PR24

Cost Adjustment Claim: Ongoing P removal operating expenditure in AMP8, resulting from AMP7 WINEP investment

Document Reference ID: UUW_CAC_003

9 June 2023

A cost adjustment claim that seeks to reflect the higher ongoing operating expenditure that UUW will incur due to AMP7 environmental obligations

United Utilities

Water for the North West

Contents

Cost Adjustment Claim Submission

Cost Adjustment claim submission	
Title:	Ongoing phosphorus removal operating expenditure in AMP8, resulting from AMP7 WINEP investment (£85.2m)
Price Control:	Wastewater network plus
Cost adjustment headline:	The AMP7 WINEP requires UUW to comply with phosphorous removal permits at or near the technically achievable limit – less than or equal to 0.5mg/l – at 43 of our WwTWs. The operating expenditure associated with ongoing compliance at these sites is material and will not be reflected in the historical cost record used to inform the efficient benchmark. Therefore, UUW requires an uplift of £85.2m to its costs to facilitate ongoing compliance with its legal obligations.
Description:	The AMP7 WINEP includes 78 new phosphorus removal requirements. Of these, 43 include permit limits of 0.5mg/l or less, which requires a step change in technology compared with historic schemes. The AMP7 P removal programme is reflected within APR table 7F. Complying with P consents at or near the technically achievable level requires substantially higher quantities of chemicals (with the marginal impact of a unit of ferric diminishing in effect as P removal nears the technically achievable level) and additional processes. This acts to increase operating costs significantly relative to those seen historically. This increase in operating costs will not be reflected in the modelled allowance for AMP8. Ongoing operating expenditure relating to the majority of schemes will not start to be incurred until the final year of AMP7, which means this expenditure will not feed through into the efficient benchmark. Therefore, an out-of-model adjustment is required. Ofwat’s acceptance of this claim would enable UUW to recover the efficient costs associated with compliance with its statutory obligations under the AMP7 WINEP.

1. Cost adjustment case summary

Gate	Summary	Location reference
Need for cost adjustment	• The AMP7 WINEP requires UUW to comply with phosphorous removal permits at or near the technically achievable limit – less than 0.5mg/l – at 43 of our WwTWs. Meeting these standards requires substantial volumes of chemicals and/or the installation of new, additional treatment processes. This will drive additional operating costs, materially higher than those incurred historically, for the following reasons:	*3.1*
	– More load needs to be removed and therefore more iron is required to precipitate it. The quantities of iron required to meet standards below 1mg/l are significantly higher than for standards of 1mg/l and higher;	*3.3*
	– A greater quantity of iron is required to remove each mole of phosphorus below 1mg/l than is required above 1mg/l; and	
	– Higher quantities of iron requires an alkalinity correction, particularly where waters are soft. This prevents acidity having an undue effect on subsequent processes and assets.	
	• Where appropriate and economic, UUW is seeking to mitigate these higher costs by delivering phosphorous reductions through innovative interventions. For example: – through nutrient catchment balancing in the River Petteril catchment; – through the River Irwell flexible phosphorus permit; – through catchment permit balancing at Bowdon and Macclesfield WwTW; – through biological nutrient removal at our Nereda plants; and – through installation of biological nutrient removal using mobile organic biofilm (MOB) technology at Macclesfield WwTW.	*3.2*
	• Despite UUW's best efforts at mitigation, the AMP7 WINEP will result in materially higher ongoing costs than seen historically. As the modelled cost benchmark is based upon the historical cost record, the higher ongoing costs associated with P removal at/near the technically achievable limit will not be reflected within the modelled allowance. This is demonstrated by reference to companies' APR22s, which show that the majority of ongoing opex relating to AMP7 WINEP P removal will be incurred from 2024-25 onwards.	*3.4*
Cost efficiency	• We derive our claim value using APR table 7F, which is due to be published as part of UUW's 2022-23 APR. We supply a copy of this table alongside this claim, ahead of its publication in July 2023.	*4.2*
	• This year's APR represents a more mature view of ongoing opex than that first published in last year's APR. This year's APR is based upon the final operating plans of each project, whereas last year's was largely based upon best expectations at the time of our PR19 business plan submission. Over time, the delivery route of our programme has matured. This has resulted in higher expected costs than those set out in APR22. We evidence the difference in cost across each of our sites as part of this claim.	*4.2* *Table 4*

	• We would support the use of 7F data to identify an efficient benchmark for P removal opex, subject to the data being robust and of high quality. However, this data was not available to UUW at the time of this submission.	*4.1*
Need for investment	• We do not consider this gate to be applicable to this claim because the claim relates to higher ongoing expenditure due to our AMP7 WINEP.	*5.1*
Best options for customers	• We engaged extensively with the Environment Agency in the lead up to PR19 to appropriately shape the AMP7 WINEP. • We implemented a comprehensive optioneering process to ensure we implemented the most efficient and effective solution. We identified the most cost effective way of meeting the future permit requirements by following the high level solution hierarchy, which demonstrates we only implement relatively expensive solutions when absolutely necessary: (1) Do nothing (2) Operations and Maintenance (3) Optimise Asset (4) Partnership/catchment solution (5) Refurbish asset (6) New asset • Customer research clearly demonstrates that customers support continued compliance with environmental obligations.	*3.2* *6.1* *6.1* *6.1* *6.2*
Customer protection	• Customers are protected by the following ODIs in AMP8: (1) Discharge Permit Compliance (2) River Water Quality (Phosphorus) • UUW is liable to prosecution if it does not meet its environmental obligations.	*7.1*

2. Introduction

2.1.1 Phosphorus is a nutrient which is essential to life and as such, is found in high concentrations in wastewater. However, if too much phosphorous is released into the environment within the final effluent from a wastewater treatment works (WwTW), its nutritional properties can cause excessive plant or algae growth and lead to an alteration of the ecosystem from the natural state. It can also cause blue-green algal blooms in some waterbodies, which can prevent people and animals from using the waterbody and can damage the wider ecology of the habitat.

2.1.2 Reducing the concentrations of phosphorus in the final effluent reduces the risk of adverse environmental impacts. The AMP7 WINEP requires us to meet new low phosphorous limits at many treatment works in order to meet the targets of the Water Framework Directive.

2.1.3 Following the national phosphorus removal trials[1], the technically achievable limit for phosphorus was set by the Environment Agency at 0.25mg/l. The AMP7 WINEP includes 43 permit limits less than 0.5mg/l, which require a step change in technology compared with schemes that have been delivered historically. Of these, 16 permits limits are at the boundary of technical feasibility at 0.25mg/l. 39 of these schemes are due for completion in December 2024, of which 14 are at the technically achievable limit (the scheme at Kendal WwTW has a March 2025 regulatory date).

2.1.4 Chemical solutions are the most common intervention because they tend to have the lowest whole-life cost. However, we are seeking to deliver phosphorous reductions through innovative interventions where appropriate and economic. For example:

- Through nutrient catchment balancing in the River Petteril catchment;
- Through the River Irwell flexible phosphorus permit;
- Through catchment permit balancing at Bowdon and Macclesfield WwTW;
- Through biological nutrient removal at our Nereda plants; and
- Through installation of biological nutrient removal using mobile organic biofilm (MOB) technology at Macclesfield WwTW.

2.1.5 Meeting phosphorous permit limits at or near the technically achievable limit is a relatively new requirement for water companies. This means that the industry has not incurred the associated costs in the past and that the historical record used to inform the cost benchmark will not be reflective of future expenditure requirements. Therefore, a cost adjustment is required to enable the industry to meet its statutory obligations as set out in the WINEP.

2.1.6 We note that Ofwat has raised the possibility of using APR data to benchmark efficient ongoing phosphorous removal opex. While consistent and robust data was not available to UUW at the time of writing this claim, we would support the use of data in table 7F as part of a benchmarking exercise.

2.1.7 This document sets out the evidence to support our proposed cost adjustment relating to the higher ongoing costs we will incur as a result of the WINEP programme in AMP7. Specifically, we are only seeking the efficient costs incurred within AMP8 relating to meeting permit limits less than or equal to 0.5mg/l established as part of the AMP7 WINEP.

2.2 Outline of this document

2.2.1 We have divided our cost adjustment claim into the following sections:

a) Section 3 provides an overview of the need for this cost adjustment, explaining the Water Industry National Environment Programme at PR19 and the inclusion of very low phosphorus permit limits.

[1] UKWIR (2018) *The National Chemical Investigations Programme 2015-2020, Volume 3 wastewater Treatment Technology Trials; Annex – CIP2 P Trails Innovation results synthesis report.* Available here

The operation of wastewater treatment works to these very low permit requirements is not reflected in the historical data set or within the cost assessment framework so the modelled allowance will be insufficient to maintain our legal obligations to comply with these permit limits.

b) Section 4 provides evidence that our costs to maintain compliance with very low phosphorus limits are efficient and that all costs are derived from the regulatory reporting table 7F. We also evidence any changes in operating plans since the submission of our PR19 business plan. This is relevant because table 7F in the 2021-22 APR tended to be based upon the PR19 submission due to solutions not being fully mature at the time of last year's APR.

c) Section 5 sets out why the 'need for investment' test gate is not applicable to this claim. The cost pressure reflected within this claim is a result of the AMP7 WINEP, which represents an ongoing statutory obligation.

d) Section 6 sets out our approach to optioneering and optimising solutions to demonstrate we have considered a range of options for complying with the very low phosphorus permits, from 'do nothing' where we are able to balance permits across a catchment, to the installation of new assets.

e) Finally in Section 7 we explain how customers are protected if we are unable to comply with permits.

