAS detections sources, the high-risk nature of the catchment and recent detection of PFHxS it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

9. Holmestone WTW

Holmestone is located in an industrial estate approximately 2 miles to the north-west of Dover, Kent. The raw water for Holmestone is supplied from an unconfined chalk borehole. The catchment is mainly rural with arable farming and conservation areas. Treatment at the site includes UV irradiation followed by chlorination, which as mentioned previously would not be effective for directly removing PFAS compounds. Final water is pumped under borehole pump pressure to Primrose pumping station where it joins the network and Downsgate Reservoir.

Our original PFOS and PFOA risk assessment of Holmestone source carried out after monitoring concentrations in 2008 and 2009, showed that the source was low risk and consequently monitoring ceased. Monitoring for PFAS resumed in 2021 and until recently, no PFAS concentrations were detected in the raw water. However, a sample taken in April 2024 showed a 6:2 FTAB concentration of 0.065 µg/l in the raw water. The 6:2 FTAB compound was included in the PFAS analysis suite in October

2023, and this was the first sample analysed for it, hence there was no prior awareness of its presence in the source water as shown in Figure 26.

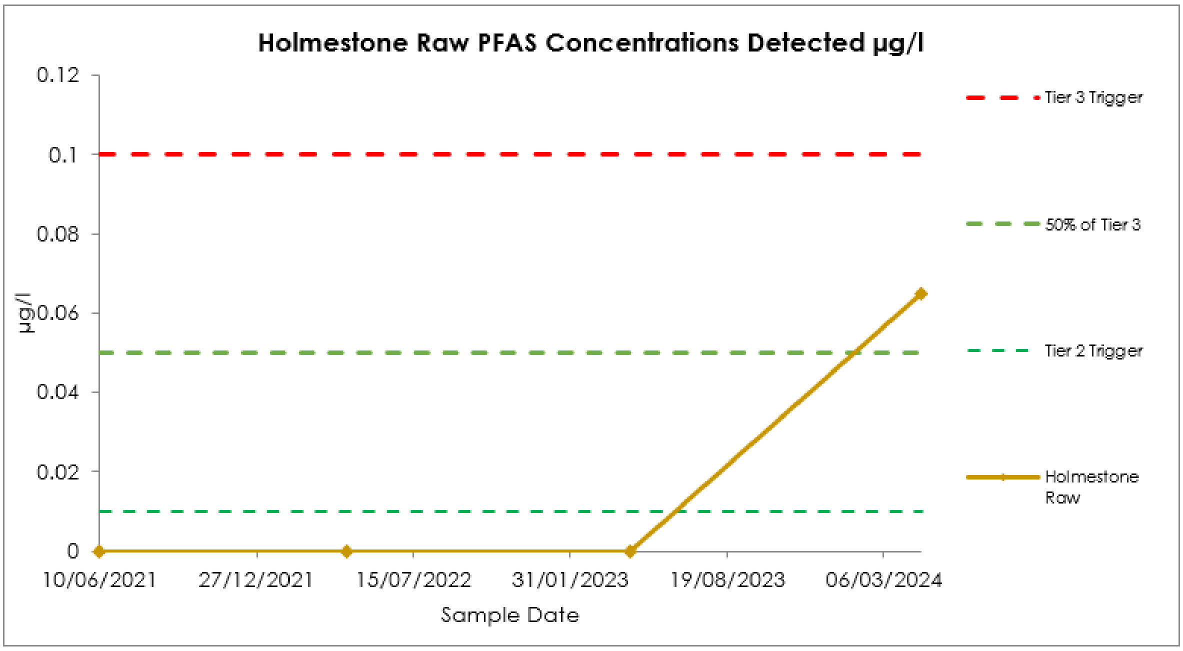

Figure 26. Holmestone Raw PFAS Concentrations Detected µg/l.

Repeat samples collected from the Holmestone raw, final water, associated water supply zone (WSZ) 078 (Dover) and Downsgate Reservoir following the elevated sample result are shown in Table 5 below. The results confirm the initial concentration detected in the raw water. Concentrations of 6:2 FTAB were also detected in the Final and associated WSZ. No 6:2 FTAB concentrations above the LoQ was detected in Primrose WTW source water and Downsgate Reservoir. The sample taken from WSZ 078 (Dover) on 2 July 2024 was when Primrose water was blending with Holmestone to reduce the final water concentrations to ~0.04µg/l, which is currently being considered as the short-term mitigation to ensure the Holmestone can remain in supply. If our ongoing PFAS monitoring shows an increasing trend the source will be taken out of supply.

Table 5. Holmestone WTW 6:2 FTAB Concentrations Detected µg/l (Including resample results from associated supply system).

Sample Date	Sample Point and 6:2 FTAB µg/l				
	Holmestone Raw	Primrose Raw No.1 Well	Holmestone Final	Downsgate Reservoir	Dover Network Investigation Samples
23/04/2024 10:02	0.065				
17/06/2024 09:36				0	
17/06/2024 11:08	0.07				
17/06/2024 12:33					0.076
17/06/2024 12:55			0.059		
26/06/2024 11:52	0.06				
02/07/2024 10:01		0			
02/07/2024 10:05					0.04
02/07/2024 10:20	0.082				
04/07/2024 11:52	0.05				
08/07/2024 11:57	0.049				

Given the recently detected 6:2 FTAB concentrations in the raw waters and subsequent confirmation from repeat sampling, in order to reduce the risk of any PFAS being in the final water above 0.01 µg/l then PFAS treatment will be needed.

10. Hunton Bridge WTW

Hunton Bridge WTW is situated approximately ½ mile from the M25 motorway at junction 19 in the direction of Watford, Hertfordshire. The site is flanked by the canal and a stream. There is a railway line running to the north of the site boundary. Raw water for is supplied from two unconfined chalk boreholes. The catchment is mainly rural, with predominantly arable farming and conservation areas. Water from some of the sources contains elevated concentrations of iron, turbidity and PFAS compounds have been detected. Treatment at the site includes UV disinfection and chlorination for residual chlorine, and as mentioned previously research indicates this type of treatment has poor removal for PFAS compounds.

PFAS concentrations in Boreholes 2 and 4 are generally below 0.01µg/l. There has been one detection of PFBS at 0.01 µg/l in 2023 in Borehole 2 as shown in Figure 27 below.

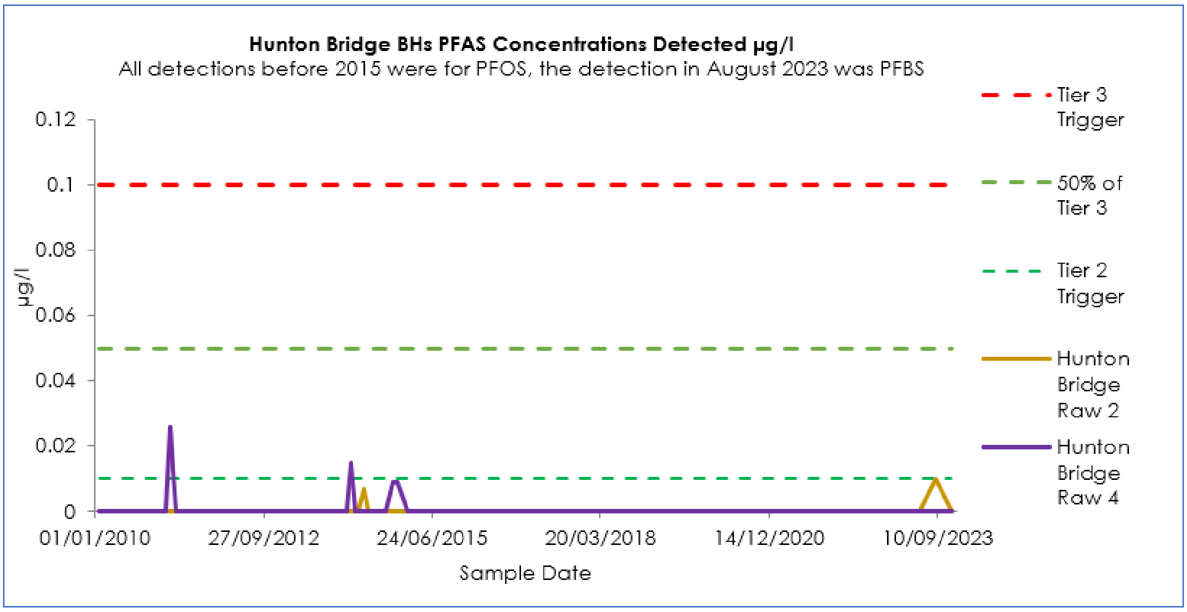

Figure 27. Hunton Bridge BHs PFAS Concentrations Detected µg/l.

We will continue with enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. Given the historic PFAS analytic data trends appears to be on a decreasing trend, it is unlikely water leaving Hunton Bridge WTW will be at risk of entering Tier 3 PFAS concentrations. However, in order to reduce the risk of any PFAS being in the final water above 0.01 µg/l then PFAS treatment will be needed.

11. Iver WTW

Iver WTW is supplied from the River Thames, abstracted 7km away from the works at our Sunnymeads intake. The Thames catchment contains heavily urbanised areas in the east and northern parts while the western parts of the catchment are predominantly rural. As a result, water quality is an ongoing challenge in the Thames, including pollution from sewage treatment works, and significant challenges from agricultural pollution and urban runoff.

Despite this the concentration of both PFOA and PFOS detected in the River Thames have shown decreasing trends over the last decade as shown in Figure 28 and Figure 29 below, and none of the extended suite of PFAS compounds have been detected since monitoring began approximately two years ago. Despite this trend, we believe the risk of detectable concentrations of PFAS being present in the River Thames remains high because of the wide range of industrial discharges into the River and its tributaries.

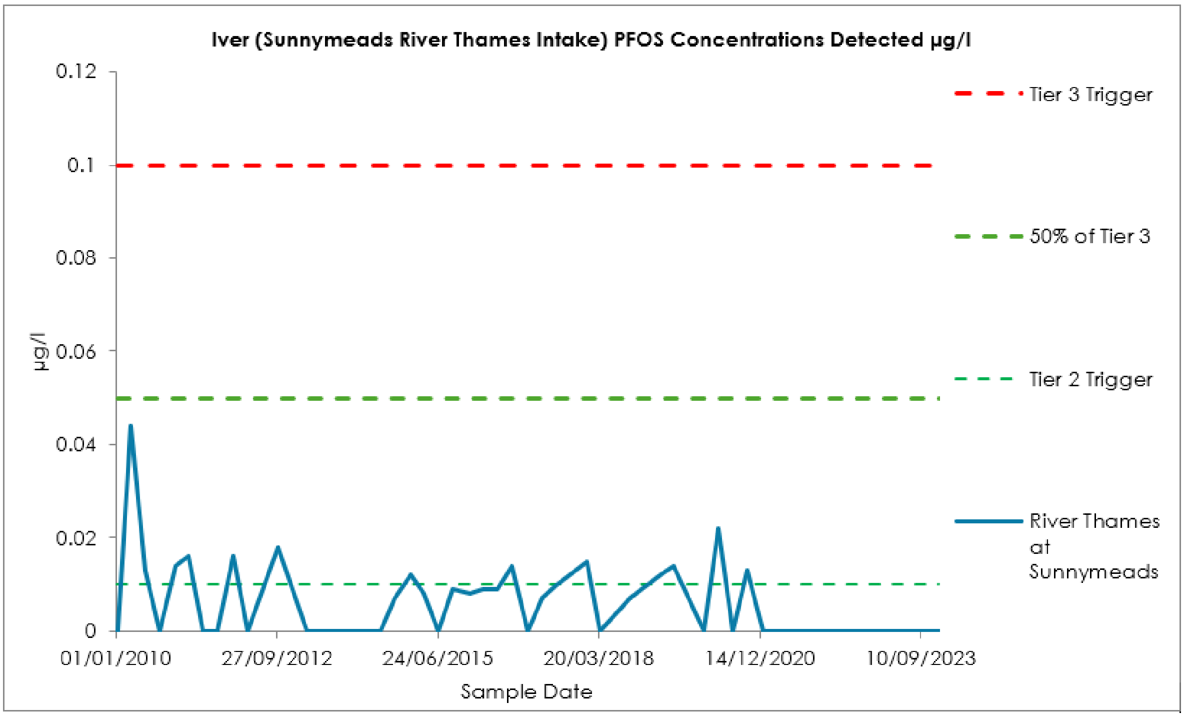

Figure 28. Iver (Sunnymeads River Thames Intake) PFOS Concentrations Detected µg/l

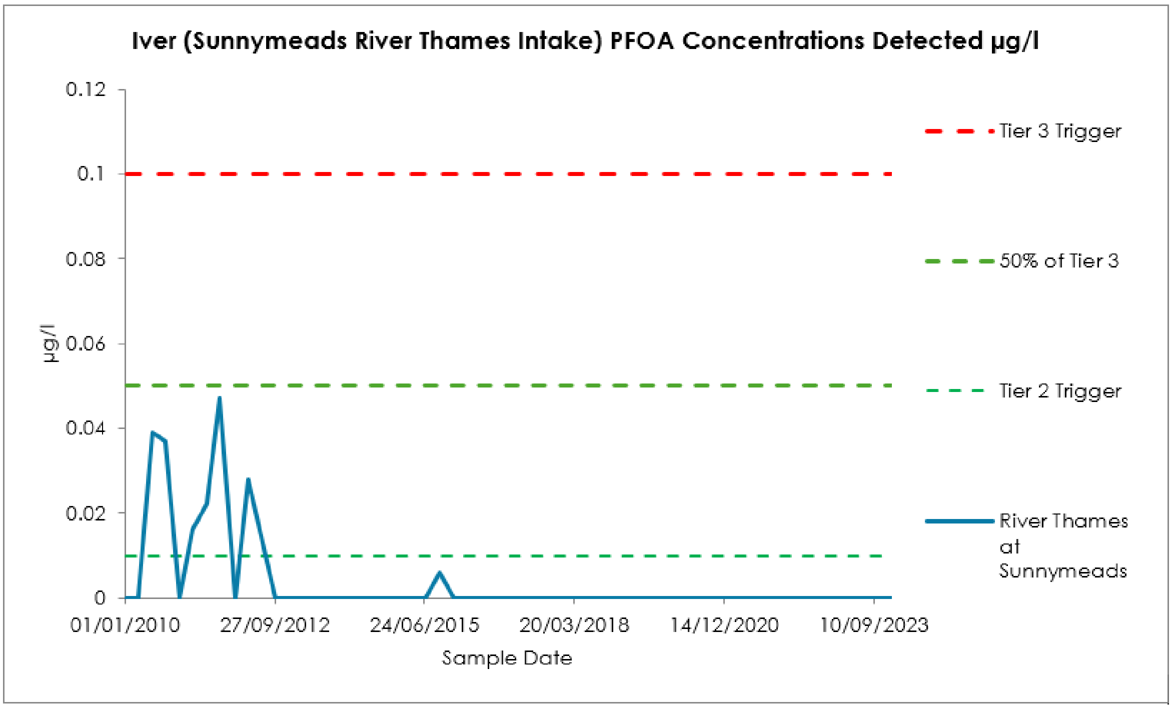

Figure 29. Iver (Sunnymeads River Thames Intake) PFOA Concentrations Detected µg/l

The treatment process which would be expected to remove PFAS compounds at Iver is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTWs. Given the high-risk nature of the catchment, it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain total PFAS concentrations below 0.01 µg/l.

12. Marlowes WTW

Marlowes is located approximately a mile from the town centre of Hemel Hempstead, Hertfordshire. The area is mainly urban with a mixture of residential housing, shops and office buildings. The River Gade runs through the 50-day travel zone.

The treated water is pumped under the pressure of the borehole pumps to Adeyfield Reservoir, where it then gets distributed into the local supply zones of Hemel Hempstead and Kings Langley. Treatment at the site consists of marginal chlorination, research indicates this type of treatment has poor removal for PFAS compounds.

PFAS concentrations in Boreholes 3 and 4 sources are generally below 0.01µg/l, although there is a lack of recent analytical data from the sources (as these were out of service for the last couple of years). There was one detection of PFOS at 0.028 µg/l in 2015 in Borehole 4 as shown in Figure 30.

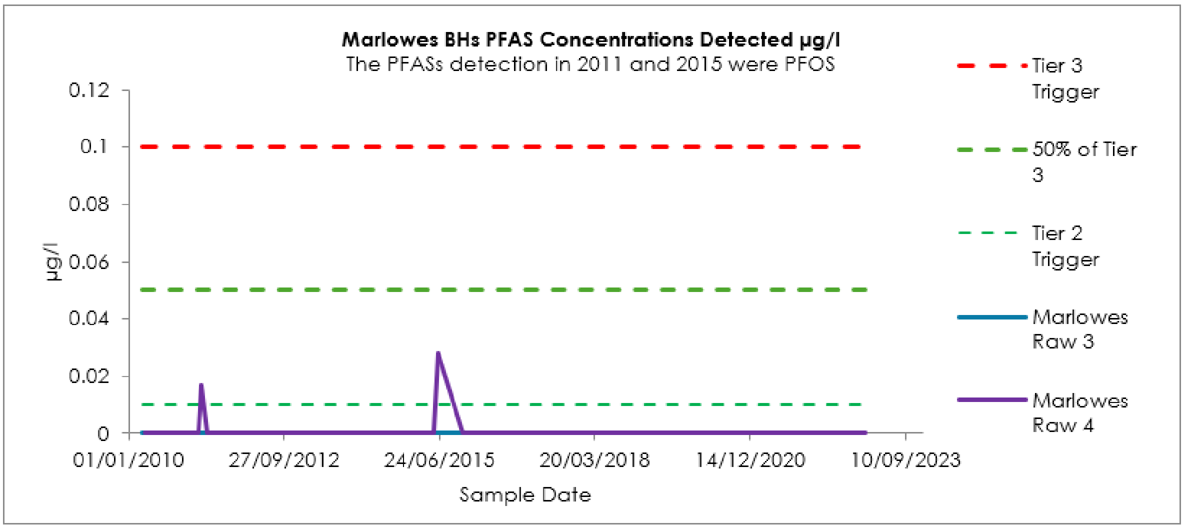

Figure 30. Marlowes BHs PFAS Concentrations Detected.

Given the historic PFAS analytic data, it is unlikely water leaving Marlowes WTW will be at risk of entering Tier 3 PFAS concentrations. However, as we have seen concentrations >0.02 µg/l historically and we have limited recent analytical data, in order to reduce the risk of any PFAS being in the final water above 0.01µg/l, then PFAS treatment will be needed.

13. Mill End WTW

Mill End WTW is located approximately 1 mile from the centre of Rickmansworth, Hertfordshire. Raw water is supplied from three unconfined chalk boreholes located on site and two off-site unconfined chalk boreholes (Springwell source) located approx. 1 km to the south of the main treatment works. The catchment is a mixture of urban and rural land use. Water from some of the sources contains elevated concentrations of iron, turbidity and PFAS compounds have been detected. Treatment at the sites includes microfiltration, designed to provide a barrier against Cryptosporidium, research indicates this type of treatment has poor removal for PFAS compounds.

PFOS concentrations in the Mill End sources are generally below 0.01µg/l, the last positive detection was in March 2016. Average PFOS concentrations of 0.025 µg/l have historically been seen in the two Springwell sources, however the trends are gradually decreasing as shown in Figure 31 below. No PFOA concentrations have been detected in over the last decade. One sample of the extended suite collected from Springwell Raw 2. taken on 24/09/2021 showed a PFHxS concentration of 0.01µg/l, this was during the early stages of laboratory analysis and considered may not be representative. A sample taken since showed results <LoQ for PFHxS.

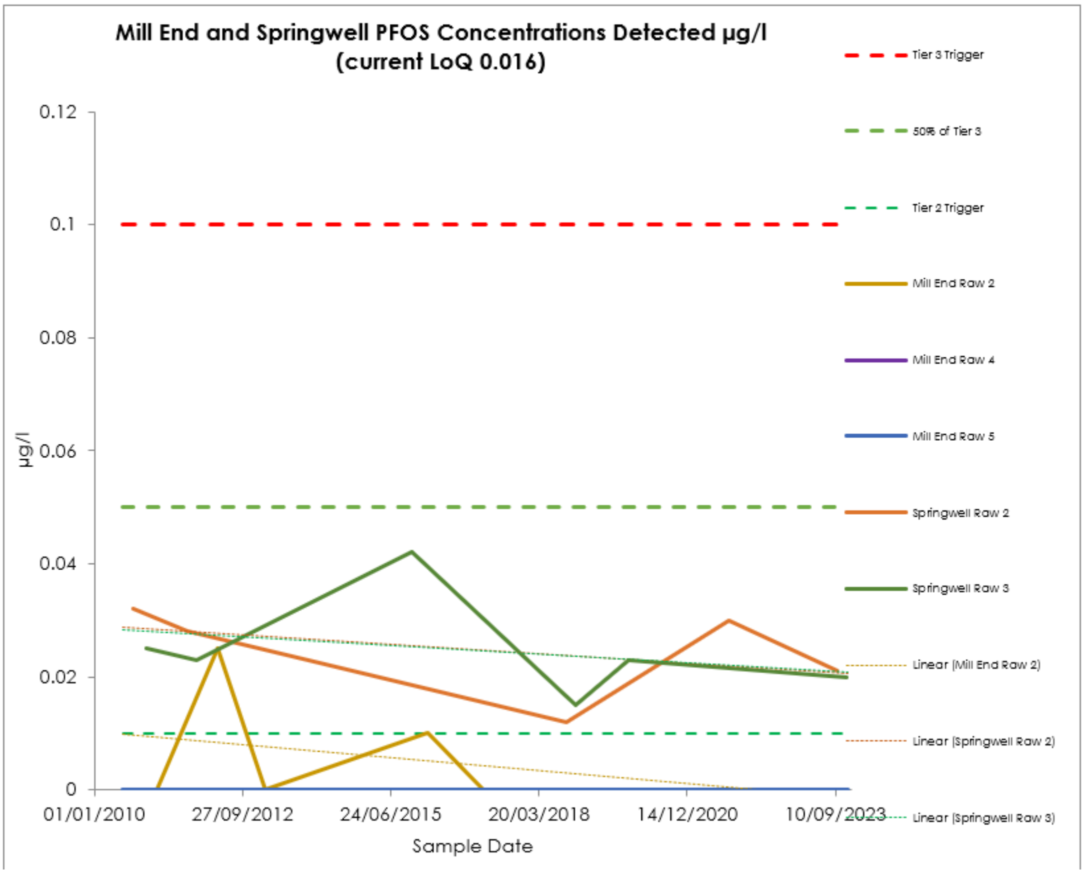

Figure 31. Mill End and Springwell PFOS Concentrations Detected µg/l.

We have one set of the full PFAS analysis suite taken from Mill End final water in March 2024 which showed all PFAS results <LoQ. Given the historic PFAS analytic data trends appears to be on a decreasing trend and the blending of source waters, it is unlikely water leaving Mill End WTW will be at risk of entering Tier 3 PFAS concentrations. We will continue enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. However, in order to reduce the risk of any PFAS being in the final water above 0.01µg/l, then PFAS treatment will be needed.

14. Northmoor WTW

Northmoor WTW is located in Denham, Buckinghamshire. Raw water supplied from three unconfined chalk boreholes. The catchment is mainly rural consisting of predominantly conservation areas and agricultural land. PFAS compounds have been detected in the sources. Treatment at this site includes ultrafiltration for turbidity removal (installed as a temporary measure while nearby HS2 construction works are ongoing.) and UV irradiation for disinfection of the water, which would not be effective for directly removing PFAS compounds.

PFOS concentrations are now generally below 0.01µg/l and have shown a declining trend over the last decade as shown in Figure 32. PFOA concentrations have also been declining over the last the decade, however peaks of up to 0.032 µg/l have been seen in Borehole 2 have been seen in recent years, as shown in Figure 33 below. No other PFAS compounds have been detected >LoQ in the source waters.