3. Need for adjustment

3.1 Unique circumstances

3.1.1 This claim does not primarily relate to differences in operating circumstances across company regions, however it does warrant a separate cost adjustment. The AMP7 WINEP included requirements to meet phosphorus permits at or near the technically achievable limit (below or equal to 0.5mg/l). Meeting phosphorus permits at this level is a new cost driver that isn't materially present in the historical period covered by the dataset. We expect all companies to incur additional operating expenditure relating to phosphorus removal projects set out in the AMP7 WINEP, meaning the industry as a whole requires an expenditure uplift, relative to historical levels.

3.1.2 However, UUW's region does have some features that mean the opex impact of the WINEP is more pronounced:

- Water in the North-West tends to be softer making it harder to balance the pH in the wastewater treatment process.
- Soft water is more acidic than hard water. The dosing of ferric for phosphorus removal further lowers the pH and therefore additional pH correction (in the form of caustic[2] dosing) is required to protect our assets from deterioration (for example, acidic effluent can erode concrete structures). This is particularly the case at sites with low ammonia permits as nitrifying bacteria are sensitive to pH. The nitrifying bacteria consume ammonia within the wastewater. Without appropriate conditions for these bacteria the ammonia permit at the wastewater treatment works is unable to be met. Correction is therefore needed post-ferric dosing to maintain effective denitrification.

3.1.3 Although we have a large number of stringent phosphorus permits within our AMP7 WINEP, UUW is not the only company impacted by the opex growth caused by phosphorus removal. All companies with low phosphorus permit limits are affected by ongoing phosphorus removal opex to some extent, although some companies may be more affected than others, depending upon their AMP7 environmental programmes.

3.1.4 The WINEP is a statutory obligation which requires us to remove phosphorous in line with the permit limit. There are two main interventions available to companies: chemical solutions and biological solutions.

3.1.5 Chemical precipitation of phosphorus is the most common approach as it has the lowest totex whole life cost when it is the sole driver at a treatment works. The technology installed to achieve very low phosphorus permits (below 0.5mg/l) requires a significant amount of iron salts to precipitate the phosphorus as well as alkalinity correction to ensure there is no detrimental impact on the process or undue degradation of concrete structures.

3.1.6 Although biological treatment to remove phosphorus does have the potential for lower chemical operational costs, it does have a relatively high initial capital outlay. Where there are no other environmental drivers, investment in biological phosphorus removal is not the preferred solution as it has a higher whole life cost than chemical precipitation. Also, to robustly achieve the technically achievable limit of 0.25mg/l phosphorus, a chemical 'trim' plus tertiary solids removal may be needed in addition to the biological removal process. An additional challenge is that many of the low phosphorus permits in AMP7 are on smaller more rural sites, where the secondary treatment process tends to be trickling filters. However, creating the conditions for biological phosphorus removal would require an activated sludge process. Therefore a biological phosphorus removal process would require a complete rebuild of the secondary treatment process and therefore significantly greater capital costs.

[2] Caustic soda also known as sodium hydroxide or NaOH is an alkaline used for pH correction in wastewater treatment works

3.1.7 As we discuss in paragraph 3.2.5, we continue to seek innovative solutions to minimise associated costs, as evidenced by our involvement in a related Ofwat innovation fund project - alternatives to chemical dosing for phosphorus removal on small sites [3].

3.1.8 We discuss our approach to selecting the most efficient option in more detail in section 6.

3.2 Management control

3.2.1 The WINEP (Water Industry National Environment Programme) and its predecessor, the National Environment Programme (NEP), states what actions water companies must take to meet their environmental legislative requirements. The environmental policy that needs to be delivered through the WINEP is determined by the UK Government and identified through legislation such as Water Framework Directive and Urban Wastewater Treatment Directive. The WINEP defines the programme of actions required to meet statutory environmental obligations, non-statutory environmental requirements or delivery against a water companies statutory functions[4].

3.2.2 Detail of the UUW AMP7 phosphorus removal programme was set out within our PR19 business plan submission[5]. Throughout AMP7, our programme has matured and, with the agreement of the Environment Agency, our programme has evolved from that submitted at PR19 as we have explored innovative ways of delivering environmental improvements. The current view of the phosphorus removal programme is included in the regulatory reporting table 7F.

3.2.3 In developing our PR19 programme we engaged extensively with the EA in the lead up to PR19 and throughout AMP7 to ensure the WINEP delivers significant environmental improvements as efficiently as possible. However, while we have appropriately engaged with the EA to shape our WINEP to the extent possible, ultimately the WINEP is a statutory obligation with which UUW must comply.

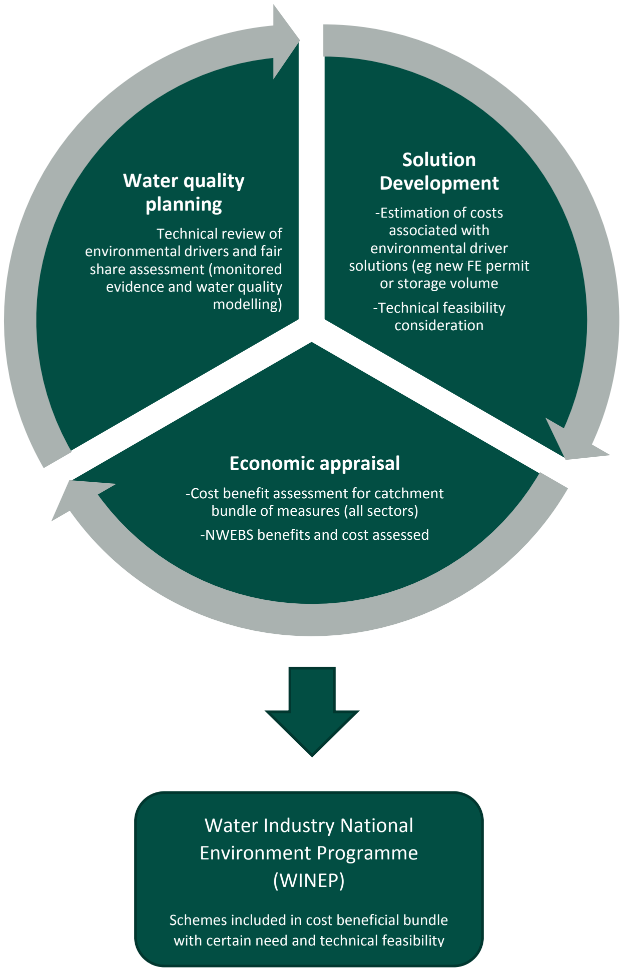
3.2.4 The process used for PR19 development illustrated in Figure 1 shows the cycle of engagement with the Environment Agency for solution development at PR19. Here we undertook a technical review of the environmental drivers and a fair share assessment which was used to develop the solution. We then carried out an economic appraisal which was critical at PR19 to ensure catchment bundles of measures were cost beneficial. The outputs of this were then shared back with the EA. Schemes identified as cost beneficial were included in the AMP7 WINEP, these had a confirmed need and were assessed as technically feasible.

[3] Ofwat (2022) *Alternative approaches to phosphorus removal on rural wastewater treatment works.* Available here

[4] Environment Agency (2022) *Water industry national environment programme (WINEP) methodology.* Available here

[5] UUW (2018) *Enhancement expenditure: WINEP - Phosphorus and sanitary determinands*. Available here

Figure 1 - Process used with the Environment Agency to ensure that requirements included in the AMP7 WINEP were appropriately justified



3.2.5 We have also sought to control costs in the following ways:

- We have trialled the use of ferric rich water treatment residuals (sludge) using those from Wybersley water treatment works, instead of virgin ferric salts to achieve phosphorus permits. Results of these trials so far have concluded that we were unable to achieve low phosphorus of 0.4mg/l at Knutsford, so an alternative solution at this site is needed, but we were able to achieve lower than the UWWTD permit of 2mg/l at Hazel Grove WwTW where this has now been implemented as the solution. We will continue to explore this approach to deliver further efficiencies. The use of water treatment sludge in this way is also a good example of circular economy.
- We have considered whether there are catchment offsetting opportunities with agreement of the Environment Agency to relax permit requirements at WwTW such as in the Petteril catchment[6]. We are also leading on an Ofwat innovation fund project looking into alternatives to chemical dosing for phosphorus removal on small sites. We will implement the learning from this within our AMP8 plans.
- We have explored and adopted permit balancing in agreement with the EA in the Bollin catchment. As part of this agreement, we accepted a tightening of the proposed permit at Macclesfield WwTW from 0.4mg/l phosphorus to 0.3mg/l which has allowed a no-build, and therefore, no additional opex, solution at Bowden WwTW.