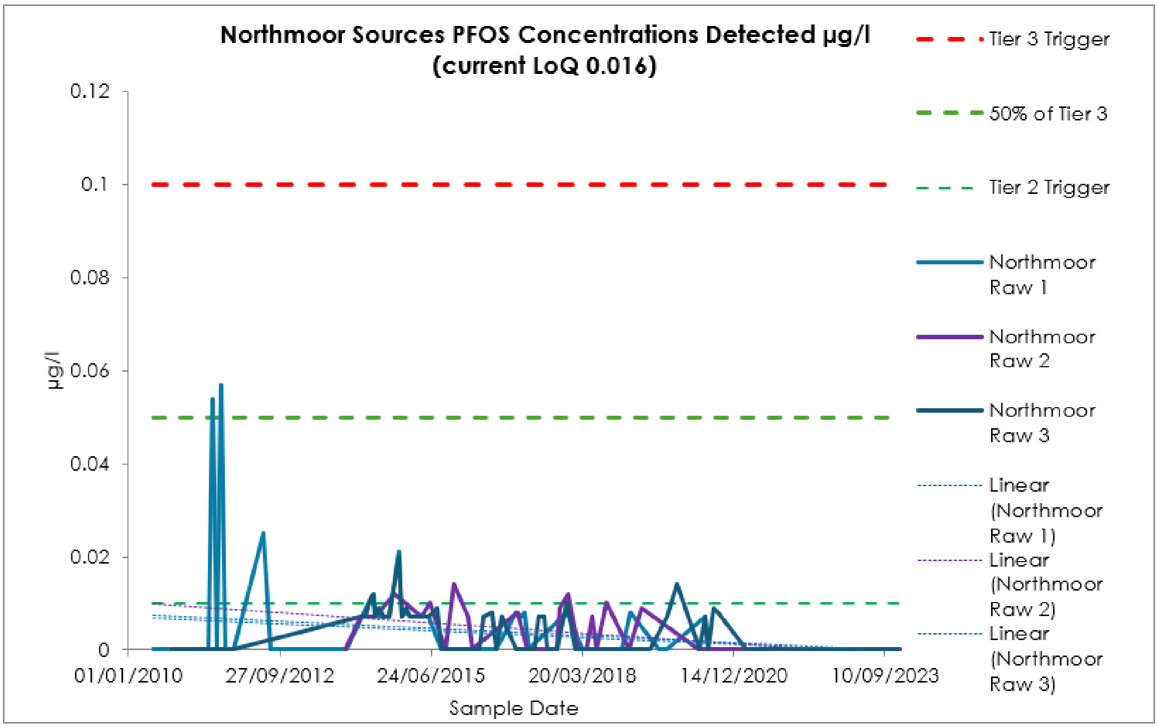

Figure 32. Northmoor Sources PFOS Concentrations Detected µg/l.

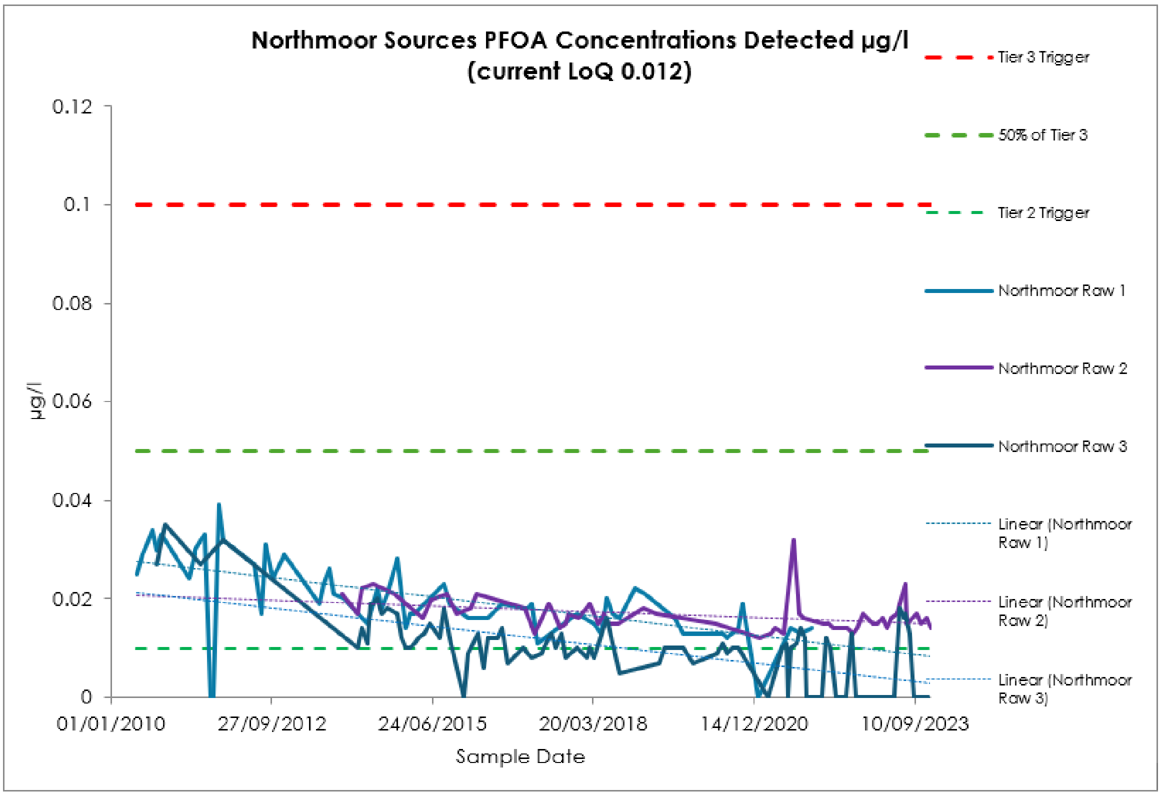

Figure 33. Northmoor Sources PFOA Concentrations Detected µg/l.

Given the historic PFAS analytic data trends appears to be on a decreasing trend and the blending of source waters, it is unlikely water leaving Northmoor WTW will be at risk of entering Tier 3 PFAS concentrations. We will continue enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. However, in order to reduce the risk of any PFAS being in the final water above 0.01µg/l, then PFAS treatment will be needed.

15. North Mymms WTW

North Mymms WTW is located 7km south of Hatfield, Hertfordshire. Raw water supply comprises of groundwater from a borehole on site and from three further sources at Tyttenhanger Pumping Station (PS), Roestock PS and Essendon PS. All water is sourced from a karstic chalk/gravel aquifer, the response to rainfall for this aquifer is rapid due to swallow holes in the catchment.

The land use is predominantly agricultural land (arable and pasture). There are small areas of rural residential land use, woodland (conservation) sites and various recreational land uses, including golf courses. Water from some of the boreholes shows elevated turbidity, nitrate, nitrite, metaldehyde, bromate concentrations and PFAS compounds have been detected.

PFOS concentrations at North Mymms, Roestock and Tyttenhanger sources are now generally below LoQ and have shown a declining trend over the last decade as shown in Figure 34. However, more frequent detections of PFOS have been seen in Essendon source water, with an average concentration of 0.009 µg/l and peak of 0.031 µg/l seen in 2014. PFOA concentrations were last detected in 2010 and have since been less than 0.01µg/l, as shown in Figure 35 below. No other PFAS compounds have been detected >LoQ in the source waters.

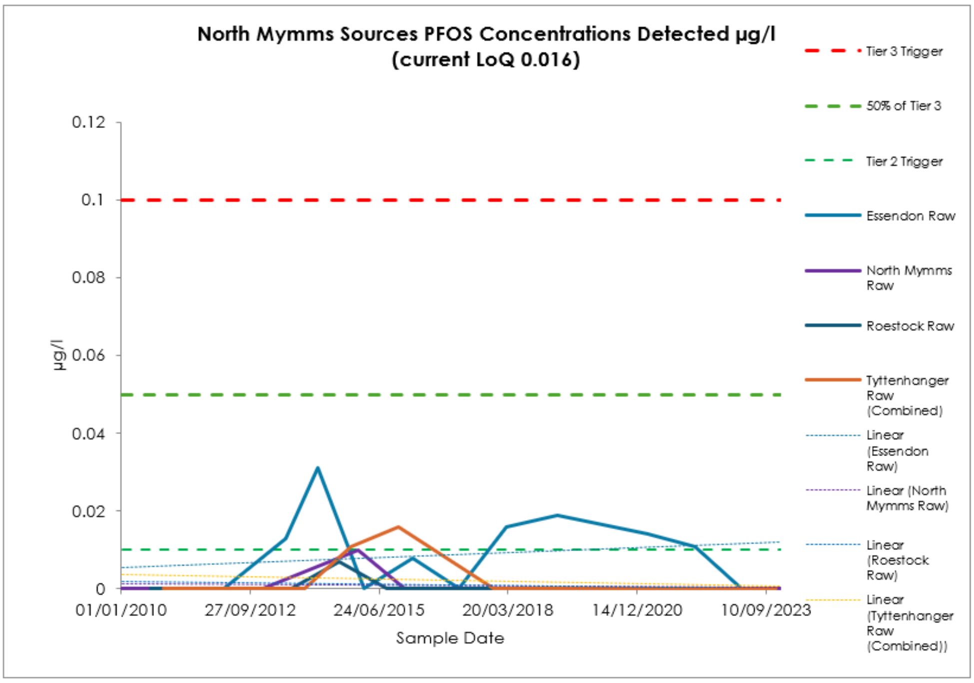

Figure 34. North Mymms Sources PFOS Concentrations Detected µg/l.

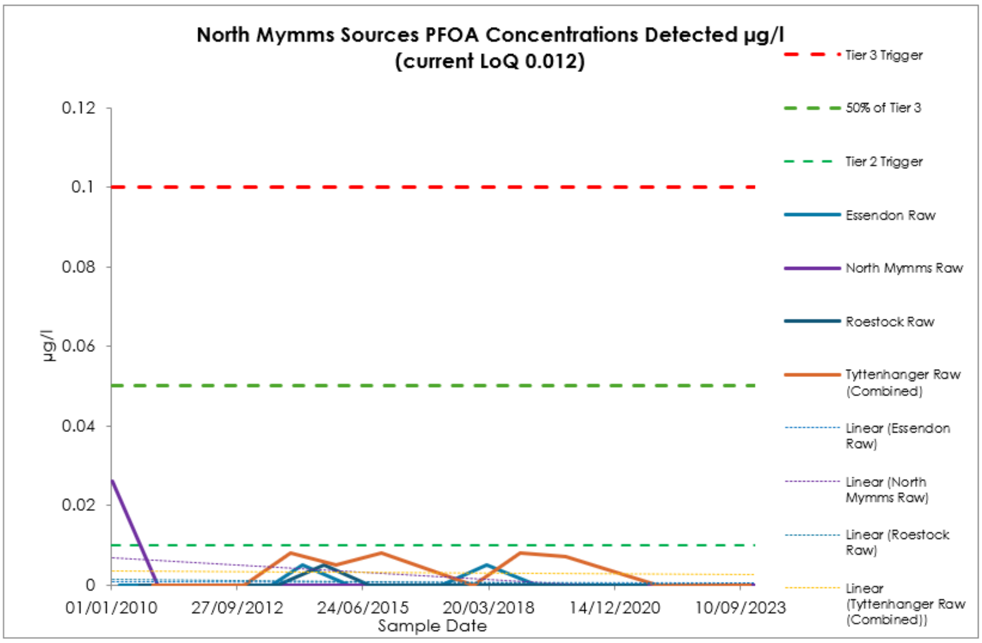

Figure 35. North Mymms Sources PFOA Concentrations Detected µg/l.

The treatment process which would be expected to remove PFAS compounds at North Mymms is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTWs. Given the historic PFAS detections sources, the high-risk nature of the catchment, it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain all PFAS concentrations below 0.01 µg/l.

16. Roydon WTW

Roydon WTW is located near Harlow Essex supplied. Raw water is supplied from two boreholes (Borehole 1 and Borehole 3) and Borehole 2 is decommissioned. The catchment is mostly rural farming of which the majority are arable or pasture. Small areas of woodland and a SSSI and small residential areas. There is a very small area of light industrial units towards Harlow. Water from the sources shows elevated turbidity, iron, metaldehyde, ammonium and PFAS compounds have been detected. Treatment at this site includes pre-oxidation, Rapid Gravity Filters (RGF) and chlorination with contact for disinfection, which would not be effective for directly removing PFAS compounds.

The pie charts below Figure 36 show the different PFAS compounds detected in the source waters and the maximum concentration. Seven different PFAS compounds have been detected have been detected in Borehole 3, compared with the lower concentrations seen in Borehole 1.

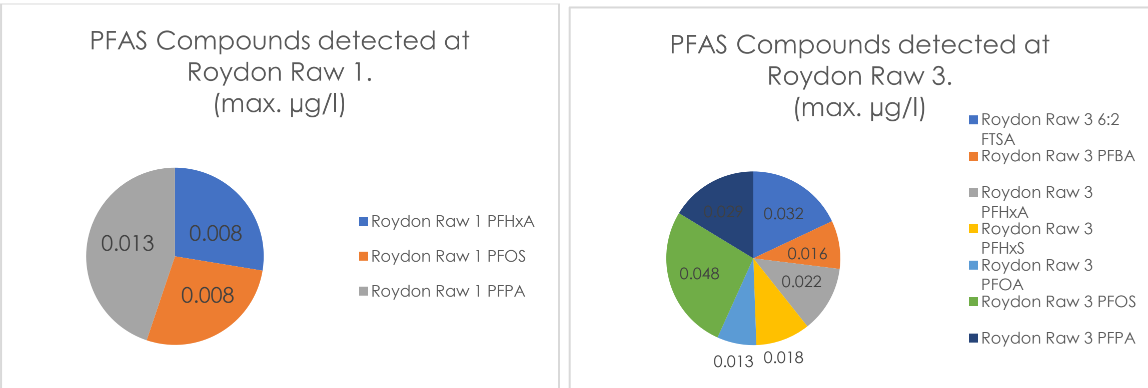

Figure 36. PFAS Compounds detected in Roydon Raw 1 and Raw 3

PFOS concentrations at Roydon Borehole 1 are generally below the LoQ, however, more frequent detections of PFOS have been seen in Borehole 3, with an average concentration of 0.03 µg/l and recent peak of 0.043 µg/l seen in June 2023, as shown in Figure 37. PFOA concentrations are generally below the LoQ, as shown in Figure 38 below.

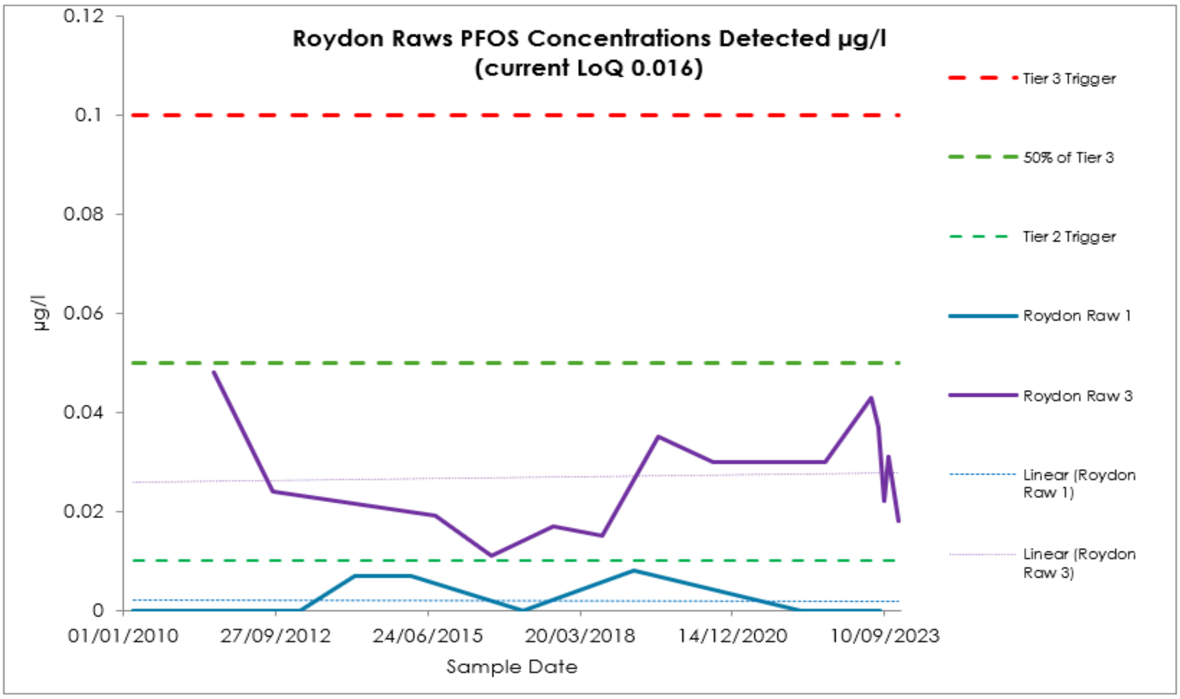

Figure 37. Roydon Raws PFOS Concentrations Detected µg/l.

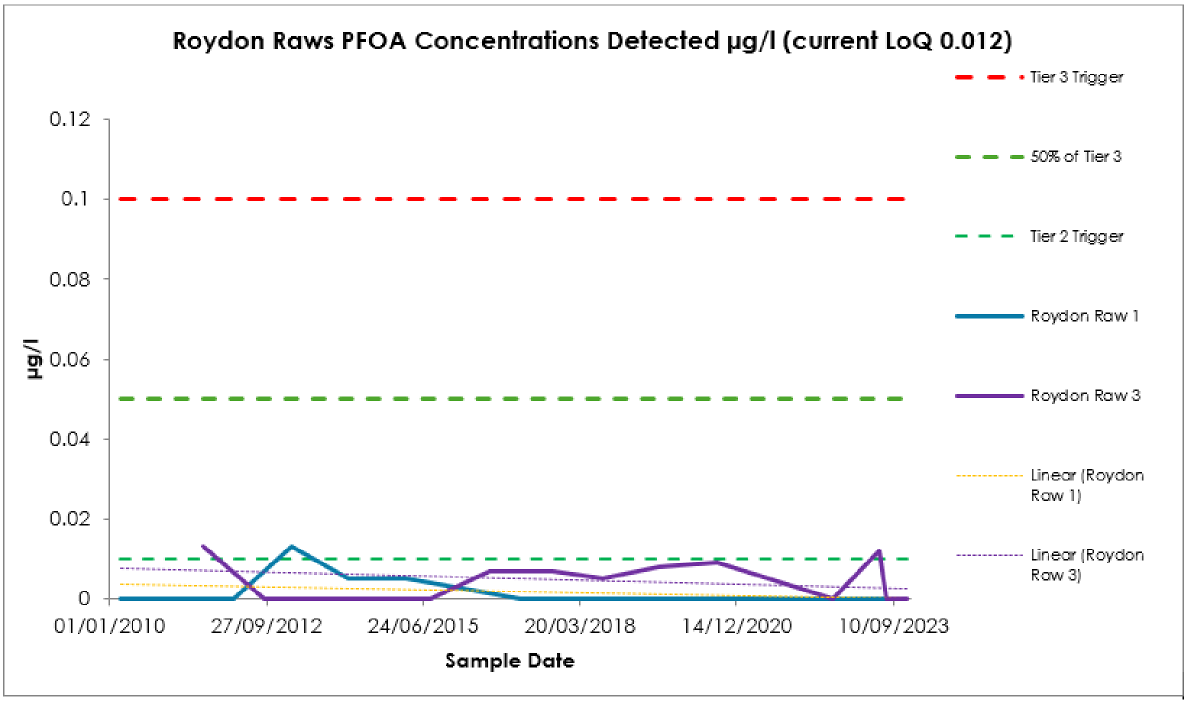

Figure 38. Roydon Raws PFOA Concentrations Detected µg/l.

Other PFAS compounds detected in Roydon sources are summarised in Figure 39 below.

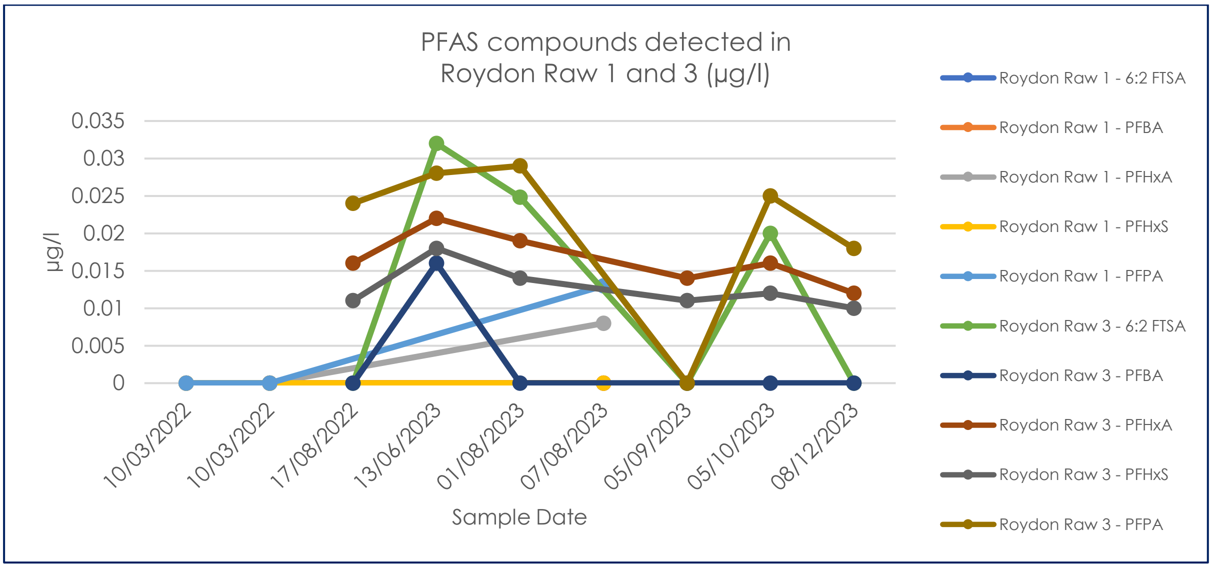

Figure 39. PFAS compounds detected in Roydon sources.

Final water from Roydon WTW is pumped to Rye Hill Reservoir complex, which is also fed by Hadham Mill WTW and Grafham import. Water from Roydon first feeds Rye Hill Reservoir 2 before feeding the water tower, as such there is limited blending of supply water within the complex before entering water supply zones (WSZ) AF024 and AF025. A single set of samples collected from each of the reservoirs showed the PFAS compound PFPA at the outlet of Rye Hill Reservoir 2, all other sample results where <LoQ, included additional PFAS samples taken from the supplied WSZ.

We are proposing to conduct some R&D at Roydon to establish which treatment would be optimal for the removal of PFAS compounds as well as other contaminants in the raw water.

We will continue enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. However, in order to reduce the risk of any PFAS being in the final water above 0.01µg/l, then PFAS treatment will be needed.

17. Stansted WTW

Stansted Pumping Station is situated in a residential area of the village of Stansted Mountfitchet, Essex and in proximity of an airport. The area around the site is mostly residential with arable land to the north of the 50-day zone. The 400-day travel zone is predominately agricultural land. Treatment at the site consists of chlorination, contact tank and sodium bisulphite for de-chlorination, research indicates this type of treatment has poor removal for PFAS compounds.

The treated water is pumped under the pressure of the borehole pumps into Berden Water Tower feeding the distribution system on the way.

PFAS concentrations in Boreholes 1 and 2 sources are generally below 0.01µg/l. There has not been any PFAS detection in Borehole 1 since 2014 and there has been one detection of PFOS at 0.0115 µg/l in 2021 in Borehole 2 as shown in Figure 40 below.