[6] 7UU100007b Greystoke WwTW, 7UU100012b Motherby WwTW, 7UU200449b Southwaite incorporated into Project Eden Integrated Catchment (U.80061540)

- We have followed a risk and value approach for the solution development through AMP7. This process is aimed at positively challenging our projects to ensure we have sufficient evidence behind decisions. It provides us with confidence that solutions are correct and maximises the value for customers from investments. This comprises three stages:
  - RV0 Verify requirements: What is the purpose of the scheme?
  - RV1 Asset review: What are the current issues?
  - RV2 Solution and cost review: Does the solution meet the requirement?

3.2.6 An example of this process driving efficiency is where, following the optimisation of chemical dosing at sites such as Bury WwTW and Rochdale WwTW, we have not required the installation of a tertiary solids removal process despite the solution meeting the requirement.

3.2.7 We work extremely hard to control our chemical costs. Our procurement teams have worked extensively with suppliers and along with the other WaSCs have shared our predicted volumes for these chemicals with the chemical manufacturers so that they have visibility to increase their production capacity. As a result of this process, all three UK ferric sulphate manufacturers have built or are building new production facilities to meet the increasing demand from the water industry. The last exercise to get the latest UK's forecasted AMP7 and AMP8 volumes was submitted on 12th May 2023 and the industry is meeting again in early June. Following this meeting we will be supplying a further update to the manufacturers again. We have also had several meetings with Water UK on this matter.

3.2.8 Prior to confirming our ferric sulphate strategy we issued a PIN (Periodic Indicative Notice) to the market to ask the manufacturers how we can get the best overall package for ferric sulphate, for example, through longer-term contracts or guaranteed volumes. We have used the manufacturers' responses to optimise our procurement strategy. [✄

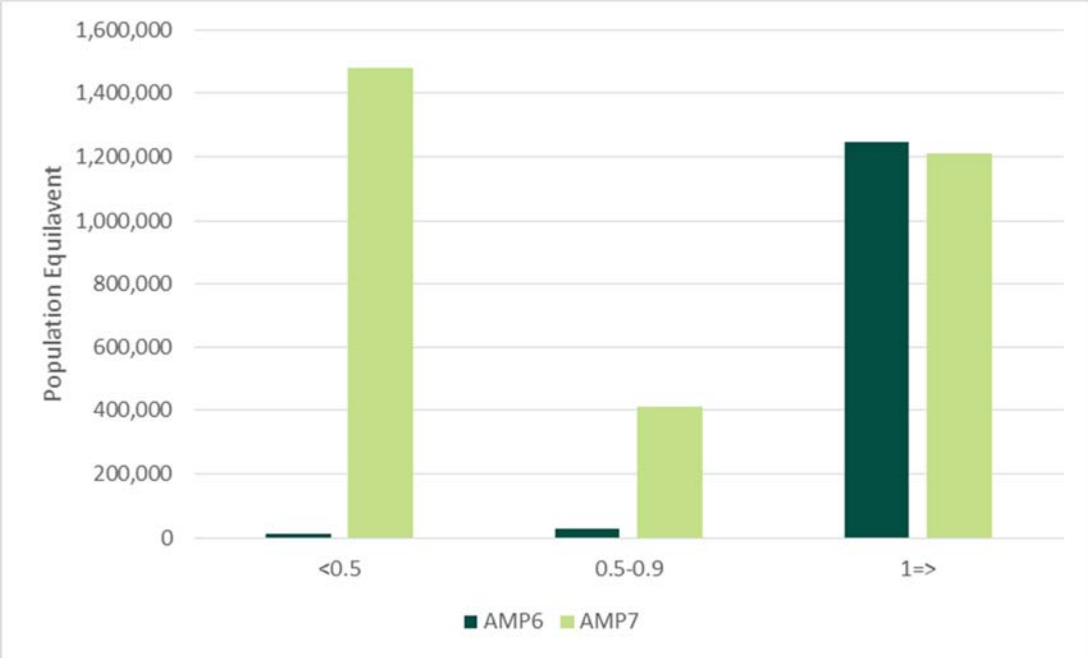
].

3.2.9 To control our caustic costs, we have framework agreements with three suppliers and will carry out mini-competitions for additional work up to twice per year. This approach helps to ensure that prices we pay remain competitive.

3.3 Materiality

3.3.1 Prior to AMP7 most phosphorus removal schemes across the industry were driven by the Urban Wastewater Treatment Directive which has comparatively relaxed limits of either 1 or 2mg/l. This means that historic costs are a poor indicator of the cost of many Water Framework Directive schemes as achieving lower permits requires a change in technology/process which is associated with higher ongoing operating costs. Figure 2 shows the step change in permit limits for UUW from those we held at the end of AMP6, usually 1 or 2mg/l to 39 permits at 0.5mg/l or below by the end of AMP7.

Figure 2 - Distribution of phosphorus permit standards currently compared with AMP7 permit limits (source: UUW internal permit database and APR table 7F)



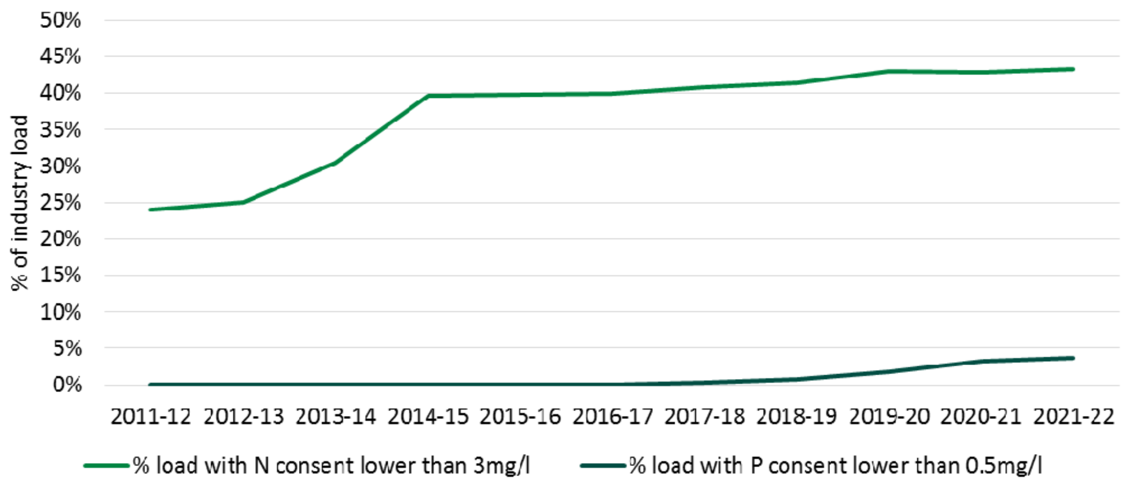
3.3.2 The implementation of solutions to meet phosphorus limits below 1mg/l in particular leads to a significant increase in operating costs. This is for three key reasons:

- More load needs to be removed and therefore more iron is required to precipitate it. The quantities required to meet standards below 1mg/l are significantly higher than for standards of 1mg/l and higher;
- Higher quantities of iron requires an alkalinity correction, particularly where waters are soft. This prevents acidity having an undue effect on subsequent processes and assets. If we fail to sustain alkalinity at adequate levels it leads to a risk of an adverse impact on the ammonia performance of the treatment works and/or degradation of the concrete structures. As iron dosing can make the effluent more acidic, without correction through caustic dosing we can also be at risk of not complying with the final effluent pH permit at sites. We have a significant number of sites with 1mg/l ammonia permits - for these, more alkalinity is needed in the chemical reactions to achieve the low ammonia limit. The need for alkalinity correction is heavily influenced by i) whether the water is soft and ii) the amount of iron salts used. As we have a predominance of soft waters in the North West and low phosphorus limits which require significant amounts of iron to be used, the extent of alkalinity correction is significant;
- The discharge of particulate matter must be kept to an absolute minimum as phosphorus will be associated with the solids and thus in most cases it is necessary to have a tertiary solids capture process in place. Solids management and capture is key in ensuring we comply with our iron permits.

3.4 Adjustment to allowances (including implicit allowance)

3.4.1 AMP7 was the first period in which companies have been required to meet stringent phosphorous permits at a large scale. Figure 3 shows at an industry level the percentage of load subject to i) an ammonia permit lower than 3mg/l and ii) a phosphorous permit lower than 0.5mg/l over the period covered by Ofwat's cost assessment dataset. It's clear that a significant proportion of the industry's load was subject to a relatively stringent ammonia permit and that this proportion has been relatively stable from AMP6 onwards. Importantly, there are almost no historical instances of load being subject to the stringent phosphorous permits now required as a result of the AMP7 WINEP – the percentage of load with a permit less than 0.5mg/l is zero for the majority of the historical period considered by the models. This means there is no meaningful correlation between the two and therefore we cannot assume that the ammonia variable acts as a proxy for phosphorus removal.

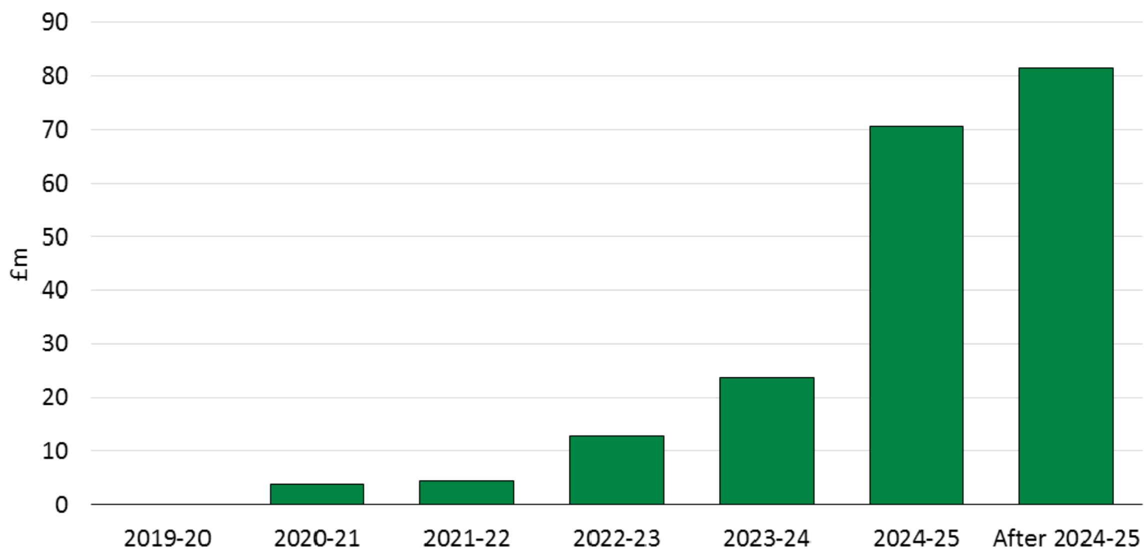
***Figure 3 - There is very little cost data in the historical dataset relating to stringent P consents* (source: UUW analysis using Ofwat's cost assessment dataset. Available here)**



3.4.2 The fact that there is no evidence within the historical dataset of companies meeting the AMP7 phosphorus permits means that the models will not make an appropriate allowance. This was recognised by Ofwat in its econometric model consultation[7]: *"We recognise that the additional ongoing cost associated with more stringent phosphorus removal programmes across the sector may not be fully captured in our proposed base cost models."*

3.4.3 Additionally, as Figure 4 illustrates, the majority of opex resulting from the AMP7 WINEP will start to be incurred towards the end of AMP7. This is too late for the models to be able to properly reflect higher ongoing opex in AMP8 – the last year of data Ofwat will have available at the time of the FD will be 2023-24 and it is clear that this year is not reflective of the ongoing opex companies will incur in AMP8.

Figure 4 – Industry operating expenditure from AMP7 Phosphorus removal projects (APR table 7F, 2021-22 return)



3.4.4 Finally, there is no crossover between phosphorus removal and ammonia removal. Removing each type of nutrient requires fundamentally different interventions. In fact, as discussed in section 3.3, implementing both ammonia and phosphorus removal can lead to operational challenges due to the

[7] Ofwat (2023) *Econometric base cost models for PR24*. Available here.

need to balance and optimise between the two chemicals and the resulting reactions within the treatment process. Therefore, the presence of ammonia removal activity within the historical dataset should not be assumed to provide any form of implicit allowance for phosphorus removal.

3.4.5 Therefore, we consider that it is clear Ofwat's models will not provide sufficient allowance for ongoing opex resulting from the AMP7 WINEP.

3.4.6 We have calculated the implicit allowance using opex data in table 7F. We used table 7F in APR22 to collect all companies' operating expenditure relating AMP7 WINEP P removal projects because this is the only data available to us at the time of writing this claim. This dataset is set out in Table 1. It would be appropriate to use an updated version of this table as newer years' of data becomes available.

Table 1 - P removal operating expenditure from Table 7F in APR22

Company	2019-20	2020-21	2021-22	2022-23	2023-24	2024-225	After 2024-25
ANH	0.000	2.387	0.177	1.420	6.516	10.588	12.266
HDD	0.000	0.000	0.000	0.000	0.010	0.043	0.043
NES	0.000	0.000	0.000	0.000	0.000	1.851	3.044
NWT	0.000	0.108	1.363	3.279	5.737	9.982	12.262
SRN	0.000	0.000	0.000	0.499	0.499	0.499	0.000
SVE	0.000	0.162	0.928	1.571	2.946	10.199	13.138
SWB	0.000	0.000	0.061	0.144	0.144	0.144	0.144
TMS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSH	0.000	0.865	1.010	1.230	1.420	2.640	3.120
WSX	0.000	0.450	0.944	4.259	4.431	5.302	5.885
YKY	0.000	0.000	0.081	0.412	2.112	29.256	31.589

3.4.7 We used Ofwat's recommended model suite, as set out in its 2023 consultation[8] and Ofwat's latest wastewater cost assessment dataset[9] to calculate a botex plus allowance for Wastewater Network Plus. We then subtracted the costs set out in Table 1 from sewage treatment botex plus and re-calculated the allowance using the same model suite and underlying cost data. The difference between these allowances is the implicit allowance for this claim.

Table 2 - Implicit allowance calculation

	2025-26	2026-27	2027-28	2028-29	2029-30	Total
Base comparator	443.07	442.18	441.29	440.39	439.49	2,206.43
Base comparator minus 7F	442.97	442.08	441.19	440.29	439.39	2,205.93
Implicit allowance	0.101	0.100	0.100	0.100	0.099	0.50

3.4.8 This suggests that the implicit allowance is £0.5m. We have deducted this from the gross claim value.

3.4.9 While this implicit allowance may appear small, we consider that this is entirely expected, given the lack of industry expenditure on P removal at sites with a permit less than 0.5mg/l in the period up to 2021-22, and is in line with the cost data set out in Table 1. For example, while UUW spent £1.363m on ongoing opex in 2021-22, the historical dataset covers 2011-12 to 2021-22, a period of 11 years. This means that UUW's expenditure of £1.363m in 2021-22 will receive a weight of 1/11 in the cost allowance, which equates to £0.12m a year (i.e. £1.363m divided by 11), which is roughly in line with our implicit allowance. This calculation assumes that UUW receives the full allocation of opex incurred in

[8] Ofwat (2023) *Econometric base cost models for PR24*. Available here.

[9] Available on Ofwat's website here.

2021-22, £1.363m, from the modelling process. However, the lack of a P removal cost driver which reflects 0.5mg/l within the recommended model suite[10] means that this £1.363m will not be allocated in full to UUW – other companies will likely receive a share. Therefore, while this calculation suggests that the £1.363m is contributing around £0.12m to UUW's allowance, in actual fact it is almost certainly contributing less than this.

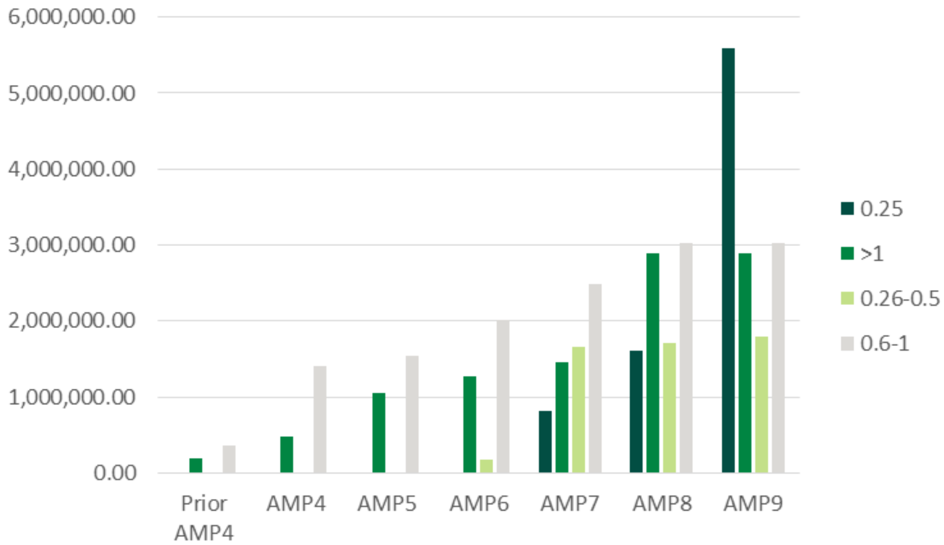
3.4.10 Therefore, we consider that our implicit allowance calculation is appropriate and robust.

3.4.11 UUW will not benefit from any offsetting circumstances related to this claim. This is because higher ongoing phosphorus removal opex represents an incremental cost pressure on UUW's existing cost base.

3.4.12 Higher ongoing phosphorus removal opex is an incremental cost, additional to the current cost base. Given the WINEP is a statutory obligation, it would be inappropriate to expect UUW to absorb associated ongoing opex as an efficiency challenge. Therefore, allowances are insufficient in the round to accommodate the factor.