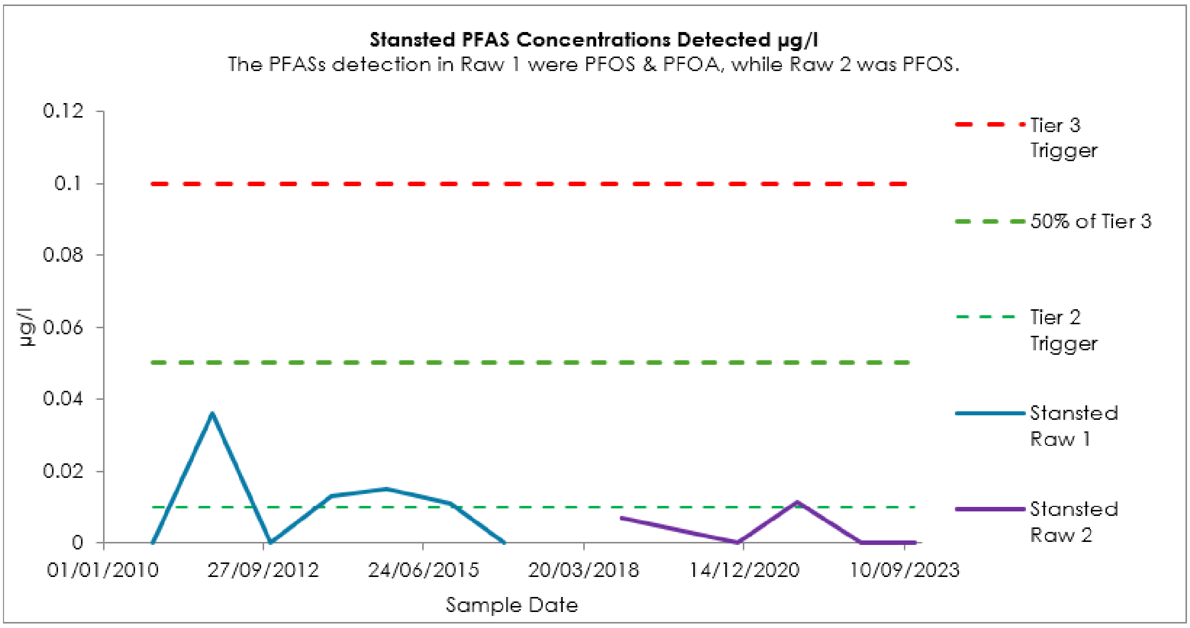

Figure 40. Stansted Raws PFAS Concentrations Detected µg/l.

While we have not seen any PFOS concentrations >0.016 µg/l (the LoQ for PFOS since 2022) in the last two years at Stansted sources, and because we had limited analytical data, we interrogated the most recent results further. Our Laboratory were able to retrieve the 'limit of detection' results which showed PFOS concentrations of 0.014 µg/l in 2022 and 0.012 µg/l in 2023.

We will continue enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. Given the historic PFAS analytic data trends appears to be on a decreasing trend, it is unlikely water leaving Stansted WTW will be at risk of entering Tier 3 PFAS concentrations. However, given the additional laboratory information and the proximity of the source to the airport in order to reduce the risk of any PFAS being in the final water above 0.01 µg/l, then PFAS treatment will be needed.

18. Walton WTW

Walton WTW is supplied from the River Thames and groundwater from the Ranney Well on occasions when either nitrate or turbidity are elevated in the river Thames. The Thames catchment contains heavily urbanised areas in the east and northern parts while the western parts of the catchment are predominantly rural. As a result water quality is an ongoing challenge in the Thames, including pollution from sewage treatment works, and significant challenges from agricultural pollution and urban runoff.

Despite this the concentration of both PFOA and PFOS detected in the River Thames have shown decreasing trends over the last decade as shown in Figure 41and Figure 42 below, and none of the extended suite of PFAS compounds have been detected since monitoring began approximately two years ago. Despite this trend, we believe the risk of detectable concentrations of PFAS being present in the River Thames remains high because of the wide range of industrial discharges into the River and its tributaries.

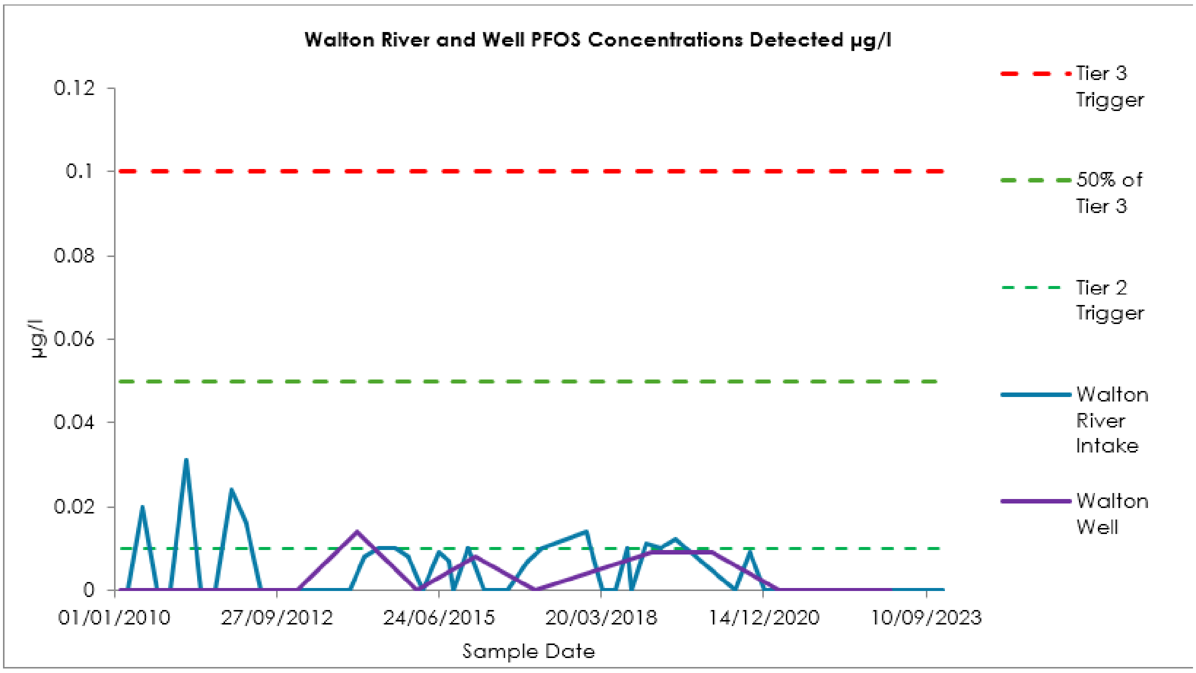

Figure 41. Walton River and Well PFOS Concentrations Detected µg/l.

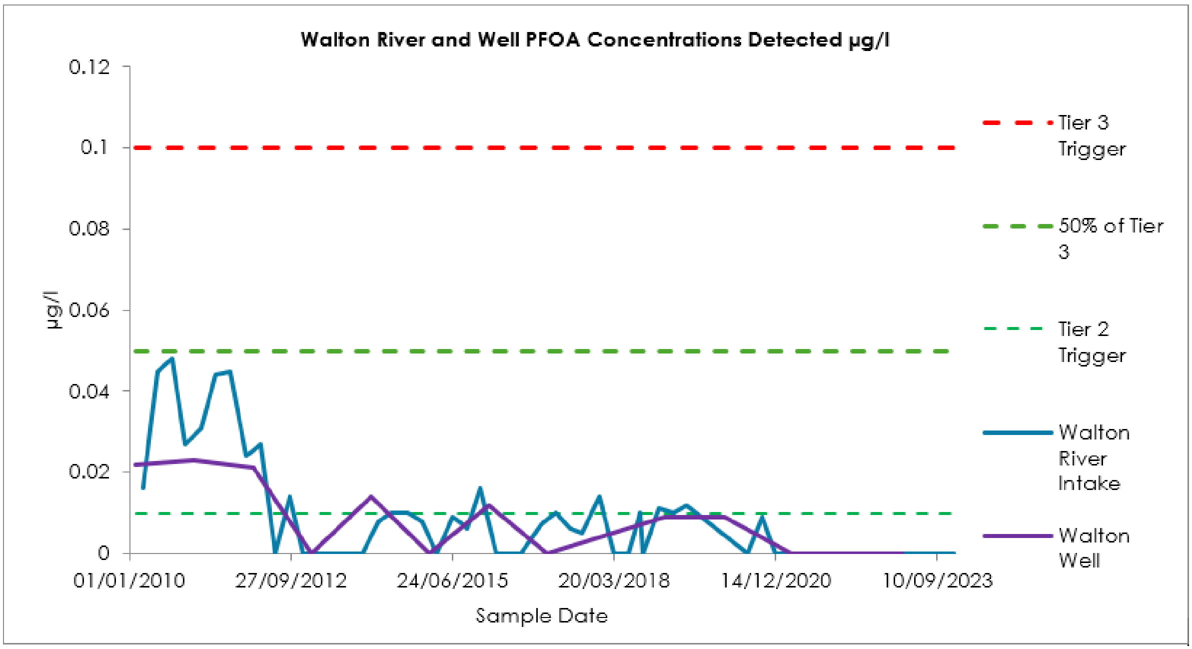

Figure 42. Walton River and Well PFOA Concentrations Detected µg/l.

The treatment process which would be expected to remove PFAS compounds at Walton is GAC, although the co-contaminants detected in the raw water could affect the efficacy of the GAC stage of treatment. In addition to the type of GAC, the replacement programme may contribute to the current PFAS removal performance at the WTWs. Given the historic PFAS detections sources, the high-risk nature of the catchment, it is likely that current treatment processes with respect to PFAS removal/reduction, such as GAC would require enhancement to maintain total PFAS concentrations below 0.01 µg/l.

19. Watton Road WTW

Watton Road is located close to the centre of Knebworth, Hertfordshire. The town of Knebworth is to the west of the A1 (M) and the south of Stevenage. The catchment is a mixture of residential (~50%) and agricultural (~50%) land. The A1(M) and the main railway line to London run through the catchment.

Treatment at the site includes UV disinfection and chlorination for residual chlorine, research indicates this type of treatment has poor removal for PFAS compounds.

PFAS concentrations in Boreholes 1 and 2 sources are generally below 0.01 µg/l, there was one PFAS detection at 0.023 µg/l in August 2023, as shown in Figure 43.

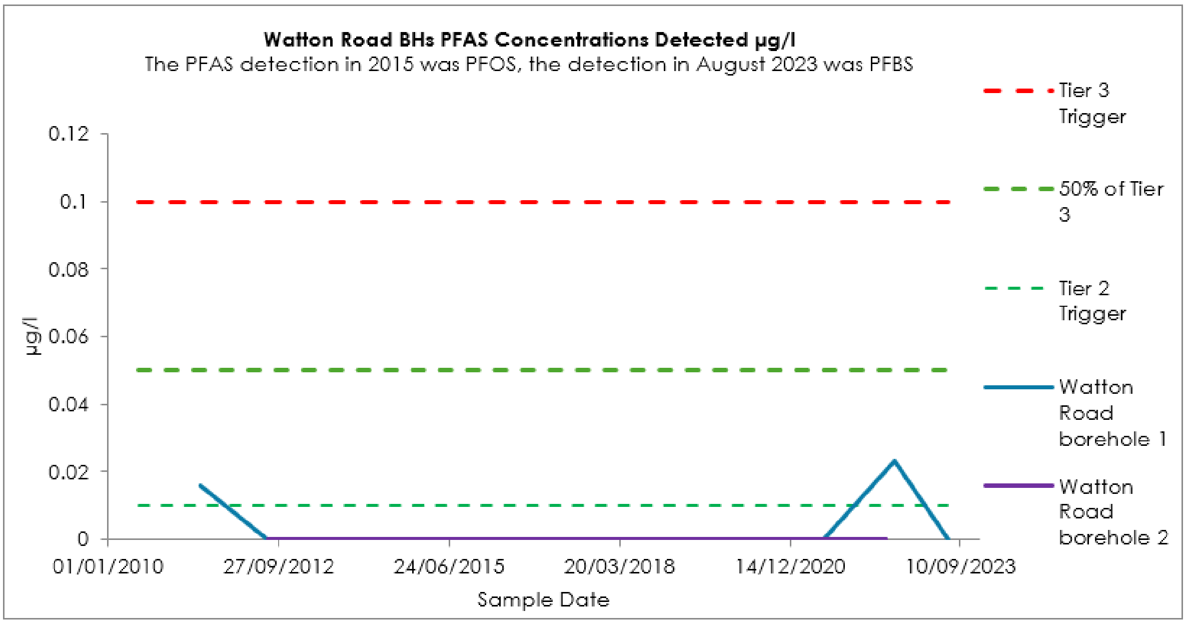

Figure 43. Watton Road BHs PFAS Concentrations Detected µg/l.

We will continue enhanced monitoring of the source waters to confirm PFAS concentrations in the drinking water supplies. Given the number of samples above 0.01 µg/l is very limited, it is unlikely water leaving Watton Road WTW will be at risk of entering Tier 3 PFAS concentrations. However, in order to reduce the risk of any PFAS being in the final water above 0.01µg/l, then PFAS treatment will be needed.

Catchment Investigations

Tier 2 sites fall into five catchment areas – Colne, Ivel, Thames, Lee and Little Stour, in addition to the three Tier 3 sites currently under catchment investigations. As seven of the Tier 2 sites fall into the Colne catchment and two of the Tier 3 sites also fall into the Colne catchment, this has been selected as the most appropriate operational catchment to focus on catchment source-pathway-receptor investigations.

The nine WTW sites are associated with 29 groundwater source protection zones (SPZs) and four surface water abstractions. Each requires a catchment investigation to determine the source(s) and pathway(s) for PFAS risks affecting our source and to determine if any form of remediation might be deemed suitable in the future (see Table 6 below). This will aid informing our long-term strategy for GAC replacement for those sites.

Of the 29 SPZs shown below, previous work commissioned by Affinity Water and carried out by the British Geological Survey as part of the Water Industry National Environment Programme (WINEP) investigations carried in AMP7 showed that nine of these sources in the Colne are potentially influenced by karst features, such as stream sinks. These features allow for the direct movement of surface water to groundwater and the flow velocities and volume associated with these karst features can vary greatly across the catchment. As such, it is of vital importance that the Colne Micropollutants Study including PFAS carried out by the Colne

Catchment Action Network (see section 'Co-design and Co-delivery' for more details) is supported and expanded because this work will further the understanding of sources of surface water contamination across the Colne and indicate hotspots which might be influencing groundwater quality (e.g. historic landfills) which can be targeted for further investigation during AMP8.

Table 6. Operational catchments associated with the selected WTWs.

WTW selected for catchment investigations	Source Protection Zone	Operational catchment	Potentially influenced by Karst features	Notes
Batchworth	Batchworth	Colne		
Clay Lane	Berrygrove	Colne	✓	
	Bricketwood	Colne	✓	
	Bushey Hall	Colne		
	Bushey PS	Colne		
	Eastbury	Colne	✓	
	Netherwild	Colne	✓	
	Tolpits Lane	Colne	✓	
	Wall Hall	Colne	✓	
North Mymms	North Mymms	Colne	✓	
	Tyttenhanger	Colne	✓	
	Essendon	Lee Upper	✓	
Hunton Bridge	Hunton Bridge	Colne		
Mill End	Mill End	Colne		
	Springwell	Colne		
Northmoor	Northmoor	Colne		
Broomin Green	Broomin Green	Lea		
Chertsey	Surface Water abstractions	Thames		
Egham				
Iver				
Walton				
Crescent Road	Hart Lane	Lee Upper		
Dover Priory	Dover Priory	Dour		
Holmestone	Holmestone	Dour		
East Hyde	East Hyde	Lee Upper		
Marlowes	Marlowes	Colne		
Roydon	Roydon	Lee Upper		
Stansted	Stansted	Lee Upper		
Watton Road	Watton Road	Lee Upper		
Baldock Road / Bowring	Baldock Road / Bowring	Ivel		Tier 3 sites currently under existing catchment investigations
Blackford	Blackford	Colne		
Holywell	Holywell	Colne		
Wheathampstead	Wheathampstead	Lee Upper		

Problem Statement and Stated Need / Driver

Understanding of the potential risks associated with PFAS compounds is ever evolving. DWIs latest guidance is to adopt a precautionary approach to PFAS during AMP8 and for all sources that fall into Tier 2, companies should design a proactive and systematic risk reduction strategy implementing a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water.

The potential of a further significant reduction in the wholesomeness threshold limit by the DWI has led us to re-evaluate our risk assessments and we have identified 19 priority water supply systems that require investment to ensure water supplies remain wholesome and to safeguard security of supply and service levels to customers.

Risks, Issues and Requirements

Regulatory Position for PFAS in Drinking Water

In January 2021, DWI published new guidance which reduced the wholesomeness level for both PFOS and PFOA to 0.1 ug/l and in July 2022 this wholesomeness level was extended to 45 other PFAS (IL 03/22). These changes led to a review of our risk assessments across all sources and drinking water supplies.

There is currently no prescribed concentration or value for PFAS in drinking water. However, the presence of PFAS represents a potential risk to the wholesomeness of drinking water, as defined in the Regulations and contrary to section 68(1)a of the Water Industry Act 1991 (as amended) (‘the Act’). Where sources are blended to mitigate PFAS, there is a risk of deterioration, in contravention of section 68(1)(b) of the Act.

Through DWI guidance, we adopted a three-tiered approach to the monitoring and management of PFAS in drinking water supplies and developed our PFAS strategy. The broad details of the source water monitoring programme are included in Table 7 below.

Table 7. Broad summary of our source water monitoring programme.

DWI Tier	AFF risk assessment	Monitoring	Comments
Tier 1 <0.01ug/l Regulation 27 – Risk assessment	No foreseeable risks	Annual	
Tier 2 0.01-<=0.05ug/l Regulation 10 – Sampling: further provisions	Low risk	Quarterly	Includes river Thames abstractions.
Tier 2 0.05 - <=0.1ug/l Regulation 10 – Sampling: further provisions	Moderate risk	Monthly	Roydon 1 & 3 Runley Wood chalk is under investigation single unusual result
Tier 3 >0.1ug/l Regulation 4(2) wholesomeness – concentrations that may constitute a potential danger to human health	High risk	Weekly	Baldock, Blackford, Holywell, Tolpits, Wheathampstead (when operational)

In June 2023, the 'Royal Society of Chemistry' published their PFAS position statement[8] outlining policy options for the management of PFAS in UK drinking water, Figure 44 below shows a summary of the the policy options.

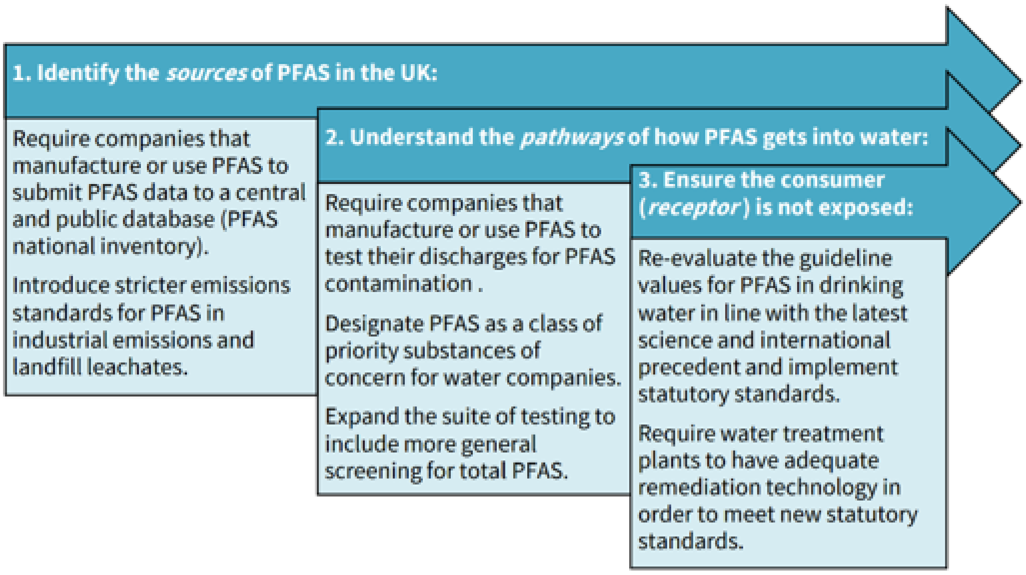

Figure 44. Policy options for the management of PFAS in UK drinking water.

Their policy options included a re-evaluation of the current guideline values for PFAS in drinking water in line with the latest science and international precedent and

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implement statutory action standards for water companies. Figure 45 show the varying approaches to setting limits for PFAS in drinking water in the UK, US and EU.

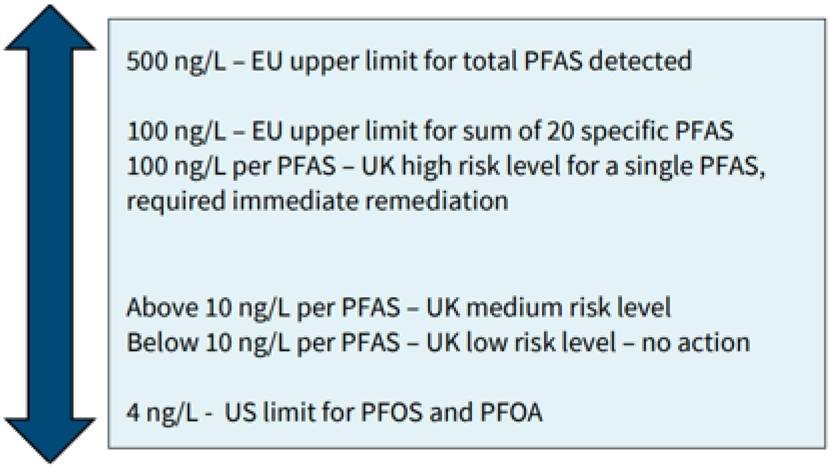

Figure 45. Current limits on PFAS concentrations in drinking water in the UK, US and EU.

They recommended that a new statutory action standard should lower the limit to 0.01 µg/l or lower per PFAS, and accredited analytical methods should be developed within the next few years to ensure this standard can be met for all of the DWI listed individual PFAS.

Compared to the current DWI Tier system, any measurement above 0.1 µg/l would be considered a Higher Risk, while Lower Risk would be 0.01 µg/l or less. The new system would focus on bringing the whole of the UK population into a lower risk scenario. They also recommended that Water companies would be required to remediate down to 0.01 µg/l or less in order to meet wholesomeness requirements, according to the current Tier 3 guidelines, summarised in Table 8 below.

Table 8. Existing DWI guidelines versus proposed statutory standards.

Tier	**Current DWI guidance***	**Proposed statutory standards***
Tier 1 – Low Risk	Less than 0.01 µg/L (10 ng/L)	Less than or equal to 0.01 µg/L (10 ng/L)
Tier 2 – Medium Risk	Less than 0.1 µg/L (100 ng/L)	Tier eliminated
Tier 3 – High Risk (action standard)	Greater than or equal to 0.1 µg/L (100 ng/L)	Greater than 0.01 µg/L (10 ng/L) – triggers remediation action

*for measurement of a single PFAS

During November 2023 (post PR24 submission) we received an assessment of our PFAS Strategy from the DWI, while they were broadly supportive of our approach, they encouraged us to submit a statutory section 19 Undertaking. This included a requirement for all sources that fall into Tier 2, companies should design a proactive and systematic risk reduction strategy implementing a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water.

We have liaised with the DWI to update our PFAS strategy to include an acceptable approach to meet their requirements, and signed a statutory Undertaking in August 2024.

Risks

At present, we believe there is currently no risk of prosecution or failing current regulatory standards as we have implemented a comprehensive, risk-based sampling and monitoring programme at all our sources and have introduced appropriate control measures where required. The frequency of monitoring on each source is determined by the individual risk level. This ensures that we have visibility of changes in raw water quality, and our teams monitor the trends on the water sources to identify any change in risk level.

The risk, therefore, is to water supply and water availability. If the sources were to be turned off due to increasing PFAS concentrations and in the event of a further reduction in wholesomeness value, then there would be a decrease in water availability in the area. This in turn could lead to low pressure events or, in the extreme, loss of supply to customers. Populations served by the 19 WTWs are shown in Table 9 below.

Table 9. Populations served by the 19 WTWs (Note: Clay Lane WTW is recorded as two supply systems because of compliance sampling purposes) and four high risk Tier 3 Sites.

Supply System Name	Population of zones within system	Risk Assessment Reference (name of Regulation 28 Report or Supply System Reference)
Batchworth	413,075	Y002
Broomin Green	97,172	Y036
Chertsey	143,274	Y078
Clay Lane 27	192,580	Y112
Clay Lane 36	284,347	Y075
Crescent Road	183,084	Y013
Dover Priory	46,463	Y087
East Hyde	38,675	Y014
Egham	300,712	Y079
Holmestone	46,463	Y089
Hunton Bridge	160,512	Y020
Iver	1,006,857	Y077
Marlowes	190,430	Y024
Mill End	365,406	Y025
North Mymms	289,511	Y081
Northmoor	72,165	Y026
Roydon	159,929	Y056
Stansted	12,107	Y061
Walton	105,819	Y080
Watton Road	97,172	Y068
High Risk Tier 3 Sites		
Blackford	47,669	Y005
Bowring	49,991	Y117
Holywell	96,632	Y018
Wheathampstead	38,675	Y034

Allocation of Costs

The delivery of this scheme is driven by a statutory requirement to maintain potable water quality in the context of deteriorating raw water quality conditions and a future potential further change in the wholesomeness threshold limit as defined by the DWI. The investment will result in a step-change in the service level provided to consumers and is therefore Enhancement expenditure.

The treatment solutions proposed are new standalone processes, with GAC and ion exchange plants costs developed separately. There are no plans or costs included to replace existing assets, therefore no overlap with base expenditure. The new plants will be constructed alongside existing assets, then integrated into the existing treatment process, having no impact on existing asset life expectancy.

For sites where the solution is to replace existing GAC media with dedicated PFAS removal media, the initial media costs are included in the enhancement capital expenditure. The forecast from current data is that the life expectancy of the PFAS dedicated media will be shorter than standard GAC now in use. Higher frequency replacement will be required, increasing consumption of virgin GAC media effectively as a consumable item.

Cross referencing was carried out between the schemes proposed in this business case and all other schemes submitted as part of the PR24 business plan. Any schemes with links to the sites in this business case were highlighted for further consideration of any scope items that may be common to both as shown in Table 10. For those schemes where overlap was identified, Table 10 states how costs were allocated to ensure no double counting.

Table 10. Other 2025-30 enhancement schemes on PFAS sites and assessment of potential cost overlap.

PR24 Scheme name	Scope	Link with PFAS T2 Additional BC? Y/N	Scope Crossover? Y/N	How any crossover was addressed in the PFAS Additional costs
Egham/Chertsey/Walton DO Increase - Connect 2050 - WRMP	1 GAC Walton, 2 GAC Chertsey	Y	Y	Additional GAC media for the DO increase project was not included in PFAS Additional BC
WQ - Surface Works DWI Egham (DWI) AMP	RGF and GAC expansion; FBC mods	Y	N	No crossover with GAC media change
WQ - Surface Works Iver Crypto DWI AMP8	New RGF plant, GAC covers	Y	N	No crossover with GAC media change
WQ - PFAS - Wheathampstead	R&D	Y	N	No crossover with new GAC plant
WQ - PFAS - Holywell	GAC media	Y	N	No crossover with new ion exchange plant
WQ - PFAS - Bowring & Baldock Road	GAC plant	Y	Y	Bowring and Baldock Road is the only site where extra land is needed for two separate schemes (GAC and Ion exchange). These were costed separately with no double counting
WQ - PFAS - Blackford	GAC plant	Y	N	PFAS additional business case includes only costs for the ion exchange plant. For additional land costs
Blackford Site ADO	RGF filtration	Y	N	At Blackford Group Treatment Works, where three schemes are proposed (PFAS [GAC], PFAS additional [Ion exchange] and ADO [RGF]), the solutions have been developed to ensure no doubling up of work elements. The schemes were assessed as requiring entirely different treatment solutions, however, elements such as borehole related works have only been costed within the AMP Sustainability Reductions intervention and therefore not included within the costs of this business case.
Storford Resilience	Blending main and valve at Stansted	Y	N	No crossover with new GAC plant
Northmoor Site ADO	Package cartridge filters; replacement of 2 pumps	Y	Y	PFAS additional business case requirements were developed after the Northmoor ADO scope was submitted in the WINEP programme. A new GAC plant for PFAS removal could potentially negate the need for Amazon filters, although GAC is not a turbidity treatment. No cost adjustments have been made. Pump costs are only included in the ADO business case.
North Mymms Site SR	Pumps	Y	N	No crossover, BH pump change costs included only in SR business case
Marlowes ADO	Pumps	Y	N	No crossover, BH pump change costs included only in ADO business case
Crescent Road Site SR	Pumps	Y	N	No crossover with GAC media change at Hart Lane; schedule on expiration of existing media

A review of all AMP7 schemes and investments was also carried out, cross referencing against the list of sites included in this business case preferred option to check for any overlap or impact on base expenditure as shown in Table 11. None of the AMP7 scheme scopes is affected by the solutions proposed in this business case for the same reason stated above, that all new plant is separate and additional. On sites with existing GAC treatment, PFAS specific GAC media will be installed. The high frequency of GAC media replacement means this is treated as a consumable, therefore not accounted for as a replacement of an existing asset.

Table 11. Results of assessment of overlap with 2020-25 schemes.

2020-25 (AMP7) Schemes	Overlap of scope to this case? (Y/N)
Chertsey Bisulphite Tanks	N
Chertsey HV	N
Chertsey lagoons	N
Crescent Rd UV	N
Egham (and Iver) aluminium management - flushing	N
Egham Chertsey Walton Ozone	N
Egham Poly & Retention Tanks	N
Egham SEW Pumps	N
Egham SWR	N
Egham Waste Water Upgrade	N
Existing Egham Generator	N
GAC media replacements [consumable]	Y
Holywell and Mud Lane Pumps	N
Hunton Bridge Iron Removal	N
Iver Lagoons	N
Iver Ozone	N
Iver raw water tunnels / Iver reservoir tunnel	N
Iver SWR	N
Marlowes RTW	N
North Mymms Pesticides	N
North Mymms Turbidity	N
RGF House 1 Refurb. at Chertsey	N
RGF House Repl. & Refurb. At Walton	N
SSF at Walton and Chertsey	N
Supply 2040: Blackford re-lift to Ickenham (ST2)	N
Supply 2040: Egham to Iver (ST1)	N
Walton Waste Water Recovery WWR	N
Waste Water Recovery at Clay Lane	N
Watton Road	N
Wheathampstead Cr VI	N

DPC

This scheme is not suitable to be considered for a Direct Procurement for Customers approach as the value is below the £200m Totex threshold. Further, DPC will not apply because it cannot be separated from our existing asset base, it will be an integrated part of wider sites i.e. not a whole separate treatment works or reservoir.

Research, Pilots, and Technology Development

We will make use of the outcomes from several cross-industry research and development trials, continue to learn from the experiences of other water companies who have implemented PFAS removal treatment in AMP7 and we will also draw on our own experiences as detailed below.

Wheathampstead trials:

Through the implementation of hexavalent chromium specific ion-exchange at Wheathampstead WTW and our journey to gain DWI Regulation 31 approval for the new Cr VI ion-exchange resins during AMP7 we now have a deeper understanding of the challenges and obstacles involved in obtaining approval.

Currently, there is no route for new products to be tested and added to the DWI approved list, as no designated test laboratories are available. This posed a potential barrier to commissioning our new treatment process at Wheathampstead, because the resin beads inside the vessels lack full DWI approval.

The resin is approved in the USA, where it is used in several treatment works in California, and DWI granted us temporary approval to use the product for 12 months. For the approval to be extended beyond July 2024, DWI set us the challenge of conducting our own materials testing on the resin in accordance with the relevant British Standard.

We carried out laboratory bench scale leachate testing of the ion-exchange resin, acquiring equipment for the resin testing and following the methodology in the British Standard. The resin underwent a precise cycle of stagnation and periods of flowing water, and the leachate samples generated each day were analysed via Gas Chromatography Mass Spectrometry (GCMS) within 24 hours. Extracting and analysing samples via GCMS is complex and time-consuming, and the extended test period required our team to repeat the process for nine consecutive days.

We have shared our findings with the DWI Regulation 31 team to demonstrate compliance and ensure the continued supply at Wheathampstead. We will continue to work with the DWI and other water companies to improve the Regulation 31 approval process by actively participating in Water UK working groups.

The ion-exchange resin at Wheathampstead WTWs is specialised for the removal of Cr VI but has shown a secondary capacity for the removal of PFAS compounds. Since commissioning in July 2023, approximately 102,000 bed volumes have passed through each ion-exchange vessel. Three PFAS compounds were detected in the raw water but concentrations in the treated water were below the LoQ maximum. Concentrations detected in samples taken in May 2024 are shown in the Table 12 below.

Table 12. Ion-exchange at Wheathampstead WTWs PFAS Results.

Sample point	Sample point description	PFECHS (µg/l)	PFHxS (µg/l)	PFOS (µg/l)
WHSD_R1_	Wheathampstead Raw 1	0.031	<0.009	0.057
WHSD_R2_	Wheathampstead Raw 2	0.067	0.015	0.108
WHSD_IXB68	IEX Vessel B68	<0.019	<0.009	<0.016
WHSD_IXB65	IEX Vessel B65	<0.019	<0.009	<0.016
WHSD_IXA62	IEX Vessel A62	<0.019	<0.009	<0.016
WHSD_IXA61	IEX Vessel A61	<0.019	<0.009	<0.016
WHSD_IXOU	IEX Combined outlet	<0.019	<0.009	<0.016
WHSD_FN_	Wheathampstead Final	<0.019	<0.009	<0.016
SHAKRD_SR_	Shakespeare Road Reservoir	<0.019	<0.009	<0.016

Holywell trials:

Our GAC treatment at Holywell WTW for PFAS which is being funded by DEFRA Accelerated Infrastructure Programme funding opportunity in the last two years of AMP7 has given us some insight into establishing a baseline for the efficacy of PFAS removal, bed life of the GAC treatment. As of June 2024, four contactors have had new virgin media installed at Holywell.

- Contactor 1 has been in service with the new virgin reagglomerated carbon media since November 2023. The first detections of PFOS and PFHxS at the top sample point (i.e. indicating the GAC media at the top mass transfer zone of the contactor is reaching saturation) was in June 2024, at which point the bed volume (BV) was 18,371. The concentrations seen were 0.017 and 0.01 µg/l (incoming raw water concentrations were 0.03µg/l). The average empty bed contact time (EBCT) has been 17.2 minutes (min 13.5 and max 25.3 minutes) during the trial period, which is in accordance with our operating guidance for GACs.

- The performance of the other three contactors with different GAC media is still being assessed. Initial results for two of the media indicate that these are not as effective as the reagglomerated carbon. The fourth contactor was commissioned in June with surface modified reagglomerated GAC so no performance conclusions can be drawn yet.

In conclusion, we have confirmed that we have no initial breakthrough in the outlet of the reagglomerated GAC filter for the long chain PFAS compounds present in Holywell raw water. We have also confirmed that the short chain compounds found in Wheathampstead raw water are removed through ion-exchange. This is in line with industry findings showing that the combination of GAC and ion-exchange for PFAS removal may be the optimal treatment option due to their complementary benefits to effectively treat all PFAS compounds.

Customer Engagement

Detail of Customer Engagement work

We have previously undertaken extensive engagement with our customers to build a detailed understanding of their priorities and reflected these in this business case. For more detail on our customer engagement see AFW04 What Customers and Stakeholders Want.

We carried out some customer engagement, [9,10,11,12] as part of the Strategic Resource Options programme of work, looking at how customers preferred to be communicated with. This gave us the opportunity to gain some insights into their thoughts and preferences about several of the long-term plans related to water resourcing, including source types.

An evidence review was carried out of 50 documents and stakeholder interviews with each of the water companies, with documents gathered directly from the 6 water companies involved in WRSE, and the evidence was then synthesised to identify consistent findings which were triangulated to assess their strength. During the qualitative phase we tested these findings with 96 household customers across the 6 companies, including Gen Z and vulnerable customer. During the quantitative phase we held 15-minute online surveys with 1,762 household and 198 non-household customers for robust segmentation and validation of findings.

This research reinforced our understanding that water is a low salience topic with our customers, in that they have a low level of awareness and understanding of issues relating to it. This in part is driven by general satisfaction with the customer experience of water in terms of taste, smell and hardness.

We followed this up with some deep dive sessions in July 2022 to specifically test on our own long-term plans with a wide cross section of our customer base[13]. 82 customers and 10 business representatives participated in this research. Customers were divided into "household", "vulnerable" and "future" groups to reflect a range of views, whilst local business representatives provided views on behalf of their place of work ("Non-household").

The Non-household individuals were recruited from businesses which are heavy water users. Customer groups covered a range of ages, socio-economic backgrounds and areas within Affinity Water's region in order to enable a diverse range of views. Given the long-term focus of the research, future customers were also included to gauge an understanding of priorities from individuals who are likely to become Affinity Water customers in the future.

[9] WRSE Customer Preferences Part A Evidence Review Final Report ICS February 2021.pdf
[10] Water Club - Changes of Source - June 2022.pdf
[11] Affinity Water Customer Valuation Research Summary Report May 2023.pdf
[12] Affinity Water Customer Priorities for Long-term Ambitions
[13] 'Customer Priorities for long-term ambitions to support PR24 and long-term delivery strategies,' September 2022

Ten online focus groups were held (household and future customers) and fifteen one-to-one interviews conducted (vulnerable and non-household customers). Focus groups were conducted via online video, using the specialist VisionsLive platform, each session lasting 90 minutes. Voting exercises and activities were used throughout the focus groups, to aid engagement, capture strength of feeling, and focus the discussion on the core research questions.

These were qualitative sessions, and the outcomes gave us some insight into customer views of the relative importance to them of, among other considerations:

- Reducing amount of chemicals used in water treatment,
- Reducing carbon emissions associated with treating water for customers,
- Hardness level of their water supply, and
- Keeping customer bills as low as possible.

We also held some quantitative research sessions between February and March of 2023 with a second set of workshops looking at Customer views on priorities covering customer preferences for changing service levels. Customers were generally observed to be more sensitive to avoiding deteriorated service levels compared to the preference for improvements. In general, there was a limited preference for changes in service levels for hard water and hosepipes bans.

911 household customers completed the survey between February and March 2023 800 respondents completed an online survey and 111 completed an in-person interview, qualifying as "digitally disengaged." 42% of the household respondents (383 people) were classified as being in vulnerable circumstances. Around 13% of respondents who took part in the study (117 people) were registered with the Priority Services Register. Of these 117 respondents, 31% were medically dependent on water, 56% suffered from physical issues, and 9% need information in alternative formats.

There was a good distribution among the respondents of all targeted characteristics. Females were slightly over-represented (57% of respondents) and were within +/- 7 percentage of sample quotas. Socio-economic group (SEG) profiles were within +/- 3 percentage points of sample quota. All age cohorts were within +/- 4 percentage points of sample quotas. b

150 non-household (NHH) respondents completed the survey online. These comprised a good mix of NHHs achieved when measured by both number of sites and by number of employees. Around a third of organisations had only 1 site (34%), 12% of respondents were a sole trader and 15% of respondents had between 100-150 employees. Also, the sample distribution by economic sector has the expected profile with 1% as Primary, 28% as Secondary and 71% as Tertiary.

Finally, in developing our representation, given the movement in bill profiles we recognised the importance of carrying out further customer engagement and affordability support work to support our customers. Given the limited time available to develop representations, we have engaged with customers through our Qualtrix platform which is a powerful engagement tool which allows us to turn customer feedback into actionable insights. We gained insights from 546 customers on our revised plans and associated bill profiles, and we are committed to continue working with our customers to develop further plans for affordability and vulnerability support ahead of bill increases in 2025.

Customers are aware of the emerging importance of removing PFAS from water, with 33% of customers aware and a further 33% vaguely aware of the issue. This also ranked highly (third) in customers' priorities and 63% liked our proposed solution quite, very or extremely well.

When asked about the bill profile as a result of this addition to our plan and the other changes in our Representations, 73% of customers thought it was a little or a lot more than they were expecting.

Evidence of Customer Preferences

We have developed all of this research and analysis into a document called "What our Customers & Stakeholders Want[14]" which presents the findings from the various customer engagement activities. The key takeaway point from the research is that customers have a high level of inherent trust in us as a water provider, and generally are happy for us to make decisions about technology selection and water quality risk management without consultation with them – we are the experts, and they trust us to make those decisions.

Another outcome of the research was a strong steer that customers expect us to meet our regulatory duties at all times, with respect to the Water Supply (Water Quality) Regulations. Any strategic decisions we make with respect to cost or carbon emission reduction must not have any detrimental impact on water quality performance.

The outcomes from the deep-dive qualitative sessions with our own customers indicated that they have wide ranging responses to the questions of whether we should be reducing chemical use in water treatment and whether we should be reducing operational carbon emissions, which could be influenced by many factors including the respondents' own socio-economic group, with no overall preference or point-of-view expressed[15]. Two thirds of customers did not support investment to soften hard water, with a third supporting investment. Hard water tends to polarise customer opinions. However, there was a clear steer from customers, from these qualitative sessions, that their main priority over any of the other considerations was to keep bills as low as practicable.

The 'Strategic Resource Option' customer communication preferences work indicated that there are some acceptance barriers in place for customers around some of our water resourcing ideas, particularly with respect to direct or indirect

[14] What our Customers and Stakeholders Want V5 final.pdf
[15] Line of Sight V3.doc

wastewater effluent reuse schemes. They indicated that they would need reassurance if this type of approach were taken that water would be safe to drink.

The qualitative research sessions indicated that customers were generally observed to be more sensitive to avoiding deteriorated service levels compared to the preference for improvements. Household customer values for improved service levels for areas including tap water aesthetics was relatively modest – but nevertheless improvement in these areas was viewed as beneficial. In general, there was a limited preference for changes in service levels for hard water and hosepipes bans. Respondents felt that Affinity Water's services are good value for money and were generally satisfied with the services they receive.

Customer protection

We recognise that, given the materiality of expenditure and uncertainty, appropriate customer protection is paramount for the expenditure to address current Tier 2 sites. PCDs represent an effective mechanism for this protection. The proposed PCD for the PFAS strategy would apply to this additional investment, however, given the materiality and singular nature of this existing PCD, this would not appropriately account for the uncertainty or protect customers.

We therefore considered several potential designs of the PCD to accurately reflect the uncertainty and best protect customers. We examined proposed PCDs across the industry and those Ofwat includes within draft Determinations for similar schemes. The three most appropriate options for the PCD unit were;

i. number of sites (where treatment has been installed and commissioned),
ii. treated Peak Week Production Capacity (PWPC protected by additional treatment installed and commissioned)
iii. DWI legal instrument approval

The investment primarily relates to treatment installations across 23 sites, with less material costs that could be included within the PCD, either within the unit rates for option i. and ii. or within the overall legal instrument for iii.

A brief summary of the considerations for different protections is included in Table 13 below.

Table 13. Considerations for PCDs for the PFAS additional business case.

PCD unit considered	Advantage of approach in protection to customers	Alignment with current PCDs
i. Number of sites	Returning costs to customers on an average cost per site basis, regardless of the number of sites within a legal instrument	Does not align with Ofwat PCDs within the draft Determination
ii. Treated peak week production capacity	Returning costs to customers on a cost per treated flow may most accurately reflect the scheme costs, therefore providing protection most proportional to those allowed within the determination	Does not align with Ofwat PCDs within the draft Determination
iii. DWI Legal Instrument	The DWI Legal Instrument ensures we meet regulatory expectation. However, multiple sites many be included within a single undertaking, limiting proportionality to allowances.	Aligns to Ofwat PCDs within the draft Determination

Given the recent signing of the Undertaking, it is thus far unclear whether legal instruments will be applied to each individual site. We propose a PCD aligned to the DWI legal instrument, under the assumption that individual Notices will be applied to each site prior to final Determination. Should all sites instead be covered by a single Undertaking, we propose reverting to a more proportional unit as per options i. or ii.

Below we provide a table (Table 14)of individual site costs and how differing units of PCDs could apply. The average variance at each site between investment cost and PCD rate should be as low as possible to best protect customers and manage uncertainty. We have therefore assessed this variance for both option i) and ii).

Option i) setting a standard rate for each site, creates an average variance of £4.31m per site. Whereas option ii) setting a rate based on capacity of the site, created a larger average variance of £8.34m.

We therefore propose that should no individual Notices be applied to each site, the PCD is designed to using number of sites (where treatment has been installed and commissioned).

We also propose no time incentive, in line with draft Determination PCDs for all other raw water deterioration investments.

Table 14. PFAS additional business case costs and potential PCD unit rates.

Site	Peak week production capacity (Ml/d)	Enhancement expenditure within investment case (£m)	i) PCD value at unit rate per site (£m)	ii) PCD value at unit rate per treated Ml/d, Peak week production capacity (£m)	iii) PCD value at unit rate per legal instrument* (£m)
Non-site specific expenditure	0	3.74	0	0	0
Batchworth	23.95	6.98	6.48	4.28	6.48
Broomin Green	2.56	0.13	6.48	0.46	6.48
Chertsey	59.55	1.65	6.48	10.64	6.48
Clay Lane	144.38	3.5	6.48	25.8	6.48
Dover Priory	5.59	19.16	6.48	1	6.48
East Hyde	6.43	0.19	6.48	1.15	6.48
Egham	137.4	5.7	6.48	24.55	6.48
Hart Lane (Crescent Road)	28.9	0.81	6.48	5.16	6.48
Holmestone	2.04	10.77	6.48	0.36	6.48
Hunton Bridge	8.85	3.73	6.48	1.58	6.48
Iver	225.58	6.72	6.48	40.31	6.48
Marlowes	6	5.78	6.48	1.07	6.48
Mill End	29.35	12.21	6.48	5.24	6.48
North Mymms	28.3	0.89	6.48	5.06	6.48
Northmoor	17.98	6.23	6.48	3.21	6.48
Roydon	10.81	3.98	6.48	1.93	6.48
Stansted	3.89	3.54	6.48	0.7	6.48
Walton	39.2	1.44	6.48	7	6.48
Watton Road	3.9	2.11	6.48	0.7	6.48
Baldock Road/ Bowring	6	10.65	6.48	1.07	6.48
Blackford	19.53	16.6	6.48	3.49	6.48
Holywell	19	18.19	6.48	3.39	6.48
Wheathampstead	5.37	4.42	6.48	0.96	6.48
Total	**834.56**	**149.12**	**149.12**	**149.12**	**149.12**

*Provided legal instrument applies to each site

Partnering

Collaboration and Partnering

Collaboration and Partnering were evaluated as part of our high risk PFAS business case[16] as detailed below.