3.4.13 UUW will not be able to balance this additional expenditure over the long-term because ongoing opex cannot be expected to reduce in future. We can see this through the development of the AMP8 WINEP where there is currently a requirement to improve an additional 22 sites, increasing the population equivalent to 1.6 million meeting a 0.25mg/l phosphorus limit within AMP8. Due to the requirements of the Environment Act an additional 31 sites, increasing the population equivalent served by works with the technically achievable limit of 0.25mg/l to 5.5million, by 2038 (Figure 5).

Figure 5 - Population equivalent of WwTW with total phosphorus permits by AMP (Source: UUW internal data and draft WINEP at 2nd May 2023)



3.4.14 We do not use an alternative explanatory variable to value this claim. It would be inappropriate to value the claim by adding a phosphorus treatment complexity cost driver. This is because the ongoing costs of achieving the AMP7 permits is not fully reflected in the historical dataset (as demonstrated in Figure 3 above).

[10] We agree with Ofwat's decision not to use a treatment complexity driver reflecting P consents less than 0.5mg/l at PR24. The historical cost data may be better able to accommodate such a driver at PR29.

4. Cost Efficiency

4.1.1 We have valued our claim using Table 7F from the 2022-23 APR reporting year. At the time of submission, we do not have access to other companies' 2022-23 7F submissions, meaning we have not been able to benchmark our costs against the industry. We note that ongoing P removal opex is likely to be a cost driver for the majority of the industry. As such, we would support Ofwat's use of 7F data, as reported in companies' 2022-23 APR submissions, to identify an efficient benchmark for the sector.

4.2 How we calculated our claim value

4.2.1 Our claim value is derived from table 7F in the regulatory accounts. This table contains information on the opex, capex and cost drivers at each WINEP phosphorous removal project in AMP7. The cost driver information includes data on the population equivalent served, current permit limit and enhanced permit limit i.e. the permit limit in place once the project has concluded. Cost data is available for each year from 2019-20 to 2024-25 with a value reflecting ongoing expenditure after 2024-25.

4.2.2 Costs in 7F exclude business rates, which is appropriate because business rates are separately assessed as an un-modelled cost item. Where there are multiple drivers of expenditure, we have allocated costs proportionately to ensure that we only include costs related to P removal within the table.

4.2.3 Table 7F allows us to directly calculate the ongoing costs attributable to the P removal elements of UUW's AMP7 WINEP. We did this by summing the ongoing opex post-2024-25 for each scheme with an enhanced phosphorous permit equal to or less than 0.5mg/l. This shows that UUW will need to spend £87.64m over the course of AMP8 on phosphorous removal. We have appended table 7F and associated calculations to this claim.

4.2.4 We then applied a frontier shift assumption of 0.55% to calculate a post-frontier shift cost of £85.7m. We applied the frontier shift before subtracting the implicit allowance because the implicit allowance calculation includes frontier shift. We implement a slightly stronger frontier-shift challenge than the mid-point of the range Economic Insight identified in a study[11] it carried out on behalf of a consortium of companies. The range identified by Economic Insight was 0.3% to 0.7%, meaning the mid-point is 0.5% per year. We consider that the mid-point is justified because the frontier shift estimate produced by EU-KLEMS data is potentially subject to both upwards and downwards bias. There is a risk of downwards bias (i.e. the estimate being too low) due to question marks over the extent to which embodied technical change is reflected in the estimate. There is a risk of upwards bias (i.e. the estimate being too high) due to the presence of catch-up efficiencies within the EU-KLEMS data, the presence of which would produce a double count in the catch-up efficiency challenge. However, there is no robust way to quantify these opposing factors. Therefore, we consider the mid-point to be an appropriate and pragmatic estimate for frontier shift. We do not net off any Real Price Effects (RPEs) against the frontier shift challenge. We added an additional stretch to the mid-point to reflect the uncertainty inherent in estimation of the frontier shift, resulting in an overall frontier shift challenge of 0.55% per year.

4.2.5 We then subtracted the implicit allowance to calculate the net claim value of £85.2m. The implicit allowance calculation is described in section 3.4.

[11] Economic Insight (2023) *Productivity and frontier shift at PR24.* Available here.

Table 3 - How we calculated our claim value

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8
Ongoing opex at sites <=0.5mg/l	12.262	17.529	17.529	17.529	17.529	17.529	87.643
Frontier shift assumption	0.55%	0.55%	0.55%	0.55%	0.55%	0.55%	
Compounding frontier shift	0.55%	1.10%	1.66%	2.22%	2.78%	3.35%	
Efficient gross claim value	12.194	17.335	17.238	17.140	17.041	16.942	85.697
Implicit allowance		0.101	0.100	0.100	0.100	0.099	0.500
Net claim value		**17.234**	**17.137**	**17.040**	**16.942**	**16.843**	**85.196**

4.2.6 While 7F was published as part of last year's APR, the data quality was not sufficient to use in a robust benchmarking exercise as part of this claim. For example, companies appeared to take different approaches to filling in cost driver data, with some companies not reporting any cost driver information despite reporting expenditure at a project. We note that this appears to have been recognised by Ofwat because it recently carried out a data collection exercise that sought to improve data quality reported within 7F.

4.2.7 Additionally, it is also important to note that our expectations of ongoing opex costs following AMP7 have changed since last year's APR. While costs at some projects have come down, costs have generally increased within table 7F. This is because we have a much better understanding of the ongoing delivery at each site. Table 7F last year was largely based upon our expectations at the time we submitted the PR19 business plan. We set out the differences in delivery plans at a site level in Table 4. We note that this means that a benchmarking exercise using data from 7F published in APR22 would result in an unrealistically low view of ongoing opex requirements in AMP8.

4.2.8 As well as indicating the FY22 and FY23 table 7F ongoing operating costs and any variance, Table 4, Table 5 and Table 6 include the anticipated solution at PR19, on which the FY22 version of 7F was largely based. Table 4 shows project level information where there has been an increase in opex costs from PR19, Table 5 shows where the cost is not significantly varied and Table 6 shows where there is a decrease in opex cost.

4.2.9 These tables also include the current view of the solution for the sites and the updated operating costs from the most recent operating plan. Solutions identified for installation are the lowest whole life cost, most resilient option assessed using both the capital and ongoing operational cost using the solution hierarchy as discussed in section 6.1.

4.2.10 In some cases there is a significant variance (both above and below) the anticipated costs at PR19. The table has been split to show the schemes where there has been an increase in cost, those where the costs are not significantly varied and those where the anticipated opex is significantly below that estimated at PR19, the most significant of which is Blackburn WwTW where the solution of Nereda optimisation for biological phosphorus removal has reduced anticipated opex by over £1m per annum. This is not only from the change in solution e.g. where the addition of a pump would increase power costs, but also from a change in the anticipated quantity of chemicals required. This change is associated with the learning from the installation of more of these very low phosphorus solutions. At PR19 we had very little experience in maintaining such low permits and the operational cost of doing so, this experience is growing and we are reflecting this in operating plans and hence costs in table 7F.

Table 4 - Project level information regarding increases in ongoing costs (all costs stated in 2022-23 prices)