Engagement with Stakeholders and Partners

- DEFRA (Department for Environment Food and Rural Affairs)

Accelerated Infrastructure Programme (AIP) Opportunity – In October 2022, Defra asked water companies to propose schemes for accelerated additional infrastructure delivery in 2023-24 and 2024-25 that would provide benefits for customers, communities, and the environment. We proposed the completion of six GAC contactors for media exchange at Holywell WTWs during Year four and five of AMP7 and submitted our draft business case to the DWI. In April 2023, Ofwat's draft decision supported the acceleration of the scheme.

- Drinking Water Inspectorate (DWI)

We were invited by the DWI to carry out some early engagement with representatives from the regulator through the Autumn of 2022. We met with them during November 2022 and shared an early view of what is likely to be included in the water quality programme for PR24 and the AIP schemes, their initial feedback was supportive of our proposals.

In January 2023 we submitted a summary statement to the DWI which highlights significant new future risk mitigation measures that we will be seeking support for in the PR24 proposals. The purpose of this statement is to:

  - to understand the justification and evidence for proposals
  - to estimate the number and type of submissions to expect

In addition to the summary paper, in March 2023 we submitted to DWI our draft business cases for drinking water quality investments. We proposed five PFAS schemes (including Ardleigh WTW jointly owned and operated by Anglian Water) for investment and inclusion in the PR24 portfolio. The five schemes identified were at treatment works that treat three of our 'high risk' PFAS sources and two of our 'medium risk' sources, these were supported by the DWI, and we accepted Regulation 28(4) Notices for one site in June 2023 and the other four in October 2023.

During November 2023 (post PR24 submission) we received an assessment of our PFAS Strategy from the DWI, while they were broadly supportive of our approach, they encouraged us to submit a section 19 Undertaking. This included a requirement

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[16] Raw Water Deterioration PFAS Sites.docx

to undertake catchment investigation and develop options for blending / treatment to be considered for all sources that fall into Tier 2.

- Environment Agency (EA)

We have liaised closely with the EA to develop our WINEP and catchment management plans for PR24, and have taken a holistic approach at an Operational Catchment scale, incorporating:

- Sustainability reductions (SR's)
- Abstraction Impact Assessments
- Biodiversity enhancement
- Catchment and Nature-based solutions (C&NBS)
    - Revitalising Chalk Rivers - River restoration, habitat enhancement and monitoring
    - Resilient Chalk Catchments - Catchment management measures for multiple benefits (water resources, water quality, biodiversity, carbon, chalk stream resilience.
- Flagship Chalk Stream Catchment Restoration projects (CaBA strategy)

The engagement process is outlined Figure 46 schematic below.

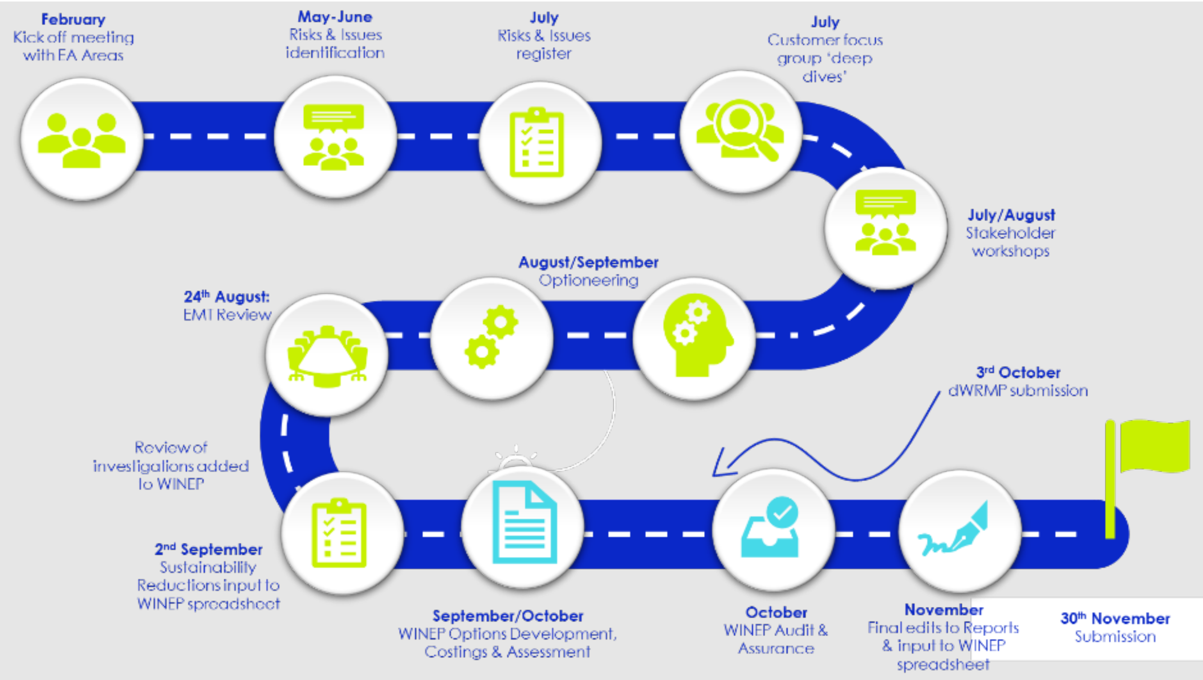

Figure 46. Schematic of our engagement process during 2023.

Co-design and Co-delivery

- Inter-company collaboration

We are members of multiple inter-company groups in which we discuss significant emerging risks and potential solutions to or approaches for dealing with them. These include: Water UK (and all the sub-groups therein), UKWIR, WRc (including Disinfection Forum), Cranfield University (including UK Water Network on Potable

Water Treatment and Supply), Isle Technologies (Technology Advisory Group, Water Treatment Technical Working Group and Water Distribution Technical Working Group).

- Early engagement with technology suppliers

We have engaged early with suppliers of specialist treatment equipment in order to understand the options currently available on the market, as well as those at various stages of development currently in use in other countries (which may not hold the approvals necessary for use in the UK). We also use information from the suppliers to begin to build up cost estimates for implementation of the novel technologies, for which we do not hold any normalised cost models.

- Colne Micropollutants Study and the continued support we are part of in the catchment.

Our Catchment management team supported the Colne Catchment Action Network (ColneCAN) and partners in the Upper River Colne, as part of a micropollutant investigation into surface water contamination impacting water quality in the Colne. We worked with key stakeholders including the Colne Valley Fisheries Consultative (CVFC) who commissioned the investigation into potential pollutant sources in the Colne catchment. This catchment is characterised by karst features which can allow for surface water to groundwater connectivity which have the potential to impact our groundwater sources in the area, under certain hydrogeological conditions.

The investigation used GCMS water quality sampling of key river sample locations (downstream of outfalls and discharges) and found the presence of 267 different substance, 85 of which carry an Environmental Hazard classification, ranging from harmful through to toxic to aquatic life. Sediment sampling was also carried out and the combination of the two methods did detect the presence of PAH and PFAS in the surface water.

We are continuing to work with key stakeholders in the Colne catchment and in 2024 we began supporting a further project to identify, log and map every outfall, channel and ditch that could discharge into any tributary within the Colne catchment during different weather conditions. This project has now expanded into a Water Quality Working Group with the ColneCAN, EA, Brunel University, and a number of other partners. The concerns around PFAS in the Colne, coupled with the number of Tier 2 and Tier 3 abstractions we have in the catchment has led to increased focus on PFAS for the project. A monitoring plan is being developed for 2024 and we will support the development of this project to support identification of the potential sources and pathways for PFAS contamination across the catchment which will form part of our action plan as per the Undertaking.

Strategy Development

Long-term Delivery Strategy Alignment

Our enhancement cases have been developed as part of our integrated investment portfolio that takes the first steps of our Long-Term Delivery Strategy and achieving our ambitions as laid out in AFW03 Strategic Direction Statement.

Long-term Delivery Strategy Alignment

In our Strategic Direction Statement[17] we commit to "Deliver what our customers need, ensuring affordability for all" which encompasses "Exceed[ing] customers' expectations for drinking water." We know that customers hold inherent trust in us to make the appropriate interventions to safeguard their water quality.

There is an additional commitment to "Be prepared for change and resilient to shocks and stresses" within which we commit to "Ensure a resilient supply of water for Affinity Water customers." We are delivering on this commit in this case by providing treatment where no blending or other management of the risk is possible without detrimental effect on the resilience of our supply network in this area.

Our long-term delivery strategy related to water treatment includes an investment line covering "Addressing raw water deterioration." In this instance, there is both an overall deteriorating (increasing) trend in the concentration of the contaminants in the raw water and a recommendation set by the DWI to design a proactive and systematic risk reduction strategy implementing a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water.

Treatment Strategy

Currently, our Treatment Strategy requires provision of treatment only when necessary due to raw water quality and when it is the best value holistic solution to provide treatment rather than any other solution.

We are exploring options around selection of treatment processes that have high power demand in preference to processes that require high chemical input in order to reduce our overall operational carbon emissions. The speed at which we implement this strategy will depend on the glidepath to net zero operational carbon emissions set by the Company, and whether these proactive changes towards power-intensive processes away from chemical-intensive processes are necessary to achieve those target future carbon emission profiles.

[17] AW0031_Strategic-direction-statement.pdf

PFAS Strategy

We developed our PFAS strategy in 2023 and further updated it in April 2024, in line with our response to DWI's assessment of our initial strategy received in November 2023. Our revised objectives for the period 2023-2030, specified in our PFAS strategy are to:

1. Complete and update catchment risk assessments with respect to PFAS.
2. Work with stakeholders to identify sources of PFAS in the catchment and consider whether environmental remediation options are cost effective and achievable.
3. Continue with a risk-based sampling programme for PFAS.
4. Comply with extant DWI guideline values for PFAS in drinking water supplies across our supply area.
5. Where there is a material risk optimise current treatment processes with respect to PFAS removal/reduction, such as blending and GAC.
6. Install and monitor new treatment processes at treatment works identified in PR24 submissions (Ardleigh, Blackford, Bowring, Holywell & Wheathampstead WTWs) using evidence from new schemes to inform our policy.
7. Where water leaving treatment works falls into Tier 2 and GAC contactors are already in place, replace the GAC.
8. Where water leaving treatment works falls into Tier 2 and there is blending downstream, carry out sampling in the distribution system to confirm PFAS concentrations in the drinking water supplies.
9. Where water leaving treatment works falls into Tier 2 and there is no treatment or blending downstream, investigate options to reduce PFAS concentrations in the drinking water supplies.
10. Continue to communicate with local public health professionals with regards to PFAS in drinking water supplies and any links to private water supplies.
11. Support research into new technologies for PFAS treatment and catchment remediation.
12. Continue awareness training of AW personnel on PFAS in source water and drinking water, including the latest scientific and public health research.
13. Maintain an in-house laboratory capability for analysis of PFAS compounds.

We reviewed our high-level assessment further in May and June 2024 and this allowed us to select 19 Tier 2 in addition to the 4 high risk sites already covered by the 'Raw Water Deterioration PFAS Sites' Business Case.

During the course of this assessment, it was determined that our Bulstrode, Chorleywood and Digswell sites could be discounted, based on their sampling results (not detected in the last two years or ever detected above 0.02 μg/l since 2015).

This business case has been developed

- to address points 7, 8, 9 and 11 above
- to install GAC on sites where PFAS has been detected historically above 0.02 μg/l and/or in the last two years and/or surface works
- and to install ion-exchange treatment on three Tier 3 sites (where GAC is proposed in our business case previously submitted) and GAC on one Tier 3 site (where ion-exchange is already in site).

Adaptive Strategy

Depending on the speed at which we want to reduce our operational carbon emissions on our treatment works, it may be necessary to select a high-power demand process for treatment of PFAS over a high chemical demand process. As this is under constant review, we will select best value solution based on cost and risk reduction at this stage.

This project is no regrets because we require the water from the sources in order to meet our supply demand balance and, without the addition of treatment processes at these sites, we predict that these sites will otherwise need to be turned off in the future as the trend for regulation of these compounds is to reduce the allowed concentration (other countries globally have lower permitted limits) as there is deemed to be no safe concentration with respect to human health. Therefore, there is high likelihood that these regulatory limits will be reduced again in the medium- to long-term.

Optioneering

In the context of an evolving understanding of the potential risks and mitigation options associated with PFAS, our approach to optioneering has encompassed both a high-level optioneering assessment where we engaged with our subject matter experts within Affinity and our structured Risk and Value (R&V) process as shown in Figure 47.

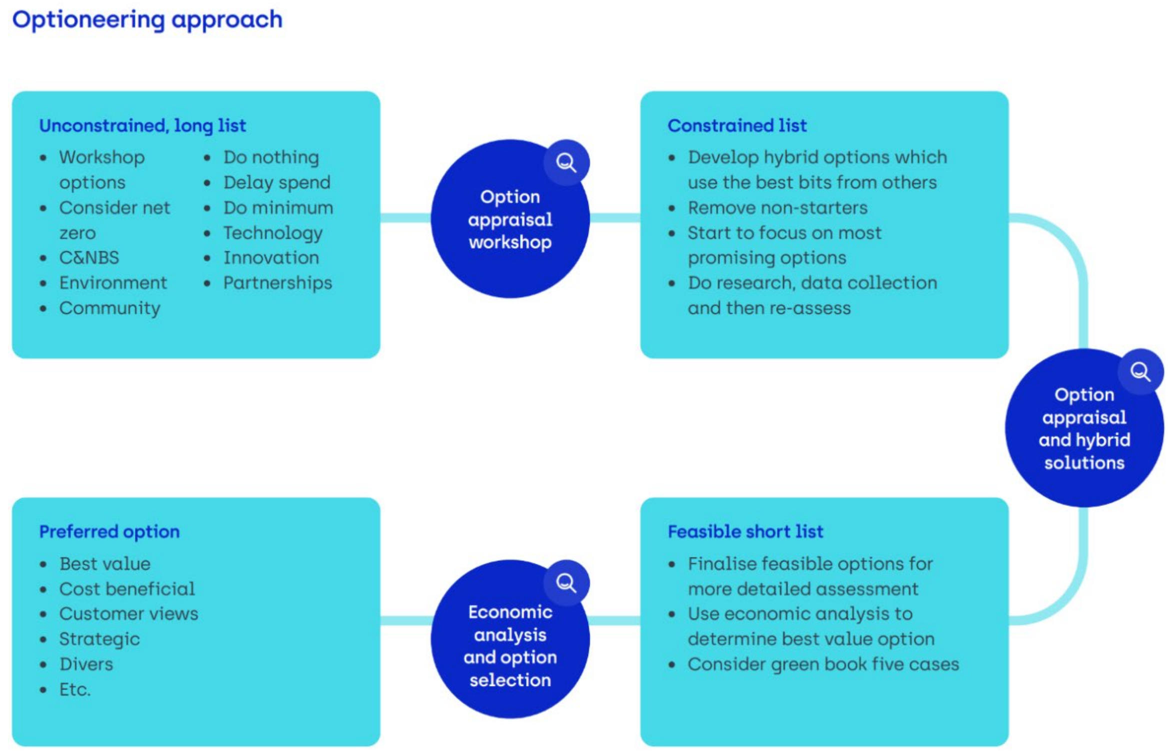

Figure 47 - Investment planning optioneering approach

The key activities undertaken and findings at each stage are summarised in Table 15 below.

Table 15. Summary of optioneering approach and findings.

Stage	Activity	Findings
Unconstrained long list	Analysis of the risk of PFAS contamination at all sites, including the likely impact of doing nothing. Subject matter expert workshop to identify all potential mitigation methods including removing sites from operation, R&D, catchment management, enhanced sampling and monitoring, blending, ion-exchange technologies, granular activated carbon (GAC), ultra and nano membrane filtration, informed by the latest research and technology reports.	Ruled out blending based on residual risk to supply resilience. Ruled out membrane filtration based on cost, treatment maturity, and lack of DWI Reg31 approval. Ruled out removing sites from operation due to WRMP requirements. Remaining options taken forward; R&D, catchment management, enhanced sampling and monitoring, ion-exchange, GAC.
Constrained list	Developed a matrix of 90 sites with potential treatment options. Site PFAS risk assessment criteria applied. Evaluated mitigating efficacy of each remaining option on each site. Enabled quick evaluation of any scenario from 'do nothing to 'do everything'.	23 sites identified for further optioneering. Concluded that treatment was necessary to mitigate to Tier 1 threshold. GAC and Ion-exchange shown as feasible technology options. Maintained R&D, catchment management, enhanced sampling and monitoring as supplementary options.
Short list	Cost estimates developed further. Site specific feasibility assessment of installing each technology at each site. Economic assessment of feasible technology options. Options selected proportional to site PFAS risk.	Selected GAC for Tier 2 sites, and both GAC and Ion-exchange for Tier 3 sites. Included R&D, catchment management, enhanced sampling and monitoring as supplementary options across all sites. Determined appropriate level of catchment management option
Preferred option	Confirmed best value approach selected through final economic assessment of net present value, optimising phasing of activity for best value and deliverability. Ensure solutions meet requirements of the DWI undertaking and reflect customer views, PFAS strategy	Selected final suite of investments.

Stage 1: High level optioneering assessment

As the DWI has asked us to design a proactive and systematic risk reduction strategy implementing a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water for all sources that fall into Tier 2, our first step was to define our mitigation methodology, using a high-level optioneering assessment.

Our previous review of available treatments for PFAS removal completed for our high risk PFAS sites during 2023 included research of the literature and existing practices. Whilst there has been much innovative research and development in this area, readiness of technologies continues to remain a challenge, our preliminary ranking is summarised in Table 16 below. Available treatments and existing practices for PFAS removal include the following options:

- Blending
- GAC
- Ion-exchange (either regenerable or non-regenerable),
- Nano Filtration (NF) / Reverse Osmosis (RO) membranes.

Table 16. Preliminary ranking of treatment options for preference.

Rank	Option	Key Logic	Main Concern
1	Blending	Lower Capex & Opex, low operational input	Control & loss of DO
2	GAC	Good performance, familiar technology, lower risk waste disposal	Some short chain PFAS species, air quality rule changes
3	Non-regen Ion-exchange	Good performance, medium risk waste disposal	Solid waste disposal
4	Regen-Ion exchange	Good performance	Waste stream disposal
5	NF / RO membranes	Good performance	Loss of DO, waste stream treatment / disposal, remineralisation may be needed with RO

Stage 2: Risk and Value

The structured Risk and Value (R&V) process has been used for optioneering, which is based on the utilisation of data to identify the best value solutions and/or opportunities. The first phase of the R&V assessment is to fully determine the risks/opportunities for the service to our customers. Once a risk is fully defined, comprehensive root cause analysis is applied to determine the right source of the asset failures and the impact these have on the business. The next phase centres around solution optioneering which identifies alternative solution options, to mitigate/resolve identified risks and opportunities. The Whole Life Cost (WLC) and potential solutions are evaluated using historic costs, and contractor/supply chain knowledge. The WLC is the total cost of owning and operating an asset over its lifetime, calculated by adding the initial capital expenditure (Capex) to the operating expenditure (Opex) over 25 years. Finally, the solution options were evaluated using two important metrics: risk reduction and risk index.

Risk reduction measures the amount of risk that is removed by a proposed solution (i.e. initial risk minus percentage risk removed by solution option). Risk index measures the cost-effectiveness of a proposed solution (i.e. WLC of solution divided by residual risk). The lower the risk index the better; the solution with the lowest risk index is usually the best value option.

By utilising the key outputs from the R&V process the optimum solution can be identified and progressed. The stages and outputs from the R&V process are as follows:

- Problem Definition Statement
- Root Cause Analysis of identified risks
- Unconstrained options – identification of any potential solution options to mitigate/resolve identified risks.
- Feasible options – selection of options to take forward based on practicality, efficacy, and affordability.
- Cost / Benefit ratios, or Risk Index, for each solution

Stage 3: Catchment Management Investigations

As described above, catchment management will deliver a twin track approach after consideration of research and long-term treatment options at all Tier 2 and 3 sites.

The objectives for the catchment management investigations are listed below:

- Schedule appropriate environmental monitoring to determine the source(s) and the pathway(s) of PFAS to the selected groundwater sources.
- Create up to date and enhanced catchment risk assessments for PFAS risk and land use surveys for all investigated groundwater sources.
- Utilise modelling to better understand the pollutant pathway and transfer within the aquifer to the selected groundwater sources.
- After investigations have concluded, complete an options appraisal for the viability of any current or future mitigation measures out in the catchment for the selected sources to inform future investment planning.

Four catchment investigation options were considered as part of this business case:

- Option CM1 – In-house delivery of catchment investigations (source, pathway, receptor investigations for 16 sites) and support for the Colne Catchment Action Network's Colne Micropollutants Study

- Option CM2 – Blended approach including option 1 plus utilisation of external consultants for trend modelling and source apportionment for more effective targeting of monitoring.

- Options CM3 – Enhanced blended option including option 1 and option 2 approaches with the addition of further monitoring such as karst tracer testing due to the geology of the Colne catchment.

- Options CM4 - Enhanced blended option including option 1, 2, 3 to cover additional sources to total 29 groundwater sources. This option also includes the addition of collaborative monitoring in the Thames Basin to cover the surface water abstractions, urban PFAS modelling and investigation consultancy project and other collaborative/partnership work in the South East.

Option CM1 - In-house delivery of catchment investigations

Enhanced catchment risk assessments

Option 1 includes enhanced catchment risk assessments (CRAs) to be carried out for the 16 SPZs.

The CRAs form part of a rolling programme supporting the Company's regulatory obligations to produce Drinking Water Safety Plans (DWSPs) for all sources. Full Catchment Risk Assessments (CRAs) are conducted at least every five years as part of a continuous programme to ascertain potential sources of point source and diffuse pollutants within the catchment area of an abstraction. The risk assessment includes the 'source' characteristics relating to land use and inferred potential pollutants associated with the land use activity which are ascertained using a land use survey and associated desk-based study. The 'pathway' characteristics relate to the geological properties of the aquifer or surface water which are investigated, and 'receptor' characteristics being the borehole or surface water intake including an analysis of water quality seen at the receptor over a 10-year period.

As part of our CRA process, a desktop study is carried out within the EA defined Source Protection Zones 1 (SPZ) and this is combined with a ground truthing survey of land use for abstraction boreholes, which are carried out within SPZ1, to ascertain potential users of PFAS within the catchment area. The desktop survey makes use of multiple datasets including remote imagery, business address data and historical contamination GIS layers alongside other data to identify potential areas of current and historical PFAS use.

An enhanced set of land uses categories specifically looked at for PFAS risk form part of this process and include fuel transport and storage points (airports), heavy industry (energy production, petrochemical works, factories, steel works), historic (landfill, contaminated land, factories, pollution incidents, firefighting incidents), institution (MoD land, Fire & Rescue centre), light Industry (industrial areas, workshops), waste facilities (landfill, waste transfer stations, incinerators, sewage treatment works) and residential (in terms of sewage connections). Individual risk scores are generated in terms of proximity to the abstraction (if none of these activities are noted in the catchment, then we will assess the source as being low risk for the unmitigated catchment risk with respect to PFAS). Water quality tend analysis over time and the geological setting of the borehole are all considered and form the CRA along with supplementary dataset listed in Figure 48 below.

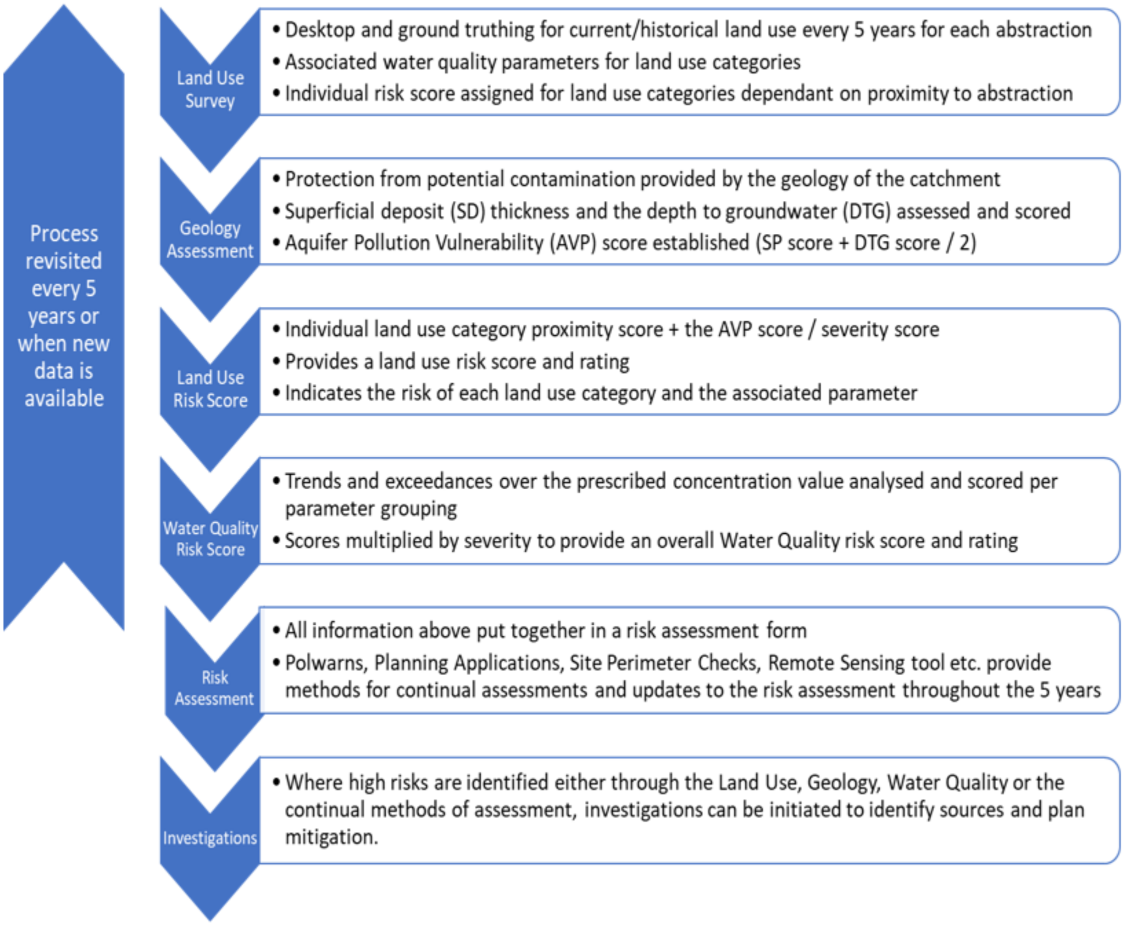

Figure 48. Process flow of the catchment risk assessment process.

<u>Groundwater monitoring</u>

In order to effectively determine the source(s) and the pathway(s) of PFAS to the investigated groundwater sources, appropriate environmental monitoring is required. Hydrogeological assessments and desktop surveys which include an investigation into existing observation boreholes (OBHs) (e.g. privately owned, EA owned etc) around the selected sources which could be used as viable locations for groundwater monitoring. Where existing OBHs are not suitably located to provide an accurate understanding of the direction/plume of pollution in the aquifer, it is proposed that observation boreholes are drilled, where deemed viable. A phased approach would need to be taken for the installation and drilling of OBHs to allow for the time required to determine optimum locations, gain permissions, and take into account the availability of contractors. Therefore, a suitable number of OBHs for each source would become available as AMP8 progresses in a phased approach each year. OBHs are already located close to Tyttenhanger PS due to the previous catchment investigation into metaldehyde and therefore the Smallford and Colney Heath OBHs can be utilised as part of the PFAS catchment investigation.

Groundwater level loggers could be installed into suitable boreholes to log the depth to water to gain an understanding of groundwater levels and the response times to rainfall events. This data would be used in conjunction with the groundwater quality data to provide an understanding as to aquifer function, response times and how this might influence PFAS contamination. It is proposed that this would also be a phased approach as suitable OBHs become available to sample as part of these investigations.

<u>Surface water monitoring</u>

Due to the karstic nature of the North Mymms and Essendon sources and the rapid interaction between surface water and groundwater ascertained from previous tracer testing and nitrate modelling work, it is more viable to add PFAS analysis onto the current catchment management surface water sample rounds rather than exploring drilling of OBHS. Furthermore, supporting the ColneCAN micropollutants water quality investigation study will be important (discussed in section 'Co-design and Co-delivery' above). This will allow for a better understanding of the sources of pollution across the Colne catchment and could inform where further forms of monitoring are required. Karst tracer testing carried out previously in the Mimmshall Brook, Essendon and Colne catchment can all be fed into the initial hydrogeological assessments and catchment risk assessments for the applicable sources.

Sampling of groundwater and surface water is proposed to be carried out on a quarterly basis however frequency will have to be agreed with the Affinity Water Laboratory due to the increased requirement for PFAS sampling required across the business. Therefore, the agreed frequency of catchment PFAS sampling will be subject to further discussions.

Option CM2 – Combined approach including option 1 plus trend modelling and source apportionment for more effective targeting of monitoring.

Option CM1 does not account for consultant fees for PFAS trend modelling and source apportionment for the 16 groundwater sources. The purpose of this work is to investigate if PFAS trend modelling is viable and carry out source apportionment calculations, using land use, existing monitoring data and the outputs of regional groundwater models to see the most likely areas of recharge and influence on the impacted groundwater sources.

Option CM2 accounts for all the proposals in option CM1 plus this additional modelling which might also include further catchment PFAS risk mapping using high resolutions satellite imagery and the assessment of any future catchment or in-situ mitigation solutions which could be utilised after the catchment investigations are complete. Source apportionment has been used in previous nitrate modelling work commissioned by the catchment management team and would allow for new observation boreholes to be drilled in the optimum locations to detect contamination within the chalk aquifer close the selected sources.

Option CM3 – Enhanced combined option with the addition of karst tracer testing.

Option CM3 includes all the approaches proposed so far with the addition of targeted karst tracer testing. The Colne catchment is characterised by a number of karst features such as stream sinks as shown by the map in Figure 49 (BGS report titled Mapping of karst features and identification of preferential pollutant pathways, 2017). These features allow for the direct transport of surface water potentially contaminated with PFAS directly into the chalk aquifer where these selected sites abstract from. Therefore, it is proposed that effective catchment investigations will require in-house monitoring and data analysis supplemented by specialist source apportionment and trend analysis for a targeted implementation of a monitoring network. In order to gain a more robust identification of the 'pathway' element and understanding of risk to the 'receptor', it is proposed that the optimum option 3 be selected which includes innovation sampling solutions such as karst tracer testing to help quantify which features are connected to groundwater sources and the significance of such connections.
Affinity Water has co-funded a PhD study by a student from the University of Leeds alongside the British Geological Survey and EA since 2020 and the catchment, hydrogeology, water quality and production teams have all supported the use of such testing. It should be noted that the PhD route would be the most cost-effective for this form of monitoring, as the price of bacteriophage tracer can be prohibitive when done via the consultant route. It should also be noted that there are only a small number of laboratories across the UK who have the capability to analyse for certain bacteriophages.

Option CM4 – Enhanced combined option with the addition of karst tracer testing including other catchments and urban PFAS modelling

Option CM4 includes all the approaches in options CM1, 2 and 3 with the addition of creating a routine monitoring network of targeted sample location across the lower River Thames with the possibility of using existing partnerships, such as the proposed support offered to the Colne Catchment Action Network surface water project. This will provide some catchment intelligence for the River Thames abstractions; however the scale of the River Thames Basin and numbers of potential sources will remain a challenge.

A core part of this option would be using a reputable consultancy to carry out an urban PFAS modelling and investigation study. There are many historical and current sources of PFAS and concerns around sources such as landfills and sewage discharges and use in industry which need to be considered across the identified catchments. This work would be required to investigate historical usage and trends in PFAS as well as current industries and urban sources of PFAS. It would need to utilise multiple datasets to identify these risks which might include satellite imagery, remote sensing, publicly available GIS datasets and walkovers etc. The modelling should forecast trends in PFAS concentrations over time and generate risk maps showing hotspots across catchments which require further investigation and sampling. This will cover the additional groundwater sources identified outside of the Colne catchment bringing the total to 29 for Option CM4.

Two of the additional catchments relates to our sources in Kent and the proposal is a collaborative partnership approach with Southern Water and the EA which includes monitoring support, if viable.

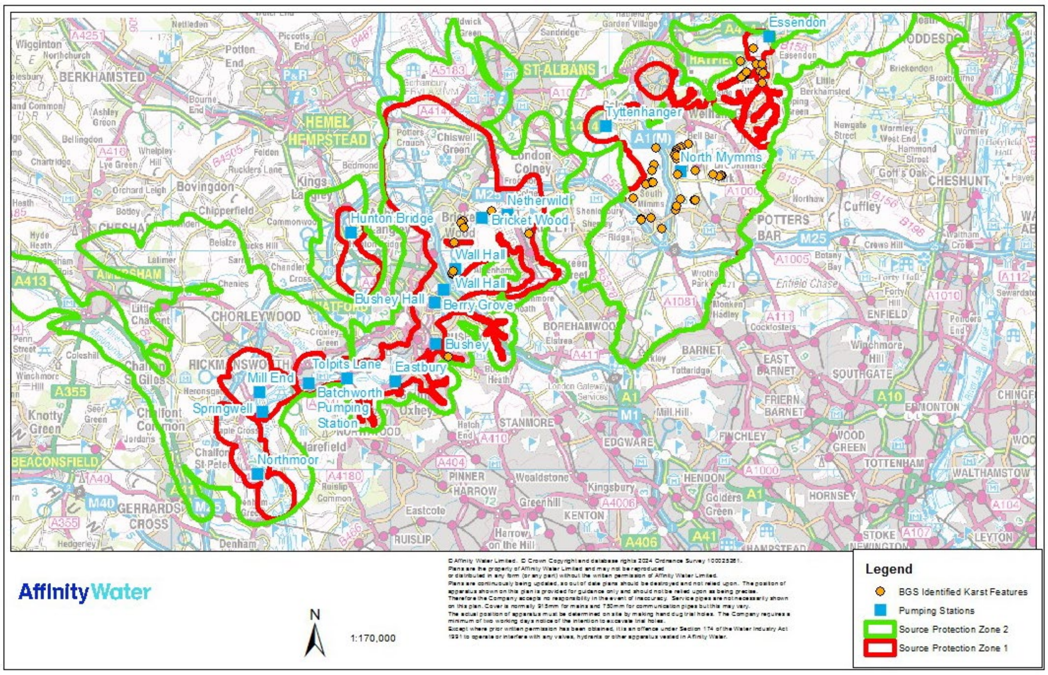

Figure 49. Map of the 16 groundwater sources for catchment investigations with stream sinks identified during the BGS study in 2017.

Selected Options

The high-level optioneering phase considered the range of treatment options available. This included catchment management, enhanced monitoring, and research and development of emerging technologies. Whilst these activities are all valid methods for understanding and addressing the PFAS contamination, none of these is reliably effective in reducing the risk. Blending as an option can be effective but it becomes unsustainable on a large scale due to the number of conditions it imposes on a number of sources, creating dependencies between assets that introduce significantly increased risk to supplies. As PFAS affect 68% of our Peak licence (Tier 2 and Tier 3 sites), blending was therefore discounted as a permanent solution.

We also considered the removal of the affected sources from service as an option. For the sources within our Central Region, we used the MISER model exercise for the 1 in 200 drought scenario combined with 1 in 10 demand developed as part of our Water Resources Management Plan (WRMP). The results of the model run as shown Table 17 demonstrate that taking any of the affected sites out of service in the central region is not an option. Note that those sites with spare capacity are significantly below the total site capacity, therefore still requiring alternative solutions.

Table 17. Central Region MISER model results.

Site	Spare capacity (Ml/d)	Site Capacity (Ml/d)
Batchworth	0	20.46
Clay Lane	0	138.9
Broomin Green	0.18	2.73
Chertsey	13.12	95.9
Hart Lane	1.8	29.3
East Hyde	0	5.88
Egham	0	146.03
Hunton Bridge	0	10.59
Marlowes	0	8.39
Mill End	0	36.36
Northmoor	0	18.18
North Mymms	0	36
Roydon	0	11.35
Stansted	0	7.28
Iver	5.38	227.3
Walton	0	55
Watton Road	0	5.38
Baldock/Bowring	0	12.51
Blackford	0	20
Holywell	0	20.46
Wheathampstead	0	11.09

For the two sites in our South East Region, we also conducted a separate model exercise for a 1 in 500 scenario for our WRMP.

Table 18. South East Region model results.

WRMP24 reference	Component	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
6.1BL	Deployable Output post forecast changes	42.551	42.546	42.541	42.536	42.530	42.525	42.520	41.715
50BL	Supply Demand Balance	-3.573	-2.900	-2.155	-2.880	-3.259	-3.719	-4.212	-5.266

As can be seen Table 18, it is clear that both Holmestone and Dover Priory cannot be taken out of supply as the South East region is already in deficit of over 2 Mld from 2025-26.

This focussed the viable solutions on the treatment options - the most effective, economically viable, and tested treatments remain as PFAS specific GAC and Ion-exchange. Whilst there are still unknown factors regarding longevity of media and waste, these were deemed to have the lowest risk attached, and therefore formed the main options for sites where treatment is required. This approach still presents a number of options, such as one of the preferred treatments or a combination of both, so the application of these was decided on a risk basis. For the highest risk Tier 3 sites, the combination of both GAC and Ion-exchange was preferred, and this business case includes additional treatment for those sites. For Tier 2 sites GAC alone was the preferred option. Initial risk and value analysis was carried out on a range of scenarios, from doing nothing new, to the most comprehensive option where both treatments would be installed at every Tier 2 and Tier 3 site. The best value options were then progressed and are described in the following sections. The risk associated with increasing PFAS concentrations alongside the recent updates to DWI guidance that require Tier 2 sites to be addressed, were both significant factors in prioritising sites and finding adequate mitigating solutions.

Do Nothing, Option 0

The 'Do Nothing' option involves continuing to sample and monitor the raw water, triggering the site to be turned off if or when the wholesomeness thresholds are exceeded. This in turn will affect the supply and demand balance and customer impact risk. As we are employing risk-based monitoring of the PFAS concentrations in our raw water, our assessment has focused on the predominant risk of water supply/site interruption while factoring in the residual water quality risk. The R&V process quantifies these risks, and each scheme was included in the evaluation to determine if the cost/benefit ratio (risk index) provides value.

The R&V process included an Opportunities and Risks Assessment (ORA), an assessment of the business impact (utilising the individual output and population data for each site), considering both risks and opportunities to the business. An example is provided below in Figure 50 . In the Risk Scoring assessment (shown in Appendix 1 – Optioneering: Supporting Risk Scoring Assessment), the assessed risk and opportunity costs were weighted to account for the various likelihoods and real-world challenges that each scenario carried.

Affinity Water — OPPORTUNITY and RISK ASSESSMENT: SUMMARY

	Units	RISK 1	RISK 2	RISK 3	RISK 4	RISK 5	RISK 6
Only populate relevant green shaded cells, the calculated value in £ will be displayed in the blue ce		[Tier 2 Sites] Risk of PFAS WQ failure (> 0.01ug/l, as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).	[Tier 2 Sites] Unplanned Outage (as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).	[Tier 2 Sites] Water supply interruption or low pressure (as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8 i.e. PFAS > 0.01).	[Tier 3 Sites] Risk of PFAS WQ failure (> 0.01ug/l, as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).	[Tier 3 Sites] Unplanned Outage (as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).	[Tier 3 Sites] Water supply interruption or low pressure (> 0.01ug/l, as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).
Mitigated OPEX							£115,308
What is the annual value of any mitigated OPEX	£						115308
Water Supply Interruptions (I2S)				£103,622,154			
How many properties are impacted by these interruptions?	No. of properties			85636.86404			
What is the expected duration of these interruptions?	Minutes			10080			2880
Average Time Properties Experience Low Pressure							£988,790
What is the expected duration of these low-pressure events below 15m head?	Minutes						2880
How many properties are impacted by these low-pressure events?	No. of properties			85636.86404			6195
Event Risk Index (ERI) -Direct Consequential Costs Only		£1,671,719			£40,311		
What is the ERI seriousness Score?(0-5)?	List	2RegulatoryImpact			2RegulatoryImpact		
What is the duration of the ERI event?	Hours	168			168		
How many people are impacted by the ERI event?	No. of people	**205528.4737**			4956		
What is the ERI Assessment Score (1-5)?	List	3RecommendationsMade			3RecommendationsMade		
Compliance Risk Index (CRI) -Direct Consequential Costs Only		£442,200			£237,615		
What is the CRI Parameter Score (1-5)?	List	5HealthRisk			5HealthRisk		
What is the CRI Assessment Score (0-5)?	List	3RecommendationsMade			3RecommendationsMade		
Which Location is the risk related to?	List						
C-MeX Risk				£4,949			£358
What is the No. of properties impacted by the level of customer service received ?	No. Properties Impacted			8563.686404			619.5
Financial, Legal and Reputational Risk (FLR)		£10,571			£10,571		£112
Amount of penalty or fine if the risk is not mitigated?	£	10571			10571		112
Unplanned Outage (AGA related)			£403,874			£142,056	
Which Location is the risk related to?	List						
If failure occurs, what is the site production capacity reduced to?	Ml/d						
How many days would it take to get production back to peak capacity?	days		30			30	
		£2,124,490	£403,874	£103,627,104	£288,497	£142,056	£1,104,568

Figure 50. Snapshot of R&V process Opportunities and Risks Assessment i.e. ORA of impacts to business, consolidated for all relevant Tier 2 and 3 sites at risk.

Option Assessment

The R&V process was followed to compare the relative value of the options.

Figure 51 shows the R&V Risk Indices tab and using a combination of Risk Index and Residual Risk the preferred option is selected Although the least cost option 1 is shown to have a slightly lower risk index it would leave high residual risk. Both options were taken forward to be NPV-assessed.

Affinity Water	Solution Impact Summary - Risk Index																			
		Risk Impact			Financial							Carbon							Total	
Opt	Description	Initial Risk Value (£)	Risk Reduction (£)	Residual Risk (£)	Solution CAPEX	Solution OPEX (p.a.)	CAPEX WLC	OPEX WLC	WLC	Residual Risk %	Risk Index (Cost)	Embodied tCO2e	Operation tCO2 (p.a.)	WL Embodied Carbon tCO2e	WL Operational Carbon tCO2e	WL Carbon tCO2e	WL Carbon £	Risk Index (Carbon)	WLC	Risk Index (Total)
1	Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs	£862,826,715	£259,354,605	£603,472,111	£9,170,509	£3,108,460	£13,766,707	£77,711,500	£91,478,207	70%	0.35	28	6,645	55	254,493	254,549	£64,146,276	0.25	£155,624,483	0.60
2	All sites where detected in last 2 years and/or detected = or> 0.02 ever to have GAC (62500BV)and surface works to have GAC (BV @125000)+ Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs	£862,826,715	£819,727,595	£43,099,120	£145,454,869	£7,059,114	£218,355,888	£176,477,844	£394,833,732	5%	0.48	18,839	10,115	22,834	370,956	393,789	£99,234,882	0.12	£494,068,614	0.60

Figure 51. Snapshot of R&V process Risk Indices, consolidated for all relevant Tier 2 and 3 sites at risk.

Preferred, Best Value –

11 new GAC plants and new GAC media at 9 sites; 3 new ion-exchange plants.

- All sites where PFAS detected in last 2 years and/or detected >=0.02 ever;
- Surface works with BV @125000 to have GAC
- Tier 3 sites to have ion-exchange plant
- Wheathampstead to have GAC
- All sites Catchment Management + Analytical Costs + R&D Costs

This option includes subsections as detailed Table 19 below.

Table 19. Solution components of Preferred Option.

Subsection	Description	Site
New GAC	Build new GAC plant inclusive of land purchase	Batchworth, Dover Priory, Holmestone, Hunton Bridge, Marlowes, Mill End, Northmoor, Roydon, Stansted, Watton Road, Wheathampstead
GAC Replacement	Replace GAC media and regenerate/replace at 62,500 BV	Broomin Green, Chertsey, Clay Lane, East Hyde, Hart Lane, North Mymms
GAC Replacement	Replace GAC media and regenerate/replace at 125,000 BV	Surface sites Egham, Iver, Walton
New ion- exchange plants	New Ionex plant with non-regenerable resin (recommended specifically for PFAS removal)	Bowring/Baldock Road, Blackford, Holywell
R&D of PFAS treatment options	Research and Development Pilot Trials to investigate effectiveness of alternative solutions recommended specifically for PFAS removal	Roydon (Whilst Roydon is proposed to have a new GAC plant, R&D activity would still be beneficial early in the AMP to further our understanding of the performance of different options)
Catchment Management Option CM4	Enhanced blended option including option CM1 and option CM2 approaches with the addition of further monitoring such as karst tracer testing due to the geology of the Colne catchment, the River Thames basin and the relevant catchment area in Kent	All Sites
Enhanced Monitoring	Enhanced monitoring including analysis of regular sampling, to assess water quality risk further	All Sites

Least Cost Option

GAC replacement for 6 sites (higher risk Tier 2) with GAC already and catchment management investigations

- 6 Higher risk Tier 2 sites with new GAC media
- Catchment Management
- Analytical Costs
- R&D Costs for Tier 2 site Roydon

This option includes subsections as detailed in Table 20 below.

Table 20. Solution components of Least Cost Option.

Subsection	Description	Site
GAC Replacement	Replace GAC media and regenerate/replace at 62,500 BV	Broomin Green, Chertsey, Clay Lane, East Hyde, Hart Lane, North Mymms
R&D of PFAS treatment options	Research and Development Pilot Trials to investigate effectiveness of alternative solutions recommended specifically for PFAS removal	Roydon
Catchment Management Option CM4	Enhanced blended option including option CM1 and option CM2 approaches with the addition of further monitoring such as karst tracer testing due to the geology of the Colne catchment, the River Thames basin and the relevant catchment area in Kent	All Sites
Enhanced Monitoring	Enhanced monitoring including analysis of regular sampling, to assess water quality risk further	All Sites

Option Assessment Approach

The process for assessing the options followed that described in the optioneering section as per Figure 52:

Figure 52 – Option Assessment Approach

The level of cost estimation and financial evaluation matured throughout the process.

Economic Assessment

A Net Present Value (NPV) analysis (also referred to as CBA or Cost Benefit Analysis) was conducted to assess the total value of the options proposed. Analysis was undertaken for the preferred option and least cost option (where relevant) for all of the PFAS-affected sites.

A standard NPV period of 30 years was used, with a depreciation period of 45 years.

Cost Estimation

The purpose of the cost estimation exercise was to move from the concept stage where all options and all affected sites were still under consideration [unconstrained options], through the asset planning stages of feasibility and risk and value, to the outline business case stage where the preferred options were costed with sufficient accuracy to have confidence in the recommended project scope.