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061365	Burnley WwTW - WFD - AMP7	0.718	Installation of an additional primary settlement tank, integrated fixed film activated sludge (IFAS) process a cloth pile filter (Mecana), additional final settlement tank chemical dosing and storm storage. Not all elements of this are associated with the phosphorus removal requirement	1.841	1.122	Through solution development this has evolved to comprise an increase in flow to full treatment through the works to 1295l/s, an additional primary settlement tank, an interstage pumping station, Biomag for tertiary solids removal, surplus activated sludge thickening, final settlement tank refurbishment, chemical dosing, odour control and 12,000m3 storm storage.	Changes in solution increasing the flow through the works has led to an increased chemical dosing requirement, the interstage pumping station requires additional power, these are reflected in higher ongoing operational costs
U.80062052	Bolton WwTW	0.000	Bolton was not included in the original PR19 submission	0.757	0.757	Installation of chemical dosing for phosphorus removal	Late addition to programme not included in PR19 costs
U.80061381	Rossendale WwTW - WFD - AMP7	0.269	Installation of a cloth pile filter (Mecana) and chemical dosing to achieve low phosphorus	0.812	0.542	The solution has been updated to reflect the stretch permit requirement at this site. It has been assessed as not requiring the tertiary solids removal originally identified at PR19. Chemical dosing (Ferric Sulphate) point into the humus tank feed. Also additional sludge consolidation process capacity of at least 462m3 to supplement the existing capacity on site is included in the solution. A pumping station to supply the existing screens with washwater is also included in the solution	Cost increase from PR19 due to the rising costs of chemicals. This increase is not as high as expected.
U.80061943	Glossop WwTW - Q and X Requirements AMP7	0.365	Installation of a cloth pile filter (Mecana) and two stage ferric chemical dosing to achieve low phosphorus and alkalinity dosing. Also the addition of nitrifying trickling filters (NTF)	0.850	0.485	Through solution development the cloth pile filters (Mecana) and NTF were assessed as not being required. However the dosing for phosphorus removal and pH correction are required for the solution.	Changes in solution has led to an increased chemical dosing requirement and therefore higher costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061421	Leigh WwTW - WFD - AMP7	0.317	Installation of a cloth pile filter (Mecana) and chemical dosing	0.795	0.478	Through solution development the requirements to meet the revised permit are polymer, caustic and ferric chemical dosing, the installation of a floc tank with mixers to ensure good mixing of the chemical into the wastewater to allow for the most efficient phosphorus removal and installation of water quality instrumentation.	Changes in solution has led to an increased chemical dosing requirement and therefore higher costs
U.80061826	Chorley WwTW - WFD - AMP7	0.217	Installation of a cloth pile filter (Mecana) and chemical dosing	0.614	0.397	Chorley WwTW was part of a batch of schemes where the chemical dosing for phosphorus removal was delivered ahead of the regulatory date to give adequate time to assess the requirement for tertiary solids removal. There are 5 WwTW sites within the batch (Bury, Rochdale, Tyldesley, Worsley and Chorley)	Changes in solution have led to an increased chemical dosing requirement and therefore higher costs
U.80061379	Castleton WwTW - WFD - AMP7	0.001	Close Castleton WwTW and transfer flow to Rochdale WwTW through a pipeline	0.393	0.391	Through solution development the solution has been updated to an on-site solution rather than a close and transfer. The updated solution comprises an additional primary settlement tank, new activated sludge plant with integrated fixed film activated sludge (IFAS), two new final settlement tanks (FST) and three tertiary pile cloth filters. Installation of dual point ferric dosing and alkalinity dosing for pH correction	The significant change in solution from close and transfer to an on-site chemical dosing solution has led to an increase in operational costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061410	Holmes Chapel WwTW	0.070	Installation of a cloth pile filter (Mecana), secondary point chemical dosing and monitoring Instrumentation	0.417	0.346	Installation of new chemical delivery, storage, transfer and duel point dosing facilities for chemical phosphorus removal. Also new chemical storage and dosing facilities to provide caustic dosing for alkalinity adjustment. The solution also includes a new tertiary solids removal feed pumping station to transfer flows to the new FilterClear system for tertiary solids removal. A new potable water system to support new chemical area is also to be installed.	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs, tertiary solids removal process also requires an increase in power
U.80061413	Sandbach WwTW - WFD - AMP7	0.209	Installation of a cloth pile filter (Mecana) and duel point chemical dosing and alkalinity dosing for pH correction	0.539	0.329	Installation of a cloth pile filter (Mecana) and duel point chemical dosing and alkalinity dosing for pH correction	Increase in operating cost aligns with increase in chemical costs
U.80061948	Macclesfield WwTW - UWWTD & WFD - AMP7	0.263	Installation of a Nerada and chemical dosing	0.592	0.329	This solution includes a new inlet works, single point ferric dosing, new mobile organic biomass pumping station, new mobile organic biomass treatment process for biological phosphorus removal, new tertiary solids removal (pile cloth filters), new backwash return pumping station from the tertiary solids removal, new sludge treatment with polymer dosing, and disposal assets for surplus activated sludge, including use of the existing gravity belt thickeners to treat primary, chemical and imports sludge.	Changes in solution has led to an increased operational costs due to the additional power required for the mobile organic biofilm plant
U.80061409	Congleton WwTW - Ammonia - AMP7	0.162	Installation of cloth pile filter (Mecana) and chemical dosing	0.469	0.307	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061954	Whaley Bridge WwTW - Q and X Requirements - AMP7	0.295	Installation of cloth pile filter (Mecana) and chemical dosing	0.572	0.277	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061947	Knutsford WwTW - WFD Drivers - AMP7	0.162	Installation of dual point ferric dosing, alkalinity dosing and cloth pile filters (Mecana)	0.438	0.276	Installation of dual point ferric dosing, alkalinity dosing and cloth pile filters	Increase in operating cost aligns with increase in chemical costs
U.80061422	Westhoughton WwTW - WFD - AMP7	0.139	Installation of a cloth pile filter (Mecana) and chemical dosing	0.414	0.276	The solution includes the installation of duel point ferric dosing, alkalinity dosing and polymer dosing for sludge thickening, It also includes the installation of tertiary cloth filter plant and a sludge storage tank.	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs

Table 5 - Project level information regarding low level changes in ongoing costs (all costs stated in 2022-23 prices)

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061411	Kidsgrove WwTW - WFD - AMP7	0.141	Conversion of the existing continuously operating upflow filter (COUF) to a BluePro process with chemical dosing points	0.339	0.198	The solution includes new primary dose ferric chloride pumps and additional ferric chloride dosing and storage rig to dose into the existing continuously operated upflow filter (COUF) feed. Also a new rapid pump mixing chamber pre primary settlement tanks and a new air mix and flocculation chamber post COUF feed pump station to ensure good mixing of ferric with the wastewater flow into the COUF. We are also using 'sand cycle' to give insight into the current operation of the sand filters to gain understanding ahead of refurbishment	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs
U.80061397	Alderley Edge WwTW - WFD & UWWTD P Removal AMP7	0.177	Installation of cloth pile filter (Mecana) and chemical dosing	0.372	0.196	New chemical dosing and storage facilities, new flocculation tank, new final settlement tank, new filter clear (tertiary solids removal), new sludge storage and odour control	Increase in operating cost aligns with increase in chemical costs
U.80061424	Helsby WwTW - Q - AMP7	0.096	Installation of chemical dosing and BluePro	0.287	0.191	Reduction in the permitted dry weather flow at Helsby has allowed a more relaxed phosphorus permit limit of 0.45mg/l. Although below 0.5mg/l the tertiary solids removal is not required at this site to achieve this revised permit limit. The solution now comprises ferric dosing.	Increase in operating cost aligns with increase in chemical costs
U.80061425	Tarvin WwTW - WFD P Removal AMP7	0.095	Installation of cloth pile filter (Mecana) and chemical dosing	0.241	0.146	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061418	Glazebury WwTW - WFD - AMP7	0.127	Installation of cloth pile filter (Mecana) and chemical dosing	0.271	0.144	The new works at Glazebury will comprise polymer, caustic and ferric dosing a floc tank with mixers to ensure adequate mixing of the wastewater with the ferric and water quality instrumentation.	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061408	Biddulph WwTW - WFD - AMP7	0.111	Installation of cloth pile filter (Mecana) and chemical dosing	0.250	0.139	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061956	Saddleworth WwTW	0.108	Installation of chemical dosing, refurbishment of the activated sludge plant and cloth pile filter (Mecana)	0.232	0.124	Installation of cloth pile filter, two point chemical dosing, percolating filters and intermediate settlement tank refurbishment	Increase in operating cost aligns with increase in chemical costs and duel point dosing
U.80061392	Bunbury WwTW - WFD Drivers - AMP7	0.039	Installation of two point ferric dosing and cloth pile filter (Mecana)	0.163	0.124	Installation of new chemical storage and dosing facilities to provide two-point ferric dosing for chemical phosphorus removal.	Increase in operating costs associated with increase in quantity of chemical dosed and increased chemical costs
U.80061407	Alsager WwTW - WFD Drivers - AMP7	0.160	Installation of tertiary ammonia removal, continuously operating upflow filters (COUF) for tertiary solids removal and chemical dosing	0.282	0.122	Installation of new ferric storage tank and dosing point, Caustic dosing and storage for alkalinity correction. New primary tank distribution chamber. Installation of a new moving bed biofilm reactor (MBBR) and associated pumping station and blowers. To ensure good mixing of the chemicals and the wastewater rapid mixing flocculation has also been installed. Instead of installation of a COUF as outlined at PR19, tertiary pile cloth filters have been installed to capture solids and a new sludge storage tank has been installed.	Increase in operating cost aligns with increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061393	Madeley WwTW WFD P AMP7	0.135	Installation of chemical dosing for phosphorus removal	0.240	0.104	Installation of new chemical storage, transfer and duel point dosing facilities for chemical phosphorus removal also new chemical storage and dosing facilities to provide Sodium Hydroxide dosing for alkalinity adjustment. Also the installation of new primary settlement tank de-sludge pumps and a new tertiary solids removal feed pumping station to transfer flows to the new Filterclear system for tertiary solids removal. New mixer upstream of the Filterclear plant for mixing ferric chloride with the wastewater.	Increase in operating cost aligns with increase in chemical costs
U.80061412	Lawton Gate WwTW - WFD - AMP7	0.155	Installation of dual point ferric dosing and alkalinity dosing for phosphorus removal and pile cloth filter (Mecana)	0.256	0.101	Installation of new chemical storage and dosing facilities for chemical phosphorus removal for dual point ferric chloride dosing also new chemical storage and dosing facilities to provide caustic dosing for alkalinity adjustment. Also a new tertiary solids removal feed pumping station to transfer flows to the new Filterclear system for tertiary solids removal.	Increase in operating cost aligns with increase in chemical costs
U.80061828	Worsley WwTW & Inlet - WFD - AMP7	0.060	Installation of cloth pile filters (Mecana) with additional ferric dosing and alkalinity dosing	0.153	0.092	Installation of cloth pile filter and chemical dosing (ferric and alkalinity)	Increase in operating cost aligns with increase in chemical costs
U.80061939	Chapel-en-le-Frith WwTW - WFD - AMP7	0.134	Installation of dual point ferric dose with refurbishment of the pH alkalinity dosing and installation of cloth pile filters (Mecana)	0.225	0.091	The solution comprises a new inlet works, duel point ferric dosing, modifications to the alkalinity dosing and the installation of a tertiary cloth pile filter.	Increase in operating cost aligns with increase in chemical costs
U.80061415	Mere Brow WwTW - WFD - AMP7	0.057	Installation of cloth pile filter (Mecana) and chemical dosing	0.139	0.083	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061399	High Legh WwTW - WFD Drivers - AMP7	0.020	Closure of High Legh WwTW and transfer of flows to Bowden WwTW	0.102	0.082	A change in solution to on-site treatment rather than a close and transfer. This comprises of new submerged aerated filter (SAF), chemical dosing (ferric and alkalinity correction) and cloth pile filters for tertiary solids removal	Changes in solution from a close and transfer to an on-site chemical phosphorus removal solution has led to an increased chemical dosing requirement and therefore higher costs
U.80061395	Tarporley WwTW - WFD P Removal AMP7	0.069	Installation of cloth pile filters (Mecana) with pre-filter ferric dosing	0.149	0.081	Current solution is the installation of cloth pile filters with pre-filter ferric dosing	Increase in operating cost aligns with increase in chemical costs
U.80061945	Mossley WwTW	0.069	Installation of new final settlement tanks, chemical dosing for phosphorus removal, cloth pile filters (Mecana) for tertiary solids removal and new storm tank	0.146	0.078	Installation of new final settlement tanks, chemical dosing for phosphorus removal, cloth pile filters for tertiary solids removal and new storm tank	Increase in operating cost aligns with increase in chemical costs
U.80061427	Waverton WwTW - WFD P Removal AMP7	0.033	Installation of chemical dosing and BluePro for tertiary solids removal	0.081	0.048	Installation of chemical dosing and BluePro for tertiary solids removal	Costs are not significantly different from PR19
U.80061405	Middlewich WwTW and Network - Supply Demand - AMP7	0.206	Refurbishment of existing continuously operating up flow filters (COUF) to provide BluePro Tertiary Treatment	0.247	0.042	Installation of new ferric and caustic dosing and a new sludge storage tank	Costs are not significantly different from PR19
U.80061420	Horwich WwTW - WFD - AMP7	0.255	Refurbishment of existing ferric dosing system and installation of cloth pile filter (Mecana)	0.287	0.032	Addition of Biomag proves for phosphorus removal, and caustic dosing for alkalinity correction.	Costs are not significantly different from PR19
U.80061371	Wilpshire WwTW - WFD Drivers - AMP7	0.109	Refurbishment of continuously operating upflow filter (COUF) to BluePRO and chemical dosing for phosphorus removal	0.117	0.007	Installation of ferric and caustic dosing for phosphorus removal	Costs are not significantly different from PR19
U.80061946	Kendal WwTW - WFD Drivers - AMP7	0.159	Installation of a cloth pile filter (Mecana) and dual point chemical dosing (ferric and caustic)	0.165	0.005	Optimisation of the Nereda for biological phosphorus removal	Costs are not significantly different from PR19
U.80061368	Barnoldswick WwTW - AMP7	0.318	Installation of cloth pile filter (Mecana) and new humus tank	0.323	0.005	Installation of cloth pile filter and new humus tank	Costs are not significantly different from PR19