The general process followed during the asset planning stage is shown here in Figure 53, indicating the approximate level of accuracy at each point from concept though to outline business case:

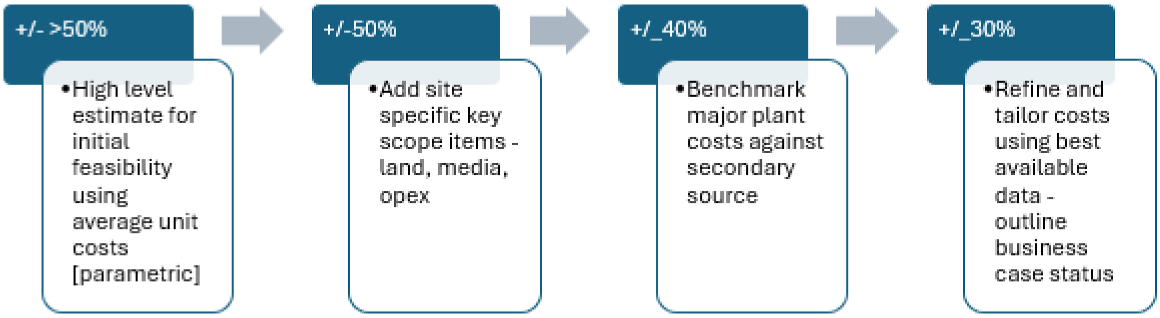

Figure 53 – Level of Accuracy

The accuracy at this stage is in line with expectations given the project maturity and would expect to be improved at subsequent stages of engagement with contractors. The level of accuracy is broadly in accordance with the Cost Estimating Guidance from the Infrastructure and Project Authority.

The costs have been compiled using a range of sources including:

- Use of recent cost estimating exercises for Tier 3 PFAS sites
- Comparison with current/recent similar project outturn costs
- Affinity Water Process Model Costs and Unit Cost Database [UCD] – developed by Mott MacDonald for Affinity Water using industry, other water companies, and internal data [see PR24 appendix AFW08 for more details on these models]
- Quotations
- Internal Opex costs database

Initial costs were developed using parametric estimating, using unit rates from similar schemes in the PR24 plan for Tier 3 PFAS sites and the process cost models. The rationale for this approach was that it was the optimum balance of time and accuracy at the starting point to enable initial feasibility assessments. This was used to estimate costs for the treatment process assets. Then an allowance was included to cover for site-specific enabling and ancillary assets or requirements, such as process model excluded assets, integration with existing assets, access arrangements, and Biodiversity Net Gain obligations. This allowance was based upon analysis of actual costs from historical projects, allowing a proportional amount to be added to the starting costs.

Land costs were calculated where applicable from plant footprint requirements, then using unit costs from previous projects. Two rates were used depending on the land being urban or rural, which were validated by external Land Agents Dalcour Maclaren.

The availability of outturn project costs for Ion-exchange plants for comparative estimation enabled internal benchmarking to be applied, ensuring a medium to high level of confidence in cost estimation at this project stage. For new GAC installation costs, benchmarking was carried out using historical outturn costs for similar filtration projects against a selection of sites representing low, middle, and high end of the range of flows. Both GAC and Ion-exchange treatment options were also compared against TR61 industry data, having normalised for inclusions/exclusions, and adjusted it to the 2022/23 cost base. See graphs Figure 54 and Figure 55 below.

Figure 54 shows the Ion-exchange plant cost estimations [PFAS Additional estimated costs] closely follow the normalised TR61 costs and are all within a 10% uncertainty factor applied to that trend. This demonstrates that the estimates are conservative, in line with industry data, and do not include unspecified headroom costs.

Figure 55 [GAC Benchmarking] shows the relative cost curve of the TR61 data plotted against the linear cost estimates used for the purposes of building this business case. This indicates that our cost estimates are lower than the TR61 model, especially at the lower end of the range, but are more in line with Affinity Water historical project costs. This does represent a risk that outturn costs may be higher than the estimates, and the challenge to seek economies of scale may be one method of mitigating this, although any significant reduction in the scope of this business case would impact the ability to do so.

The cost model data has been based upon figures applicable to the 2022/2023 financial year, and both quotations and previous project costs are sourced within AMP7. For more information about data sources related to our Capital and operational expenditure cost (Infra and non infra) see PR24 appendix AFW08 – section 2.2 to 2.6.

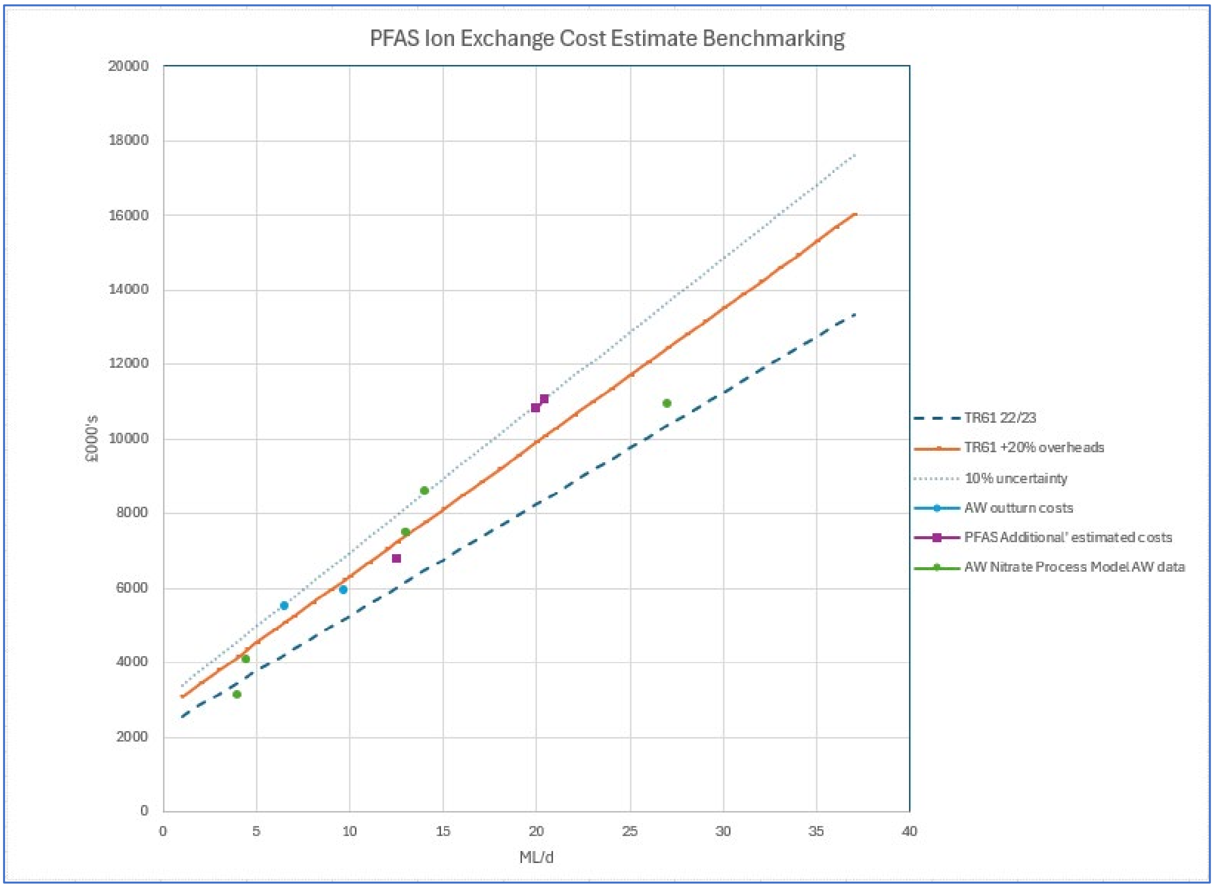

Figure 54 – Ion-Exchange Benchmarking.

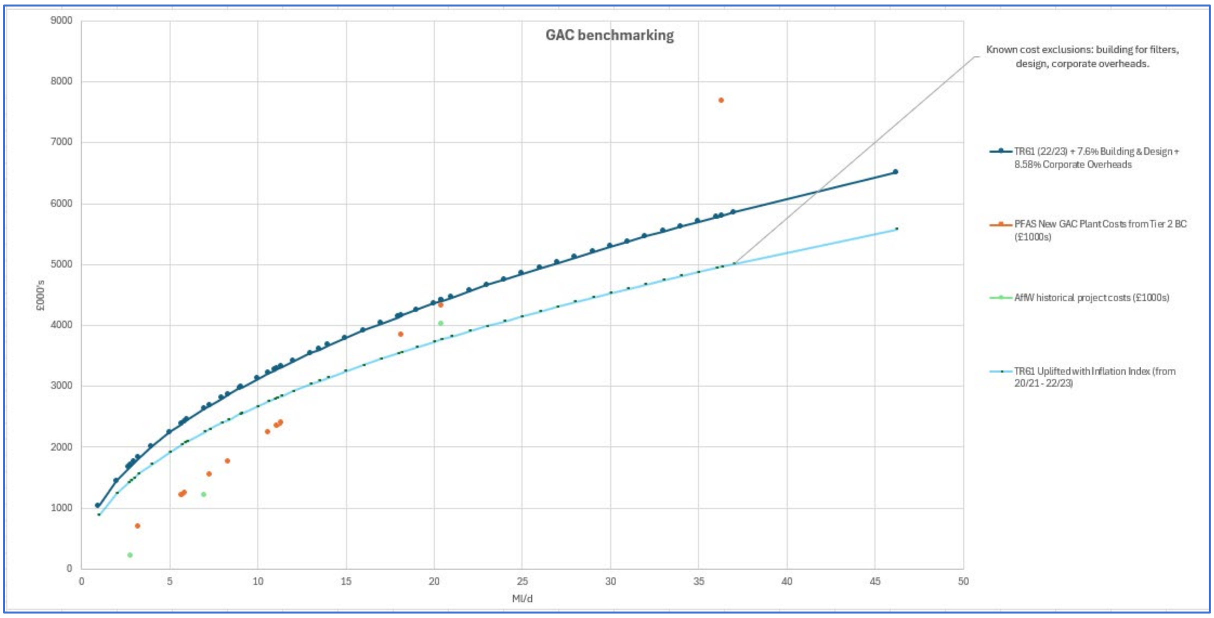

Figure 55 - GAC Benchmarking.

Assurance and governance

The basis of these costs was verified both internally and externally a number of times throughout the stages of the assessment process.

The cost estimation methodology was agreed by the Treatment Strategy Manager and Senior Asset Manager and completed by the Asset Planning Engineer in consultation with the Senior Strategy Lead. Accountability for checking cost estimations and changes was provided by the Senior Asset Manager following reviews by the Treatment Strategy Manager.

Costs were also externally assured by Atkins in July 2024. The external assurance process consisted of an audit of both methodology and data. Both Capex and Opex costs were assured through the steps listed below:

- Basis of Capex and Opex estimates and how historical costs have been used
- Approach to ancillaries
- Price base
- Contingency
- Overheads, etc

Cost Benefit Analysis spreadsheets were also assured by Atkins as part of the process.

The final business case was submitted to the Head of Strategic Asset management and Director of Regulation and Strategy for internal sign off before Senior Leadership Team approval.

The breakdown of costs showing the split across the treatment options can be seen in Appendix 2.

Benefit Estimation

All risks and benefits were converted into tangible financial benefits by assessing the service impacts to the business and applying appropriate probability factors based on frequency of expected impacts. Risks to the business were recorded using the ORA and Risk Scoring analyses conducted as part of the R&V assessment. Solution Optioneering, Solution Impact and Risk Indices stages of the R&V were then used to calculate the benefits that each option could potentially bring to the business. The scale of the benefits is based on a number of factors such as the initial risk value, the cost of each option, and the efficacy of each option. The residual risk was also estimated.

Efficiency

Effort was made to align investment with existing infrastructure, in order to help reduce costs. This is noticeable for the sites with existing GAC plants where we have proposed changing to PFAS-specific GAC media. This is particularly evident for the least cost option, where utilisation of existing GAC (on site due to historical and/or current water quality challenges) is proposed for the higher risk Tier 2 sites.

Assumptions Made

The lifespan of the options was assumed based on a combination of empirical average estimates and supplier information. This was applied to the R&V and the NPV assessments.

Where cost models have been used, it is also assumed that the interpolated/extrapolated cost values do indeed follow the trend curve formed from the underlying empirical data.

As there is still some uncertainty around GAC treatment for PFAS removal, a 95% risk reduction has been assumed in the R&V for Tier 2 sites. In addition, this has resulted in adding an additional treatment stage for Tier 3 sites (Ion-exchange) where a 100% risk reduction has then been used.

Uncertainties and Sensitivity Analysis

For the NPV and Cost Based Appraisal, the goal seek function was used to indicate how much the NPV could be reduced for the preferred option whilst remaining cost beneficial. This showed a sensitivity of 60% indicating the preferred investment would represent good value even with an NPV reduction of 60%.

Given that the consolidated NPV assessment process was preceded by the consolidated R&V analysis, the NPV assessments also served as a more in-depth whole life analysis. This effectively:

- repeats the economic assessment elements of the R&Vs
- reinforces the outcome of the R&Vs
- shows the practical financial benefits of the assessed investments to the business.

In addition to the above, the following uncertainties apply:

Supply chain - availability of components to implement the solution within planned project timescales. Mitigation: framework agreements to be utilised where possible, and early liaison with suppliers. The scale of investment and construction has been noted and considered by Capital Delivery and Procurement whilst the framework tender processes are in progress, and deliverability methods are in ongoing discussions. Both internal risks – outage availability, internal resources, integrating with existing plant; and external risks – demand on the supply chain, land availability and costs, reliance on 3rd parties such as power supply companies and EA – are being considered in this process. Internal resource planning has already been carried out, both for delivering the projects and ongoing operational needs. The process of design needs to take place before establishing land purchase needs which can delay the construction start date, affecting completion and financial forecasting in the AMP.

Significant increase in PFAS concentrations earlier than forecast, accelerating the urgency of the proposed solutions. Mitigation: partly mitigated through ongoing monitoring in place at sites identified to be at-risk, as well as wider catchment management for our sites at risk.

We have made conservative estimates for when benefits will start and finish, and how they increase and decrease over time. As such, our economic analysis is inherently conservative by nature. We then consider the benefit metric for sensitivity studies as this becomes the most material uncertainty in the analysis. A sensitivity analysis was conducted as part of the CBA.

Emergence of PFAS compounds at new sites previously unaffected

This is a significant risk in the industry and careful consideration needs to be given on how this would be addressed in AMP, with respect to the prioritisation and funding mechanism for such examples.

Waste processing

The regulations, capability, and capacity for dealing with the regeneration and waste streams associated with PFAS removal are all risks that could significantly affect operating costs. These are risks at industry level, and no specific risk amount has been included in this business case to cater for the unknown developments that may occur.

Land requirements

Estimated costs associated with land purchase and delivery are subject to significant risk in terms of availability, timescale, and actual cost.

Overall comments on cost certainty

The major components of the costs are the treatment plants, which have the highest degree of cost certainty for this level of project maturity. This gives confidence that uncertainty around land and other items has generally a low-to-medium impact on overall costs.

Carbon Assessment

Embodied carbon figures for each scheme were built from bottom-up unit carbon models. Operational carbon was calculated from energy use and chemical consumption; transport is also factored into the calculation tool. These are combined to give a whole life carbon assessment for the preferred option and any other viable options to form part of the selection process.

Across the PFAS Tier 2 sites, the only viable risk mitigation option was the GAC treatment option, and as such this was the only solution option assessed in relation to carbon. For the Tier 3 sites, Ion-exchange was also assessed in relation to carbon.

Table 21 below shows a summary of associated carbon and the relative calculated carbon for the preferred and least cost options.

Carbon Results: Preferred Option and Least Cost Option

Carbon "Option_2" – Preferred Option – 11 new GAC plants and new GAC media at 9 sites; 3 new Ion-exchange plants.

Carbon "Option_3" – Least Cost Option – GAC replacement for 6 sites (higher risk Tier 2) with GAC already.

Table 21. Consolidated carbon summary table for the preferred and least cost option, and the sites they each address, showing the respective calculated carbon related to the treatment solution for each option.

Embodied Carbon (kgCO2e)

	Option_1	Option_2	Option_3
Total Civil Works	-	14,844,710	-
Total Non-Civil Works	-	3,994,423	27,713
Total	-	18,839,133	27,713

Operational Carbon (kgCO2e/year)

	Option_1	Option_2	Option_3
Total Energy related (excludes transport)	-	668,958	132,325
Total Non-Energy related (includes transport)	-	5,424,421	1,719,916
Total	-	6,093,379	1,852,242

Total Whole Life Carbon (TCO2e) **40 Years**

	Option_1	Option_2	Option_3
Embodied Carbon	-	22,834	55
Operational Carbon	-	214,112	67,583
Total Whole Life Carbon	-	236,946	67,638

Impact on our AMP8 Operational Green House Gas (GHG) Performance Commitment

For PR24 a new common performance commitment is expected which aims at reducing 'operational' GHG emissions. Our 'Preferred Option' has an impact on our forecast emissions. The first year of this implementation shows a rise of 62 .72% from our original submission 2024/25 baseline year. Table 22 below shows the operational GHG emissions associated with each site.

Table 22. Breakdown of expected carbon emissions per site for the preferred option.

Site	Kg per Delivery of GAC Media	GAC Media-Related Emissions (All Filters Once) (tCO_2e/year)
Tier 2		
Batchworth	47382.8	911.1
Clay Lane	365029.2	6156.0
Broomin Green	5398.9	153.9
Chertsey	157680.0	2872.8
Hart Lane	66750.8	1504.8
Dover Priory	7902.6	261.8
Holmestone	3889.4	111.3
East Hyde	17213.4	291.7
Egham	315360.0	6502.9
North Mymms	73452.6	1487.7
Hunton Bridge	27830.5	471.6
Marlowes	6222.9	371.4
Mill End	55472.6	1619.2
Northmoor	43504.9	809.6
Roydon	29827.8	505.4
Stansted	19131.8	324.2
Iver	597344.4	11863.1
Walton	105120.0	2462.4
Watton Road	9342.0	253.0
Tier 3		
Wheathampstead	29144.5	493.8

Emissions related to energy consumption were generally insignificant (total for 11 sites equals 389.6tCO2e/year) compared to the associated GAC media-related emissions (total for 11 sites equals 8,341.9tCO2e/year), on a site-by-site basis.

Biodiversity Net Gain (BNG) Assessment

Biodiversity Net Gain (BNG) cost figures for this scheme were derived by applying a representative percentage value (1% as per our internal guidance for all above ground projects over £1m) to the Capex costs.

BNG is derived from a metric created by Defra, which classifies types of habitats and their condition to give a unit score for a given site being worked on. UK Hab is the methodology that is used to classify the habitats and conditions within the metric, which is nationally used across the ecology industry.

The BNG costs have been included in the site specifics allowances.

Third Party Assurance and Audit

There has been internal assurance including peer reviews, QA sheets where relevant and review by the key stakeholders. The business case has also undergone an independent audit by Atkins.

Liaison with Affinity Water production and physical site visits form the basis of all individual site option requirements. Costs have been compiled and averaged/verified by multiple sources such as quotations, cost models and information from previous similar projects.

The Desktop R&V and NPV assessments have undergone similar internal governance and assurance processes, through regular review meetings with the Asset Planning Manager.

An R&V approach with all key stakeholders will be held prior to project start, to review the risks and potential solutions using up to date data, followed up by site specific quotes from the vendors which will be used to gain financial approval to progress the solution.

The cost models in particular are based on data from other businesses in the water industry which further strengthens the reliability of the data. The carbon model data used is also based on ongoing information sharing with Mott MacDonald.

Option Assessment

Commentary on the Economic Assessment

A NPV analysis was conducted to assess and compare the total value of the investment options shortlisted. Firstly, WLC analysis was undertaken for the main options for all Tier 2 and 3 PFAS sites. These options consisted of the main treatment methods as per Table 23 that make up the preferred options, namely GAC treatment with PFAS-specific media and Ion-Exchange. Cost per site for GAC and Ion-Exchange.

Table 23. Cost per site for GAC and Ion-Exchange.

Activity	GAC WLC (£m)	Ion-exchange WLC (£m)
Batchworth	12.76	19.96
Broomin Green	1.00	2.50
Chertsey	11.18	82.07
Clay Lane	45.15	143.24
Dover Priory	20.46	16.48
East Hyde	2.54	6.75
Egham	24.48	138.39
Hart Lane (Crescent Road)	8.69	28.39
Holmestone	11.63	9.07
Hunton Bridge	7.39	10.92
Iver	43.43	234.40
Marlowes	6.88	7.74
Mill End	19.48	119.37
North Mymms	9.83	33.35
Northmoor	11.59	17.99
Roydon	7.86	11.70
Stansted	6.09	8.13
Walton	8.42	49.69
Watton Road	3.57	4.86
Baldock/Bowring	8.40	13.08
Blackford	13.15	20.62
Holywell	8.18	21.93
Wheathampstead	8.24	5.44
Total	**300.39**	**1006.08**

Then the R&V initial analysis determines the best value options based on cost, residual risk and calculated whole life costs. The effective good value options were then assessed using NPV.

The CBA showed positive value for the proposed investment, and while the least cost option was shown to be more cost beneficial than the preferred option, it is important to recognise that this option was assessed as not being able to fully meet the DWI's expectation. The preferred option provides the necessary risk mitigation required by the regulator.

The NPV assessments also served as a sensitivity analysis by effectively repeating the economic assessment elements of the R&Vs to reinforce their outcome while at the same time showing the practical financial benefits of the assessed investments (see Table 27 for results). A standard NPV period of 30 years was used, with a depreciation period of 45 years. Unlike for the R&V, the baseline option was not used as part of the final NPV assessments; rather, risk mitigation factors were applied to each option's NPV assessment directly, based on the most significant service impacts to the business that were identified in the relevant R&V. NPV Assessment / CBA summary tables for PFAS sites are shown below in Table 24, Table 25 and Table 26.

- Table 24 shows a summary of the NPV and CBA assessment of the 'Preferred' and 'Least Cost' Options that were taken forward to this stage, with our preferred spending profile scenario where Capex spend commences in AMP8 year 1 and concludes in year 4.
- Table 25 shows a summary of the same for our alternative spending profile scenario where Capex spend commences in AMP8 year 1 and concludes in year 3.
- Table 26 shows the summary for the spending profile scenario where Capex spend commences in AMP8 year 5 and concludes in year 5.

Table 24. NPV Assessment / CBA summary table for PFAS Tier 2 & 3 sites (Capex spend AMP8 year 1 to 4).

PFAS Options For Consolidated Sites (Start Spend Year 1, Completion Year 4)	Total NPV	Total NPV Benefits	Benefit/Cost
Preferred Option: All sites where detected in last 2 years and/or detected = or> 0.02 ever and surface works with BV @125000 to have GAC +Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs	£173.40m	£403.26m	1.75
Least Cost Option: Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs	£154.06m	£210.75m	3.72

Table 25. NPV Assessment / CBA summary table for PFAS Tier 2 & 3 sites (Capex spend AMP8 year 1 to 3).

PFAS Options For Consolidated Sites (Start Spend Year 1, Completion Year 3)	Total NPV	Total NPV Benefits	Benefit/Cost
Preferred Option: All sites where detected in last 2 years and/or detected = or> 0.02 ever and surface works with BV @125000 to have GAC +Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs	£163.85m	£401.95m	1.69
Least Cost Option: Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs	£151.23m	£210.34m	3.56

Table 26. NPV Assessment / CBA summary table for PFAS Tier 2 & 3 sites (Capex spend AMP8 year 5).

PFAS Options For Consolidated Sites (Start Spend Year 5, Completion Year 5)	Total NPV	Total NPV Benefits	Benefit/Cost
Preferred Option: All sites where detected in last 2 years and/or detected = or> 0.02 ever and surface works with BV @125000 to have GAC +Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs	£147.08m	£361.79m	1.69
Least Cost Option: Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs	£128.94m	£182.75m	3.40

Table 27. NPV Assessment / CBA Summary Table of Preferred and Least Cost Options.

Value	Analysis Inputs	Option Definition			Option Description
2025	Spreadsheet Start Date	Option 1:	Baseline	Baseline (Do nothing or maintain)	Baseline/Existing/Do Nothing
2022/23	Cost Base	Option 2:	Core	Alternative Option Yr1	**[Start Year 1, Complete Year 3]**: All sites where detected in last 2 years and/or detected = or> 0.02 ever and surface works with BV @125000 to have GAC +Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs
2.92%	WACC (AW1)	Option 3:	Alt 1	Alternative Option least cost Yr1	**[Start Year 1, Complete Year 3]**: Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs
45	Depreciation Period (Yrs)	Option 4:	Alt 2	Alternative Option 1	**[Start Year 5, Complete Year 5]**: All sites where detected in last 2 years and/or detected = or> 0.02 ever and surface works with BV @125000 to have GAC +Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs
30	NPV Period	Option 5:	Alt 3	Alternative Option 2	**[Start Year 5, Complete Year 5]**: Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs
		Option 6:	Alt 4	Alternative Option 3 **(PREFERRED OPTION)**	Preferred Option **[Start Year 1, Complete Year 4]**: All sites where detected in last 2 years and/or detected = or> 0.02 ever and surface works with BV @125000 to have GAC +Tier 3 sites to have Ionex + Catchment Management + Analytical Costs + R&D Costs
		Option 7:	Alt 5	Alternative Option 4 **(LEAST COST)**	Least Cost Option **[Start Year 1, Complete Year 4]**: Tier 2 sites with GAC (BV@62500) where there is GAC already (initial Tier 2 BC) + Catchment Management + Analytical Costs + R&D Costs
		Option 8:	Alt 6	Alternative Option 5	
		Option 9:	Alt 7	Alternative Option 6	
		Option 10:	Alt 8	Goal Seeking Analysis	Sensitivity analysis (based on Option 6 tab i.e. Preferred Option **[Start Year 1, Complete Year 4]**)

Allocations	Water Resources	Network+ Raw Water Transport	Network+ Raw Water Storage	Network+ Water Treatment	Network+ Treated Water Distribution	Retail	Checks
Price Controls	0%	0%	0%	100%	0%	0%	Y

Benefits					Description	Ref	Metric
Ofwat Driver 1	Addressing raw water quality deterioration (grey solutions)	100%	Y	Benefit 1	Loss of Production Capacity (Ml/d) 1 dps		
Ofwat Driver 2		0%		Benefit 2			
Ofwat Driver 3		0%		Benefit 3			
Ofwat Driver 4		0%		Benefit 4			
Ofwat Driver 5		0%		Benefit 5			

Options	Total Investment	5 yr Investment	Total NPV	NPV Costs (Capex)	NPV Costs (Opex)	Total NPV Benefits	Cost Beneficial	Benefit / Cost	NPV Financial	NPV Customer	NPV Environment	NPV Community	NPV Resilience	NPV WINEP	BP Benefits	BP Env Benefits
Option 1:	£ -	£ -	£ -	£ -	£ -	£ -	Yes	0.00	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Option 2:	£ 478,535,060	£ 160,878,181	£ 163,855,130	-£ 122,930,475	-£ 115,166,799	£ 401,952,405	Yes	1.69	£ -	£ -	-£ 33,709,151	£ -	£ 435,661,556	-£ 33,709,151	-£ 12,448,966	-£ 12,448,966
Option 3:	£ 156,569,973	£ 16,692,513	£ 151,228,287	-£ 7,688,779	-£ 51,418,763	£ 210,335,828	Yes	3.56	£ -	£ -	-£ 10,627,498	£ -	£ 220,963,326	-£ 10,627,498	-£ 3,905,123	-£ 3,905,123
Option 4:	£ 465,287,129	£ 147,630,250	£ 147,080,461	-£ 111,291,126	-£ 103,419,959	£ 361,791,546	Yes	1.69	£ -	£ -	-£ 31,150,216	£ -	£ 392,941,762	-£ 31,150,216	-£ 9,890,032	-£ 9,890,032
Option 5:	£ 151,223,350	£ 11,345,890	£ 128,937,366	-£ 7,139,058	-£ 46,677,952	£ 182,754,377	Yes	3.40	£ -	£ -	-£ 16,541,884	£ -	£ 199,296,261	-£ 16,541,884	-£ 3,097,134	-£ 3,097,134
Option 6:	£ 471,737,870	£ 149,117,879	£ 173,397,860	-£ 120,969,781	-£ 108,895,148	£ 403,262,790	Yes	1.75	£ -	£ -	-£ 32,398,766	£ -	£ 435,661,556	-£ 32,398,766	-£ 10,076,242	-£ 10,076,242
Option 7:	£ 154,086,850	£ 11,536,078	£ 154,058,875	-£ 7,596,176	-£ 49,094,547	£ 210,749,597	Yes	3.72	£ -	£ -	-£ 10,213,729	£ -	£ 220,963,326	-£ 10,213,729	-£ 3,155,447	-£ 3,155,447
Option 8:	£ -	£ -	£ -	£ -	£ -	£ -	Yes	0.00	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Option 9:	£ -	£ -	£ -	£ -	£ -	£ -	Yes	0.00	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Option 10:	£ 471,737,870	£ 149,117,879	£ -	-£ 120,969,781	-£ 108,895,148	£ 229,864,929	Yes	1.00	£ -	£ -	-£ 32,398,766	£ -	£ 262,263,696	-£ 32,398,766	-£ 10,076,242	£ -

Preferred, Best Value, Option

11 new GAC plants and new GAC media at 9 sites; 3 new ion exchange plants. R&D, Catchment Management, and enhanced monitoring at all sites.

Across all preferred option components for the affected sites, the main benefit is that the risk mitigation proposed is to fulfil commitments to meet the DWI requirement. The alternative option to doing something now would be to delay implementation of the proposed solutions by an AMP, which would only increase the risk as water quality conditions worsen and would also see implementation costs rise significantly. Additionally, if there was an event, the business would essentially be required to spend a similar amount to address the issue as it arises.

Further to the above point, Table 27 shows the greatest Total NPV Benefits value for the preferred option (i.e. "Option 6" in the table) alongside "Option 2", out of all the CBA-assessed options. However, the cost benefit is what sets the preferred option apart, having been assessed as providing the greatest benefit-to-cost ratio as shown in Table 24.

The main Service Benefit to the business is factored into the NPV assessments as mitigating loss of site output capacity (based on the capacity of the sites) beyond AMP8, using Ofwat values (£'s), site-specific average deployable output figures, and factoring in a site-specific risk likelihood for each site that is dependent on their respective water quality trend data.

Additional benefits to the business include the avoidance of:

- regulatory penalties,
- reputational decline
- additional Opex costs and
- the deterioration of one of the performance commitments, namely CRI (Compliance Risk Index). This directly reflects the business's water quality performance and is affected by treatment failure, which the preferred option will mitigate significantly.

Least Cost Option

The least cost option includes:

- Replacement of the GAC in all vessels of the existing Tier 2 sites' GAC plants with virgin media recommended specifically for PFAS removal. This provides high risk mitigation by reducing the PFAS concentrations below 0.01 µg/l, but proposed only for the Tier 2 sites assessed as higher risk (determined as part of our initial assessment, and as per the consolidated CBA summary in Table 27), namely Broomin Green, Clay Lane, East Hyde, Hart Lane, Chertsey and North Mymms.

- R&D of PFAS treatment options - Research and Development Pilot Trials to investigate effectiveness of alternative solutions recommended specifically for PFAS removal.

- Catchment Management Option CM4, as previously described.

- Enhanced Monitoring to provide relevant information required by DWI.

Meeting Affinity Water's Outcomes

The requirement for this investment is to meet the commitments set out in our Strategic Direction Statement to "Deliver what our customers need, ensuring affordability for all," which encompasses "Exceed[ing] customers' expectations for drinking water," and to "Be prepared for change and resilient to shocks and stresses".

The primary performance commitment relevant to this business case is unplanned outage, as a water treatment works will be turned off and taken out of operation if the concentration of PFAS chemicals is too high for us to be able to adequately ensure we can meet water quality regulations at consumer properties.

The secondary performance commitment linked to this business case is CRI (compliance risk index). By investing in treatment solutions, we are ensuring that we are safeguarding water quality for our consumers, now and in the future, in the most cost-efficient way.

Justification of the Preferred Option

General Approach Commentary

As part of our initial assessment, we confirmed that treatment options are still being developed and that we need to continue to carry out catchment investigations and further sampling to further assess the risk.

The basis of our assessment was around the significant risk of the DWI reducing the PFAS wholesomeness threshold to less than 0.01µg/L, corresponding to a significant risk of water supply interruption to customers in AMP8 and therefore the NPV assessments showing positive value.

Given the above, we believe site specific approaches are the best way to improve the quality of water supplies to our customers and these are detailed below:

New GAC Plants + Utilise Existing GAC plants with New PFAS-Specific Media

Where sites have existing GAC, exchanging of the GAC media will begin at the beginning of AMP8, enabling the localised reduction of the PFAS concentration in the final water to below 0.01µg/l. Given our existing infrastructure, the GAC solution is the best value option since it removes close to 100% of the risk and is not solely dependent on the operational status of any one on-site borehole to provide the blend to dilute the PFAS concentration.

Additionally, latest sample data shows that the concentration detected is gradually increasing (for most) or somewhat stable (Broomin Green). Although the concentrations are currently below 0.1 µg/l for those sites, they necessitate direct treatment to manage the risk longer term. The relatively low Opex costs associated with the GAC solution, alongside the significant NPV benefits which far outweighs that of the blending option, contribute to making the GAC solution the preferred option. This has therefore been assessed as the best value for money to deliver the required level of risk reduction.

Dual treatment for Tier 3 Sites [Bowring/Baldock Road, Blackford, Holywell and Wheathampstead]

Due to the unknown longevity and efficacy of GAC performance or Ion-exchange for PFAS removal, the highest risk Tier 3 sites were assessed as needing a dual stage treatment to ensure full compliance with the 0.01µg/l limit. Therefore new Ion-exchange plants with PFAS specific resin will be installed at Bowring/Baldock Road, Blackford and Holywell and GAC will be installed at Wheathampstead.

R&D (Roydon)

A R&D pilot trial from the beginning of AMP8, will allow further investigation of the effectiveness of alternative solutions recommended specifically for PFAS removal. The benefit will be an increased understanding of PFAS treatment, the flexibility to explore different methods based on site requirements and the potential development of alternative treatment options.

Enhanced Monitoring

Enhancement of current monitoring via further sampling, will improve our monitoring of trends and provide greater confidence in the decisions made as a result of those trends. Sampling in the distribution system greatly increases our chance to act quickly and effectively in the event increasing concentrations are observed, in which case blending controls will be considered. An example of this in practice is the recent emergence of PFAS at our Holmestone site that previously had not shown contamination and the implementation of blending with another source as a short-term mitigation.

CM4 - Included Risks and Benefits

Option CM4 of the catchment management options was chosen as the preferred option due to its benefits over the other options, as previously described. The risk of relying on option CM1 in-house delivery alone in that the locations selected for monitoring, or the installation of observation boreholes might not be accurate enough. As a result, costs might increase if more OBHs are subsequently required to improve this.

Understanding trends over time using further analysis of existing data sets and understanding of the hydrogeology of these groundwater catchment with source apportionment, much in the same way as was done for WINEP investigations nitrate modelling, will allow for more focused catchment investigations.

Given the karst nature of the Colne catchment, karst tracer testing accounted for in option CM3 will further our understanding of the surface water to groundwater connectivity in the catchment and in combination with the support for the wider Colne micropollutants study including PFAS, this will identify hotspot areas within the Colne catchment where PFAS might be an issue. Option CM3 allows for effective environmental monitoring based on source apportionment and trend analysis and further understanding of the chalk aquifer function and karst features to provide the most reliable catchment investigation results for the Action Plan and to inform further investments decisions in the future.

Option CM4 includes all the approaches in options CM1, 2 and 3 with the addition of creating a routine monitoring network of targeted sample location across the lower River Thames with the possibility of using existing partnerships, such as the proposed support offered to the Colne Catchment Action Network surface water project. This will provide some catchment intelligence for the River Thames abstractions; however the scale of the River Thames Basin and numbers of potential sources will remain a challenge.

A core part of this option would be using a reputable consultancy to carry out an urban PFAS modelling and investigation study. There are many historical and current sources of PFAS and concerns around sources such as landfills and sewage discharges and use in industry which need to be considered across the identified catchments. This work would be required to investigate historical usage and trends in PFAS as well as current industries and urban sources of PFAS. It would need to utilise multiple datasets to identify these risks which might include satellite imagery, remote sensing, publicly available GIS datasets and walkovers etc. The modelling should forecast trends in PFAS concentrations over time and generate risk maps showing hotspots across catchments which require further investigation and sampling. This will cover the additional groundwater sources identified outside of the Colne catchment bringing the total to 29 for Option CM4.

Two of the additional catchments relates to our sources in Kent and the proposal is a collaborative partnership approach with Southern Water and the EA which includes monitoring support, if viable.

Delivery Considerations

Related Projects

We have reviewed our AMP8 portfolio and identified the following related projects:

- Original PFAS PR24 business case:
    - Replacement of GAC is proposed at our Holywell site (project initiated in Year 4 of AMP7 through accelerated funding).
    - GAC contactors installed at Blackford and Baldock/Bowring sites.
    - Wheathampstead monitoring the concentration of PFAS compounds removed by the ion exchange plant for hexavalent Cr VI removal, research and development of PFAS specific ion exchange resin during AMP8.
- WINEP Sustainability Reductions: This project will need to be coordinated with Blackford turbidity and manganese treatment planned as part of AMP8 Investments.

Lessons Learnt

Replacement of the media in the GAC contactors at Holywell WTW with various media exchange during Year four and Year five of AMP7 will help establish a baseline for the efficacy of PFAS removal, regeneration, and bed life of the GAC treatment.

The requirement and journey to gain DWI Regulation 31 approval for the new Cr VI Ion-exchange resins at our Wheathampstead WTW during AMP7 has provided us with a deeper understanding of the challenges and obstacles involved in obtaining approval.

Delivery Risk Management

Phasing of each works will need to be planned and agreed with our GAC framework suppliers, preliminary discussions are currently ongoing. We have also begun internal assessment with our Capital Delivery, Asset Planning and Water Quality teams to prioritise sites discussed in this business case.

Continue to work with the DWI and other Water companies to improve the Regulation 31 approval process by actively participating in Water UK working groups.

Further detail regarding how we have ensured the deliverability of our full investment portfolio is provided within AFW 32 Deliverability of our Plans.

Monitoring and Reporting of Benefits

Our monitoring strategy for PFAS includes the monitoring of raw water sources and associated final waters on a risk-based approach. Sources in Tier 1 are sampled annually, sources in Tier 2 are below 50% of the wholesome standard and are monitored quarterly, those above 50% of the standard are sampled monthly and Tier 3 sources are sampled weekly, along with treated water sampling downstream of the blending points. Any additional monitoring sampling of in-process and final waters will be carried out when identified as necessary by our Water Quality services team.

DWI's expectations include a requirement to report on our progress annually and to provide a final report to the DWI on the efficacy of the remedial measures taken as part of the PFAS strategy by 30 April 2031. This will include evidence for closure for this scheme, appropriate documentation to confirm that the actions set out in this business case have been taken and that the company's PFAS strategy is in place.

Appendix 1 – Optioneering: Supporting Risk Scoring Assessment

Consolidated

Current State - Risk or Opportunity Quantification (of do nothing)

Named Service Risk	Risk or Opportunity Impact / Consequence (£)	Likelihood of Risk Materialisation	Risk / Opp Value (£)	Notes
Risk/Opportunity 1				
[Tier 2 Sites] Risk of PFAS WQ failure (> 0.01ug/l, as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).				
Batchworth	£2,124,490.02	0.33	£701,081.71	[Add]
Clay Lane	£2,124,490.02	1	£2,124,490.02	[Add]
Broomin Green	£2,124,490.02	0.9	£1,912,041.02	[Add]
Bulstrode	£2,124,490.02	0	£0.00	[Likelihood zero due to having no positive samples!]
Chorleywood	£2,124,490.02	0	£0.00	[Likelihood zero due to having no positive samples!]
Chertsey	£2,124,490.02	0.5	£1,062,245.01	[Add]
Hart Lane	£2,124,490.02	0.47	£998,510.31	[Add]
Digswell	£2,124,490.02	0	£0.00	[Likelihood zero due to having no positive samples!]
Dover Priory	£2,124,490.02	0.29	£616,102.11	[Add]
Holmestone	£2,124,490.02	0.25	£531,122.51	[Add]
East Hyde	£2,124,490.02	0.84	£1,784,571.62	[Add]
Egham	£2,124,490.02	0.21	£446,142.90	[Likelihood > 0 despite having no positive samples, since one of surface water sites]
Hunton Bridge	£2,124,490.02	0.02	£42,489.80	[Add]
Marlowes	£2,124,490.02	0.02	£42,489.80	[Add]
Mill End	£2,124,490.02	0.45	£956,020.51	[Add]
Northmoor	£2,124,490.02	0.8	£1,699,592.02	[Add]
North Mymms	£2,124,490.02	0.2	£424,898.00	[Add]
Roydon	£2,124,490.02	0.64	£1,359,673.61	[Add]
Stansted	£2,124,490.02	0.42	£892,285.81	[Add]
Iver	£2,124,490.02	0.36	£764,816.41	[Add]
Walton	£2,124,490.02	0.36	£764,816.41	[Add]
Watton Road	£2,124,490.02	0.06	£127,469.40	[Add]
Risk/Opportunity 1 Total			£17,250,858.96	

Current State - Risk or Opportunity Quantification (of do nothing)

Named Service Risk	Risk or Opportunity Impact / Consequence (£)	Likelihood of Risk Materialisation	Risk / Opp Value (£)	Notes
Risk/Opportunity 2				
[Tier 2 Sites] Unplanned Outage (as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).				
Batchworth	£403,874.31	0.33	£133,278.52	[Add]
Clay Lane	£403,874.31	1	£403,874.31	[Add]
Broomin Green	£403,874.31	0.9	£363,486.88	[Add]
Bulstrode	£403,874.31	0	£0.00	[Add]
Chorleywood	£403,874.31	0	£0.00	[Add]
Chertsey	£403,874.31	0.5	£201,937.15	[Add]
Hart Lane	£403,874.31	0.47	£189,820.92	[Add]
Digswell	£403,874.31	0	£0.00	[Add]
Dover Priory	£403,874.31	0.29	£117,123.55	[Add]
Holmestone	£403,874.31	0.25	£100,968.58	[Add]
East Hyde	£403,874.31	0.84	£339,254.42	[Add]
Egham	£403,874.31	0.21	£84,813.60	[Add]
Hunton Bridge	£403,874.31	0.02	£8,077.49	[Add]
Marlowes	£403,874.31	0.02	£8,077.49	[Add]
Mill End	£403,874.31	0.45	£181,743.44	[Add]
Northmoor	£403,874.31	0.8	£323,099.45	[Add]
North Mymms	£403,874.31	0.2	£80,774.86	[Add]
Roydon	£403,874.31	0.64	£258,479.56	[Add]
Stansted	£403,874.31	0.42	£169,627.21	[Add]
Iver	£403,874.31	0.36	£145,394.75	[Add]
Walton	£403,874.31	0.36	£145,394.75	[Add]
Watton Road	£403,874.31	0.06	£24,232.46	[Add]
Risk/Opportunity 2 Total			£3,279,459.37	

Affinity Water

Current State - Risk or Opportunity Quantification (of do nothing)

Named Service Risk	Risk or Opportunity Impact / Consequence (£)	Likelihood of Risk Materialisation	Risk / Opp Value (£)	Notes
Risk/Opportunity 3				
[Tier 2 Sites] Water supply interruption or low pressure (as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8 i.e. PFAS >				
Batchworth	£103,627,103.50	0.33	£34,196,944.16	[Add]
Clay Lane	£103,627,103.50	1	£103,627,103.50	[Add]
Broomin Green	£103,627,103.50	0.9	£93,264,393.15	[Add]
Bulstrode	£103,627,103.50	0	£0.00	[Add]
Chorleywood	£103,627,103.50	0	£0.00	[Add]
Chertsey	£103,627,103.50	0.5	£51,813,551.75	[Add]
Hart Lane	£103,627,103.50	0.47	£48,704,738.65	[Add]
Digswell	£103,627,103.50	0	£0.00	[Add]
Dover Priory	£103,627,103.50	0.29	£30,051,860.02	[Add]
Holmestone	£103,627,103.50	0.25	£25,906,775.88	[Add]
East Hyde	£103,627,103.50	0.84	£87,046,766.94	[Add]
Egham	£103,627,103.50	0.21	£21,761,691.74	[Add]
Hunton Bridge	£103,627,103.50	0.02	£2,072,542.07	[Add]
Marlowes	£103,627,103.50	0.02	£2,072,542.07	[Add]
Mill End	£103,627,103.50	0.45	£46,632,196.58	[Add]
Northmoor	£103,627,103.50	0.8	£82,901,682.80	[Add]
North Mymms	£103,627,103.50	0.2	£20,725,420.70	[Add]
Roydon	£103,627,103.50	0.64	£66,321,346.24	[Add]
Stansted	£103,627,103.50	0.42	£43,523,383.47	[Add]
Iver	£103,627,103.50	0.36	£37,305,757.26	[Add]
Walton	£103,627,103.50	0.36	£37,305,757.26	[Add]
Watton Road	£103,627,103.50	0.06	£6,217,626.21	[Add]
Risk/Opportunity 3 Total			£841,452,080.46	

Affinity Water

Current State - Risk or Opportunity Quantification (of do nothing)

Named Service Risk	Risk or Opportunity Impact / Consequence (£)	Likelihood of Risk Materialisation	Risk / Opp Value (£)	Notes
Risk/Opportunity 4				
[Tier 3 Sites] Risk of PFAS WQ failure (> 0.01ug/l, as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).				
Blackford	£288,497.04	0.10	£28,849.70	[Add]
Bowring/Baldock Road	£288,497.04	0.10	£28,849.70	[Add]
Holywell	£288,497.04	0.10	£28,849.70	[Add]
Wheathampsted	£288,497.04	0.25	£72,124.26	[Add]
Risk/Opportunity 4 Total			£158,673.37	

Affinity Water

Current State - Risk or Opportunity Quantification (of do nothing)

Named Service Risk	Risk or Opportunity Impact / Consequence (£)	Likelihood of Risk Materialisation	Risk / Opp Value (£)	Notes
Risk/Opportunity 5				
[Tier 3 Sites] Unplanned Outage (as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8, i.e. PFAS > 0.01).				
Blackford	£142,056.29	0.10	£14,205.63	[Add]
Bowring/Baldock Road	£142,056.29	0.10	£14,205.63	[Add]
Holywell	£142,056.29	0.10	£14,205.63	[Add]
Wheathampsted	£142,056.29	0.25	£35,514.07	[Add]
Risk/Opportunity 5 Total			£78,130.96	

Affinity Water

Current State - Risk or Opportunity Quantification (of do nothing)

Named Service Risk	Risk or Opportunity Impact / Consequence (£)	Likelihood of Risk Materialisation	Risk / Opp Value (£)	Notes
Risk/Opportunity 6				
[Tier 3 Sites] Water supply interruption or low pressure (> 0.01ug/l, as a result of the DWI tightening limits of non-wholesome levels down to Tier 2 limit in AMP8,				
Blackford	£1,104,567.65	0.10	£110,456.76	[Add]
Bowring/Baldock Road	£1,104,567.65	0.10	£110,456.76	[Add]
Holywell	£1,104,567.65	0.10	£110,456.76	[Add]
Wheathampsted	£1,104,567.65	0.25	£276,141.91	[Add]
Risk/Opportunity 6 Total			£607,512.21	

Appendix 2 – Preferred Option Costs

Preferred Option Costs (£m)		
	AMP8 Capex	AMP8 Opex
GAC	£68.00	£0.66
Ionex	£31.05	£0.83
Analysis	£0.17	£0.89
Catchment		£1.28
R&D	£1.50	
Allowance for Site Specifics	£33.24	
Total	£145.45	£3.66
Total Totex		**£149.12**