Table 6 - Project level information regarding reductions in ongoing costs (all costs stated in 2022-23 prices)

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061942	Failsworth WwTW - WFD Phosphorous AMP7	0.090	Installation of a cloth pile filter (Mecana) after the Nereda	0.074	-0.016	Optimisation of the Nereda for biological phosphorus removal	Costs are not significantly different from PR19
U.80061948	Bowdon WwTW – WFD – AMP7	0.023	Chemical dosing for phosphorus removal	0.000	-0.023	Catchment permit balancing with Macclesfield WwTW has resulted in no work needed at Bowdon WwTW	Catchment permit balancing has resulted in no additional opex required at Bowdon WwTW
U.80061391	Audley WwTW - WFD Drivers - AMP7	0.312	Installation of a new Biological aerated flooded filter (BAFF), chemical dosing and a cloth pile filter (Mecana)	0.287	-0.024	Installation of new chemical dosing for phosphorus removal, an additional humus tank, new sludge storage, moving bed biofilm reactor (MBBR) and tertiary pile cloth filters	Costs are not significantly different from PR19
U.80061825	Rochdale WwTW	0.847	Installation of cloth pile filters (Mecana) for tertiary solids removal	0.781	-0.067	Revised solution does not include a tertiary pile cloth filter as it was not required. The chemical dosing has been replaced to achieve the new permit.	Changes in solution have led to reduced costs
U.80061404	Kingsley WwTW - WFD Drivers - AMP7	0.149	Installation of a new activated sludge plant and chemical dosing to meet the revised permit	0.024	-0.126	The solution comprises of moving bed biofilm reactor, chemical dosing and cloth pile filter	Changes in solution have led to reduced costs
U.80061824	Bury WwTW - ND - AMP7	0.694	Installation of cloth pile filters (Mecana) for tertiary solids removal	0.568	-0.126	Revised solution does not include a tertiary pile cloth filter as it was not required. The solution is chemical dosing only to meet the revised permit.	Changes in solution have led to reduced costs
U.80061941	Blackburn WwTW - WINEP Requirements - AMP7	1.188	Installation of cloth pile filters (Mecana) for tertiary solids removal	0.119	-1.069	Optimisation of the Nereda for biological phosphorus removal	Changes in solution have led to significant reduction in costs

4.3 The approach to our cost build has been assessed by a third party

4.3.1 We have sought external assurance from PwC for the methodology and information used to derive our claim value. An extract from PwC's report is provided below.

"As a result of the work performed, we can conclude that management has developed a detailed and logical methodology for producing each cost build and the approach followed to develop the cost estimates appears robust. We have undertaken detailed walkthroughs to understand the source of the cost data and rationale for assumptions and estimates made. We have not identified any priority actions which require attention in advance of the submission."

5. Need for investment

5.1.1 We do not expect that the 'need for investment' assessment is likely to be applicable to this claim. The cost pressure reflected within this claim is a result of the AMP7 WINEP, which represents a statutory obligation. The claim does not seek discrete additional cost allowances for discrete interventions but rather seeks to reflect that incremental ongoing operating expenditure is reflected within the cost allowance at PR24.

6. Best option for customers

6.1 Our AMP7 WINEP programme was informed by extensive optioneering

6.1.1 At PR19 we worked closer than ever before with the Environment Agency to challenge, agree and shape the content of the AMP7 WINEP programme in order to ensure it delivers significant environmental improvements as efficiently as possible. The engagement process with the Environment Agency that was used had three key elements – water quality planning, solution development and economic appraisal (see Figure 1) There was therefore a high degree of confidence that scheme would go ahead in AMP7. This has been the case, with only a small number of changes to the WINEP as the programme has matured.

6.1.2 As part of our scoping and solution development process at PR19 we introduced a risk and value (R&V) assessment across all our major projects which has supported better challenge of our expenditure requirements, including enhancements. This ensures that when we decide projects are necessary, we only do what we need to do, that our decisions are based on strong evidence, and the value to both business and customers is clear. The process ensures that we keep challenging and validating both the need for our projects and the way we deliver them. This process has continued through project development in AMP7 giving a robust framework to enhancement delivery.

6.1.3 This risk and value assessment ensures we identify the most cost effective way of meeting the future permit requirements by following the high level solution hierarchy:

(1) Do nothing

(2) Operations and Maintenance

(3) Optimise Asset

(4) Partnership/catchment solution

(5) Refurbish asset

(6) New asset

6.1.4 Where there is no existing phosphorus removal technology on a site this rules out many of the options as there is no existing treatment capability to be optimised or refurbished. Some sites do have current phosphorus removal capabilities, however the standards we are required to meet in AMP7, due to the Water Framework Directive, mean that additional treatment is required.

6.1.5 This then leads to the consideration of the most appropriate new asset or catchment solution. Where the phosphorus permit standard is above 1mg/l the preferred solution is generally chemical dosing as this is a proven technology. The relatively low capital costs of this technology make exploring biological phosphorus removal uneconomic as it would require significant changes to civil structures.

6.1.6 Where phosphorus limits are below 1mg/l we have explored a number of innovative technology options which combine dosing with iron salts and tertiary solids removal in order to meet both the phosphorus and iron permit limits. The phosphorus removal technology trials undertaken as part of the industry wide Chemical Investigations Programme 2 (CIP2)[12] provided the best source of evidence around the effectiveness of a range of phosphorus removal technologies which are aiming to achieve the low standards required to meet Water Framework Directive. As we have moved through AMP7 and our experiences of achieving these very low limits have increased we have been able to modify our approach from our learning. Where there is already tertiary solids removal at a WwTW we have reused this and optimised it as part of the project. Where we have assessed that there is a need for installation

[12] UKWIR, The National Chemical Investigations Programme 2015-2020, Volume 3 Wastewater Treatment Technology Trials.

of tertiary solids removal, we follow a robust process selection procedure to select the technology with the lowest whole life cost.

6.1.7 As mentioned in section 3.1, where biological phosphorus removal represents an economic option, we have pursued it. Examples of this are the Nereda at Kendal, Failsworth and Blackburn WwTW constructed for other environmental drivers defined in the AMP6 NEP. These sites are being optimised in AMP7 to maximise biological phosphorus removal to meet AMP7 WINEP requirements and drive down totex. We have one biological phosphorus removal site in AMP7 where we are installing mobile organic biofilm (MOB) at Macclesfield WwTW. This will be first time installation of this biological phosphorus removal technology in Europe.

6.1.8 The following table sets out some examples of schemes assigned to each level of hierarchy.

Table 7 – Examples of AMP7 WINEP projects within the hierarchy

Hierarchy	Project	Comment
Do nothing	Bowdon WwTW	Catchment permit balancing with Macclesfield WwTW has resulted in no work needed at Bowdon WwTW
Operations and maintenance	Bury WwTW	Focused maintenance and optimisation of existing assets has reduced the requirement to add additional assets
Optimise asset	Kendal WwTW	Optimisation of Nereda for P removal
Partnership/catchment solution	Eden integrated catchment project	Catchment offsetting to allow more relaxed limits at WwTW
Refurbish asset	Kidsgrove WwTW	We are using 'sand cycle' to give insight into the current operation of the sand filters to gain understanding ahead of refurbishment
New asset	Alderley Edge WwTW	New chemical dosing and storage facilities, new flocculation tank, new final settlement tank, new filter clear (tertiary solids removal), new sludge storage and odour control
	Macclesfield WwTW	Installation of mobile organic biofilm (MOB) for biological phosphorus removal

6.1.9 Nereda is process based on granular activated sludge; a novel way of treating wastewater (which has not otherwise changed for over 100 years). Nereda technology encourages biomass to form in granules, which are dense and compact in form. These 'granules' are heavy and settle much more quickly than conventional activated sludge which means the process needs a smaller footprint than conventional activated sludge. The compact nature of the granules also offers a significant advantage over the conventional processes as this allows different zones to develop of varying oxygen content. This allows treatment of different components of the sewage in the same process stage. Crucially one of these components is phosphorous.

6.1.10 When solutions for new permit limits are being designed our engineering teams use the UUW asset standards. These are guidance documents which are used to design solutions including both what needs to be constructed, but also the quantity of power and chemicals required to achieve various permit limits. As discussed in section 4.2.7 at PR19 we did not have the experience of low phosphorus permits that we have now and that learning is growing through this AMP and is reflected in our asset standards.

6.1.11 Within our asset standard for chemical phosphorus removal we have a table which details how the dosing rate for chemicals for the various limits of phosphorus and associated assets are calculated. This is used as a starting point, as sites do operate differently depending on assets and incoming phosphorus concentrations. As can be seen from Table 8 the molar ratio (how much chemical is required to remove the quantity of phosphorus) increases where a secondary dose is required pre-tertiary solids removal (TSR), this is used for permit limits <0.75mg/l for trickling filters (TFs) and <0.5mg/l for activated sludge plants (ASP). For example, a wastewater treatment works which has a trickling filter process and a permit of 0.25mg/l would require a molar ratio of between 4 and 6 before the primary settlement tanks and a molar ratio of between 8 and 12 before a tertiary solids removal process.

Table 8 - Chemical dosing for phosphorus removal design parameters for permit limits <0.75mg/l for trickling filters and <0.5mg/l for activated sludge plants. NOTE: 'P' refers to Total Phosphorus (Source: UUW internal asset standards)

Parameter		Typical Molar Ratio (Fe^{3+}:P)		Maximum Molar Ratio (Fe^{3+}:P)		Expected average Total P load removal (%)	
Secondary Treatment Stage		Activated sludge plant	Trickling Filter (or other)	Activated sludge plant	Trickling Filter (or other)	Activated sludge plant	Trickling Filter (or other)
Dose Location	Pre Primary settlement tanks	2	4	4	6	85	85
	Pre Secondary Treatment	2	Not Recommended	4	Not Recommended	90	Not Recommended
	Pre tertiary solids removal	8	8	12	12	90	90

6.1.12 Jar tests at the pre-design stage are performed on all projects to establish if chemical precipitation is feasible for the site and which chemical coagulant gives best performance. Jar tests replicate the wastewater treatment system at a much smaller scale using representative samples from the wastewater treatment works and testing the quantity of chemical needed to achieve the required permit levels. These tests are conducted under a range of flow conditions and influent phosphorus concentrations and also consider metal concentration and pH. The jar tests are used to indicate the required dose rate (in terms of molar ratio), but due consideration of the WwTW type is required. Jar tests establish if there is variability in the optimum dose and should have sufficient resolution to identify this accurately. Given the variability in accuracy of jar testing, the dosing equipment is designed to be able to dose between 50-200% of the optimum determined molar ratio for all flow conditions. For example, if jar testing determines that the optimum required molar ratio is 4, the dosing equipment shall be sized so that any molar ratio between 2 and 8 can be dosed under all flow and load conditions.

6.1.13 The designer determines the optimum dosing configuration for dual dosing systems, this is usually required for limits less than 1mg/l. This determination is based on the following factors:

- Dosing upstream of primary settlement tanks will give rise to a greater volume of sludge;
- The effect of increased suspended solids and BOD removal at the primary sedimentation stage on downstream biological processes;
- The need for and location of alkalinity dosing;
- The risk of metal carry-over; and
- Special design consideration are given to WwTWs with total influent phosphorus concentrations higher than typical domestic (10 mg/l).

6.2 Customer research indicates protecting the environment is a key priority

6.2.1 Research for the Drainage and Wastewater Management Plan and Water Resources Management Plan carried out in April 2021 showed that 21% of those customers surveyed ranked removal of wastewater in the top 3 greatest long term challenges. It was also noted that aspects such as maintaining the network and wastewater treatment are often fairly easy for people to envisage, but happen in the background. When asked what people themselves feel is important; ‘the impact on the environment is a constant concern’ and customers ‘love living in an area with lots of countryside and green space (perhaps heightened by Covid) and want this to be preserved’. We consider this to be evidence that customers support UUW’s continued compliance with its environmental obligations.

6.2.2 At PR19, through multiple pieces of research, customers demonstrated a strong preference to protect the environment from deterioration and 60% surveyed also support improvements in service to enhance river quality, the highest of any service area in our choice experiment (Willingness to Pay June 2017). As part of this research customers stated that of ten attributes which dictate their service priority choices, the cleanliness of rivers and lakes and the cleanliness of the sea ranked 3rd and 4th respectively. Additionally, when we conducted immersive research with customers discussing ecosystem services within the River Irwell catchment (August 2017), one of the most popular service areas for improvement was ‘A heathy river to support wildlife’ with 57% selecting a desire for improvements.

7. Customer Protection

7.1 Customers are protected through Ofwat's common PCs and EA enforcement

7.1.1 Within AMP8 customers are protected through the following ODIs:

- **Discharge permit compliance** - If we are unable to comply with our permits we will incur penalty under this ODI.
- **Improving river water quality P** – it is anticipated that the phosphorus reduction projects will be built into the baseline of this performance commitment, therefore if they are not delivered or not achieved the works will not achieve the required P load removal and we will incur an underperformance payment through this ODI.

7.1.2 The Environment Agency ensures that the environment is protected on behalf of customers and monitor performance of companies through the Environmental performance assessment (EPA) for treatment works compliance. If we fail to comply with permits at wastewater treatment works we will not achieve the current 99.0% compliance required as a core measure for EPA. If we fail to comply with this we are unable to achieve 4* within the EPA even if all other measures are green.

7.1.3 Consequences of phosphorus compliance failure include:

- **Prosecution and fines** – if we are consistently unable to achieve the required permit limits the resulting non-compliance may result in prosecution by the EA. If non-compliance is through deliberate actions by the company this is likely to influence the scale of any fines issued.
- **Reputational impact** – As discussed above, treatment works compliance is a core metric within the EPA, if we are unable to achieve 99.0% we are unable to achieve 4*rating. The 4* rating which we have achieved in two out of the past three years, builds trust with the Environment Agency, loss of this trust will lead to less support for innovative approaches to delivering environmental improvements.
- **Loss of trust** – If we are unable to comply with these very low phosphorus permits customers and stakeholders will lose their trust in us protecting the environment.

United Utilities Water Limited

Haweswater House
Lingley Mere Business Park
Lingley Green Avenue
Great Sankey
Warrington
WA5 3LP

unitedutilities.com

United Utilities

Water for the North West